# Physical and Chemical Data*

**Peter E. Liley, Ph.D., D.I.C.,** *School of Mechanical Engineering, Purdue University. (physical and chemical data)*

**George H. Thomson,** *AIChE Design Institute for Physical Property Data. (Tables 2-6, 2-30, 2-164, 2-193, 2-196, 2-198, 2-221)*

**D.G. Friend,** *National Institutes of Standards and Technology, Boulder, CO. (Tables 2-333, 2-334, Figs. 2-25, 2-26)*

**Thomas E. Daubert, Ph.D.,** *Professor, Department of Chemical Engineering, The Pennsylvania State University. (Prediction and Correlation of Physical Properties)*

**Evan Buck, M.S.Ch.E.,** *Manager, Thermophysical Property Skill Center, Central Technology, Union Carbide Corporation. (Prediction and Correlation of Physical Properties)*



* The contributions of J.K. Fink, Argonne National Laboratory; U. Grigull, Tech. Universität, Munich, Germany; and H. Sato, Keio University, Japan, are acknowledged.

## WATER-VAPOR CONTENT OF GASES



## DENSITIES OF PURE SUBSTANCES



## DENSITIES OF AQUEOUS INORGANIC SOLUTIONS



## DENSITIES OF AQUEOUS ORGANIC SOLUTIONS



## DENSITIES OF MISCELLANEOUS MATERIALS



## SOLUBILITIES



## THERMAL EXPANSION

## JOULE-THOMSON EFFECT



## CRITICAL CONSTANTS



## COMPRESSIBILITIES



## LATENT HEATS



## SPECIFIC HEATS OF PURE COMPOUNDS



## SPECIFIC HEATS OF AQUEOUS SOLUTIONS



## SPECIFIC HEATS OF MISCELLANEOUS MATERIALS



## HEATS AND FREE ENERGIES OF FORMATION



## HEATS OF COMBUSTION



## HEATS OF SOLUTION



## THERMODYNAMIC PROPERTIES

## TRANSPORT PROPERTIES



## PREDICTION AND CORRELATION OF PHYSICAL PROPERTIES

Considerations of reader interest, space availability, the system or systems of units employed, copyright considerations, etc., have all influenced the revision of material in previous editions for the present edition. Reference is made at numerous places to various specialized works and also, when appropriate, to more general works. A listing of general works may be useful to readers in need of further information.

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## TABLE 2-1 Physical Properties of the Elements and Inorganic Compounds*

Abbreviations Used in the Table

a., acid
A., specific gravity with reference to air = 1
abs., absolute
ac., acetic acid
act., acetone
al., 95 percent ethyl alcohol
alk, alkali (*i.e.,* aq. NaOH or KOH)
am., amyl ($C_5H_{11}$)
amor., amorphous
anh., anhydrous
aq., aqueous or water
aq. reg., aqua regia
atm., atmosphere or 760 mm. of mercury pressure
bk., black
brn., brown
bz., benzene
c., cold
cb., cubic
cc, cubic centimeter
chl., chloroform
col., colorless or white
conc., concentrated
cr., crystals or crystalline
d., decomposes
D., specific gravity with reference to hydrogen = 1
d. 50, decomposes at 50°C; 50 d., melts at 50°C with decomposition
delq., deliquescent
dil., dilute
dk., dark
eff., effloresces or efflorescent
et., ethyl ether
expl., explodes
gel., gelatinous
gly., glycerol (glycerin)
gn., green
h., hot
hex., hexagonal
hyg., hygroscopic
i., insoluble
ign., ignites
lq., liquid
lt., light
m. al., methyl alcohol
mn., monoclinic
nd., needles
$NH_3$, liquid ammonia
$NH_4OH$, ammonium hydroxide solution
oct., octahedral
or., orange
pd., powder
pl., plates
pr., prisms or prismatic
pyr., pyridine
rhb., rhombic (orthorhombic)
s., soluble
satd., saturated
sl., slightly
soln., solution
subl., sublimes
sulf., sulfides
tart. a., tartaric acid
tet., tetragonal
tr., transition
tri., triclinic
trig., trigonal
v., very
vac., in vacuo
vl., violet
volt., volatile or volatilizes
wh., white
yel., yellow
∞, soluble in all proportions
<, less than
>, greater than
42±, about or near 42
$-3H_2O$, 100, loses 3 moles of water per formula weight at 100°C

**Formula weights** are based upon the International Atomic Weights of 1941 and are computed to the nearest hundredth.

**Refractive index,** where given for a uniaxial crystal, is for the ordinary (ω) ray; where given for a biaxial crystal, the index given is for the median (β) value. Unless otherwise specified, the index is given for the sodium D-line (λ = 589.3 mμ).

**Specific gravity** values are given at room temperatures (15° to 20°C) unless otherwise indicated by the small figures which follow the value: thus, "$5.6^{\frac{18°}{4}}$" indicates a specific gravity of 5.6 for the substance at 18°C referred to water at 4°C. In this table the values for the specific gravity of gases are given with reference to air (A) = 1, or hydrogen (D) = 1.

**Melting point** is recorded in a certain case as "82 d." and in some other case as "d. 82," the distinction being made in this manner to indicate that the former is a melting point with decomposition at 82°C, while in the latter decomposition only occurs at 82°C. Where a value such as "$-2H_2O$, 82" is given it indicates loss of 2 moles of water per formula weight of the compound at a temperature of 82°C.

**Boiling point** is given at atmospheric pressure (760 mm. of mercury) unless otherwise indicated; thus, "$82^{15\ mm.}$" indicates the boiling point is 82°C when the pressure is 15 mm.

**Solubility** is given in parts by weight (of the formula shown at the extreme left) per 100 parts by weight of the solvent; the small superscript indicates the temperature. In the case of gases the solubility is often expressed in some manner as "$5^{10°}$ cc" which indicates that at 10°C, 5 cc. of the gas are soluble in 100 g. of the solvent. The symbols of the common mineral acids: $H_2SO_4$, $HNO_3$, HCl, etc., represent dilute aqueous solutions of these acids. See also special tables on Solubility.

REFERENCES: The information given in this table has been collected mainly from the following sources: Mellor, *A Comprehensive Treatise on Inorganic and Theoretical Chemistry,* Longmans, New York, 1922. Abegg, *Handbuch der anorganischen Chemie,* S. Hirzel, Leipzig, 1905. Gmelin-Kraut, *Handbuch der anorganischen Chemie,* 7th ed., Carl Winter, Heidelberg; 8th ed., Verlag Chemie, Berlin, 1924. Friend, *Textbook of Inorganic Chemistry,* Griffin, London, 1914. Winchell, *Microscopic Character of Artificial Inorganic Solid Substances or Artificial Minerals,* Wiley, New York, 1931. *International Critical Tables,* McGraw-Hill, New York, 1926. *Tables annuelles internationales de constants et donnes numeriques,* McGraw-Hill, New York. *Annual Tables of Physical Constants and Numerical Data,* National Research Council, Princeton, N.J., 1943. Comey and Hahn, *A Dictionary of Chemical Solubilities,* Macmillan, New York, 1921. Seidell, *Solubilities of Inorganic and Metal Organic Compounds,* Van Nostrand, New York, 1940.

| Name | Formula | Formula weight | Color, crystalline form and refractive index | Specific gravity | Melting point, °C | Boiling point, °C | Solubility in 100 parts | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Cold water | Hot water | Other reagents |
| Aluminum | Al | 26.97 | silv., cb. | $2.70^{20°}$ | 660 | 2056 | i. | i. | s. HCl, $H_2SO_4$, alk. |
| acetate, normal | $Al(C_2H_3O_2)_3$ | 204.10 | wh. pd. | | d. 200 | | s. | d. | |
| acetate, basic | $Al(OH)(C_2H_3O_2)_2$ | 162.07 | wh., amor. | | d. | | i. | | s.a.; i. $NH_4$ salts |
| bromide | $AlBr_3$ | 266.72 | trig. | $3.01^{\frac{25°}{4}}$ | 97.5 | 268 | s. | | s.al., act., $CS_2$ |
| bromide | $AlBr_3{\cdot}6H_2O$ | 374.82 | col., delq. cr. | | d. 100 | | s. | s. | s. al., $CS_2$ |
| carbide | $Al_4C_3$ | 143.91 | yel., hex., 2.70 | 2.95 | d. >2200 | | d. to $CH_4$ | | s. a.; i. act. |
| chloride | $AlCl_3$ | 133.34 | wh., delq., hex. | $2.44^{\frac{25°}{4}}$ | $194^{5.2atm.}$ | $182.7^{752mm}$; subl. 178 | $69.87^{15°}$ | s. d. | s. et., chl., $CCl_4$; i. bz. |
| chloride | $AlCl_3{\cdot}6H_2O$ | 241.44 | col., delq., trig., 1.560 | | | | 400 | v. s. | 50 al.; s. et. |
| fluoride (fluellite) | $AlF_3{\cdot}H_2O$ | 101.99 | col., rhb., 1.490 | 2.17 | d. | | sl. s. | | |
| fluoride | $Al_2F_6{\cdot}7H_2O$ | 294.05 | wh., cr. pd. | | $-4H_2O$, 120 | $-6H_2O$, 250 | i. | sl. s. | |
| hydroxide | $Al(OH)_3$ | 77.99 | wh., mn. | 2.42 | $-2H_2O$, 300 | | $0.000104^{18°}$ | i. | s. a., alk.; i. a. |
| nitrate | $Al(NO_3)_3{\cdot}9H_2O$ | 375.14 | rhb., delq. | | 73 | d. 134 | v. s. | v. s. d. | s. al., $CS_2$ |
| nitride | $Al_2N_2$ | 81.96 | yel., hex. | $3.05^{\frac{25°}{4}}$ | $2150^{4atm.}$ | d. >1400 | d. slowly | | s. alk. d. |
| oxide | $Al_2O_3$ | 101.94 | col., hex., 1.67–8 | 3.99 | 1999 to 2032 | | i. | i. | v. sl. s. a., alk. |
| oxide (corundum) | $Al_2O_3$ | 101.94 | wh., trig., 1.768 | 4.00 | 1999 to 2032 | 2210 | i. | i. | v. sl. s. a., alk. |
| phosphate | $AlPO_4$ | 121.95 | col., hex. | 2.59 | | | i. | i. | s. a., alk.; i. ac. |

*By N. A. Lange, Ph.D., Handbook Publishers, Inc., Sandusky, Ohio. Abridged from table of Physical Constants of Inorganic Compounds in Lange, "Handbook of Chemistry."

**TABLE 2-1 Physical Properties of the Elements and Inorganic Compounds** (*Continued*)

| Name | Formula | Formula weight | Color, crystalline form and refractive index | Specific gravity | Melting point, °C | Boiling point, °C | Solubility in 100 parts | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Cold water | Hot water | Other reagents |
| Aluminum (*Cont.*) | | | | | | | | | |
| potassium silicate (muscovite) | $3Al_2O_3{\cdot}K_2O{\cdot}6SiO_2{\cdot}2H_2O$ | 796.40 | mn., 1.590 | 2.9 | d. | | i. | | |
| potassium silicate (orthoclase) | $Al_2O_3{\cdot}K_2O{\cdot}6SiO_2$ | 556.49 | col., mn., 1.524 | 2.56 | 1450 (1150) | | i. | | |
| Aluminum potassium tartrate | $AlK(C_4H_4O_6)_2$ | 362.21 | col. | | | | s. | s. | |
| sodium fluoride (cryolite) | $AlF_3{\cdot}3NaF$ | 209.96 | wh., mn., 1.3389 | 2.90 | 1000 | | sl. s. | | i. HCl |
| sodium silicate | $Al_2O_3{\cdot}Na_2O{\cdot}6SiO_2$ | 524.29 | col., tri., 1.529 | 2.61 | 1100 | | i. | i. | d. a. |
| sulfate | $Al_2(SO_4)_3$ | 342.12 | wh. cr. | 2.71 | d. 770 | | $31.3^{0°}$ | $89^{100°}$ | |
| Alum, ammonium (tschermigite) | $Al_2(SO_4)_3{\cdot}(NH_4)_2SO_4{\cdot}24H_2O$ | 906.64 | col., oct., 1.4594 | $1.64\,\frac{20°}{4}$ | 93.5 | $-20H_2O$, 120; $-24H_2O$, 200 | $3.9^{0°}$ | $\infty$ 100° | i. al. |
| ammonium chrome | $Cr_2(SO_4)_3{\cdot}(NH_4)_2SO_4{\cdot}24H_2O$ | 956.72 | gn. or vl., oct., 1.4842 | 1.72 | 100 d. | | $21.2^{25°}$ | | s. al. |
| ammonium iron | $Fe_2(SO_4)_3{\cdot}(NH_4)_2SO_4{\cdot}24H_2O$ | 964.40 | vl., oct., 1.485 | 1.71 | 40 | | $124^{25°}$ | | i. al. |
| potassium (kalinite) | $Al_2(SO_4)_3{\cdot}K_2SO_4{\cdot}24H_2O$ | 948.76 | col., mn., 1.4564 | $1.76\,\frac{26°}{4}$ | 92 | $-18H_2O$, 64.5 | $5.7^{0°}$ | $\infty^{93°}$ | |
| potassium chrome | $Cr_2(SO_4)_3{\cdot}K_2SO_4{\cdot}24H_2O$ | 998.84 | red or gn., cb., 1.4814 | 1.83 | 89 | | 20 | 50 | i. al. |
| sodium | $Al_2(SO_4)_3{\cdot}Na_2SO_4{\cdot}24H_2O$ | 916.56 | col., oct., 1.4388 | $1.675\,\frac{20°}{4}$ | 61 | | $106.4^{0°}$ | $121.7^{45°}$ | i. al. |
| Ammonia† | $NH_3$ | 17.03 | col. gas, 1.325 (lq.) | $0.817^{-79°}$ 0.5971 (A) | −77.7 | −33.4 | $89.9^{0°}$ | $7.4^{96°}$ | $14.8^{20°}$ al.; s. et. |
| Ammonium acetate | $NH_4C_2H_3O_2$ | 77.08 | wh., hyg. cr. | 1.073 | 114 | d. | $148^{4°}$ | | s. al.; sl. s. act. |
| auricyanide | $NH_4CN{\cdot}Au(CN)_3{\cdot}H_2O$ | 337.33 | pl. | | d. 200 | | s. | v. s. | i. al. |
| bicarbonate | $NH_4HCO_3$ | 79.06 | mn. or rhb., 1.5358 | 1.573 | d. 35–60 | | $11.9^{0°}$ | $27^{30°}$ | i. al. |
| bromide | $NH_4Br$ | 97.96 | col., cb., 1.7108 | $2.327\,\frac{15°}{4}$ | subl. 542 | | $68^{10°}$ | $145.6^{100°}$ | s. al., et., act. |
| carbonate | $(NH_4)_2CO_3{\cdot}H_2O$ | 114.11 | col. pl. | | d. 58 | | $100^{15°}$ | | i. al., $CS_2$, $NH_3$ |
| carbonate, carbamate | $NH_4HCO_3{\cdot}NH_2CO_2NH_4$‡ | 157.11 | wh. cr. | | subl. | | $25^{15°}$ | $67^{65°}$ | |
| carbonate, sesqui- | $(NH_4)_2CO_3{\cdot}2NH_4HCO_3{\cdot}H_2O$ | 272.22 | wh. | | d. | | $20^{15°}$ | $50^{49°}$ | |
| chloride (salammoniac) | $NH_4Cl$ | 53.50 | wh., cb., 1.639, 1.6426 | $1.53^{17°}$ | d. 350 | subl. 520 | $29.4^{0°}$ | $77.3^{100°}$ | s. $NH_3$; sl. s. al., m. al. |
| chloroplatinate | $(NH_4)_2PtCl_6$ | 444.05 | yel., cb. | 3.065 | d. | | $0.7^{15°}$ | $1.25^{100°}$ | 0.005 al. |
| chloroplatinite | $(NH_4)_2PtCl_4$ | 373.14 | tet. | | d. | | s. | v. s. | |
| chlorostannate | $(NH_4)_2SnCl_6$ | 367.52 | pink., cb. | 2.4 | | | $33.3^{15°}$ | | |
| chromate | $(NH_4)_2CrO_4$ | 152.09 | yel., mn. | $1.917^{12°}$ | d. 180 | | $40.5^{30°}$ | d. | sl. s. act., $NH_3$; i. al. |
| cyanide | $NH_4CN$ | 44.06 | col., cb. | $0.79^{100°}$ (A) | 36 | | s. | v. s. | s. al. |
| dichromate | $(NH_4)_2Cr_2O_7$ | 252.10 | or., mn. | 2.15 | d. 185 | | $47.2^{30°}$ | v. s. | s. al.; i. act. |
| ferrocyanide | $(NH_4)_4Fe(CN)_6{\cdot}6H_2O$ | 392.21 | mn. | | d. | | s. | | i. al. |
| fluoride | $NH_4F$ | 37.04 | wh., hex. | | | | v. s. | d. | s. al.; i. $NH_3$ |
| fluoride, acid | $NH_4F{\cdot}HF$ | 57.05 | wh., rhb., 1.390 | $2.21\,\frac{12°}{12}$ | | | v. s. | | |
| formate | $HCO_2NH_4$ | 63.06 | col., mn., delq. | 1.266 | 114–116 | d. 180; subl. in vac. | $102^{0°}$ | $531^{80°}$ | s. al. |
| hydrosulfide | $NH_4HS$ | 51.11 | col., rhb. | | d. | subl. 120 | v. s. | | s. al. |
| hydroxide | $NH_4OH$ | 35.05 | in soln. only | | | | s. | | |
| molybdate | $(NH_4)_2MoO_4$ | 196.03 | mn. | 2.27 | d. | | d. | d. | i. al., $NH_3$ |
| molybdate, hepta- | $(NH_4)_6Mo_7O_{24}{\cdot}4H_2O$‡ | 1235.95 | col., mn. | | | | $44^{25°}$ | | i. al. |
| nitrate (α), stable −16° to 32° | $NH_4NO_3$ | 80.05 | col., tet., 1.611 | $1.66\,\frac{25°}{4}$ | 169.6 | d. 210 | $118.3^{0°}$ | $241.8^{30°}$ | |
| nitrate (β), stable 32° to 84° | $NH_4NO_3$ | 80.05 | col., rhb. or mn. | $1.725\,\frac{25°}{4}$ | | d. 210 | $365.8^{35°}$ | $580^{80°}$ | $3.8^{20°}$ al., $17.1^{20°}$ m. al.; v. s. $NH_3$ |
| nitrite | $NH_4NO_2$ | 64.05 | wh. nd. | 1.69 | expl. | | s. | d. | s. al. |
| osmochloride | $(NH_4)_2OsCl_6$ | 439.02 | cb. | $2.93\,\frac{20°}{4}$ | | | | | |
| oxalate | $(NH_4)_2C_2O_4{\cdot}H_2O$ | 142.12 | col., rhb. | 1.501 | | | $2.5^{0°}$ | $11.8^{50°}$ | sl. s. al.; i. $NH_3$ |
| oxalate, acid | $NH_4HC_2O_4{\cdot}H_2O$ | 125.08 | col., trimetric | 1.556 | d. | | s. | | |
| perchlorate | $NH_4ClO_4$ | 117.50 | col., rhb., 1.4833 | 1.95 | d. | | $10.9^{0°}$ | $46.9^{100°}$ | $2^{20°}$ al.; s. act.; i. et. |
| persulfate | $(NH_4)_2S_2O_8$ | 228.20 | wh., mn., 1.5016 | 1.98 | d. 120 | | $58.2^{0°}$ | d. | |
| phosphate, monobasic | $NH_4H_2PO_4$ | 115.04 | col., tet., 1.5246 | $1.803\,\frac{19°}{4}$ | | | $22.7^{0°}$ | $173.2^{100°}$ | i. ac. |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| phosphate, dibasic | $(NH_4)_2HPO_4$ | 132.07 | col., mn., 1.53 | 1.619 | | | $131^{15°}$ | | i. act. |
| phosphate, meta- | $(NH_4)_4P_4O_{12}$ | 388.08 | col., mn. | 2.21 | | | s. | | |
| Ammonium phosphomolybdate | $(NH_4)_3PO_4{\cdot}12MoO_3{\cdot}3H_2O$ (?) | 1930.55 | yel. | | d. | | $0.03^{15°}$ | i. | s. alk.; i. al., $HNO_3$ |
| silicofluoride | $(NH_4)_2SiF_6$ | 178.14 | cb., 1.3696 | 2.01 | | subl. | $18.5^{17.5°}$ | 55.5 | s. al.; i. act. |
| sulfamate | $NH_4{\cdot}SO_3NH_2$ | 114.12 | col. pl. | | 132 | d. 160 | $134^{0°}$ | $357^{50°}$ | |
| sulfate (mascagnite) | $(NH_4)_2SO_4$ | 132.14 | col., rhb., 1.5230 | $1.769\,\frac{20°}{4}$ | 235 d. | | $70.6^{0°}$ | $103.3^{100°}$ | i. al., act., $CS_2$ |
| sulfate, acid | $NH_4HSO_4$ | 115.11 | col., rhb., 1.480 | 1.78 | 146.9 | 490 | 100 | | v. sl. s. al.; i. act. |
| sulfide | $(NH_4)_2S$ | 68.14 | yel.-wh. | | d. | | v. s. | | $120^{25°}$ $NH_3$ |
| sulfide, penta- | $(NH_4)_2S_5$ | 196.38 | or.-red pr. | | | | s. | | |
| sulfite | $(NH_4)_2SO_3{\cdot}H_2O$ | 134.16 | col., mn. | 1.41 | d. | | $100^{12°}$ | | i. al., act. |
| sulfite, acid | $NH_4HSO_3$ | 99.11 | rhb. | $2.03\,\frac{12°}{4}$ | d. | | s. | | |
| tartrate | $(NH_4)_2C_4H_4O_6$ | 184.15 | col., mn. | 1.60 | d. | | $45^{0°}$ | $87^{60°}$ | sl. s. al. |
| thiocyanate | $NH_4CNS$ | 76.12 | col., mn., 1.685± | 1.305 | 149.6 | d. 170 | $120^{0°}$ | $170^{20°}$ | s. al., act., $NH_3$, $SO_2$ |
| vanadate, meta- | $NH_4VO_3$ | 116.99 | col. cr. | 2.326 | d. | | $0.44^{18°}$ | $3.05^{70°}$ | i. al., $NH_4Cl$ |
| Antimony | Sb | 121.76 | tin wh., trig. | $6.684^{25°}$ | 630.5 | 1380 | i. | i. | s. aq. reg., h. conc. $H_2SO_4$ |
| chloride, tri- (butter of antimony)* | $SbCl_3$ | 228.13 | col., rhb., delq. | $3.14\,\frac{20°}{4}$ | 73.4 | 220.2 | $601.6^{0°}$ | $\infty^{72°}$ | s. al., HCl, HBr, $H_2C_4H_4O_6$ |
| oxide, tri- (valentinite) | $Sb_2O_3$ | 291.52 | rhb., 2.35 | 5.67 | 656 | 1570 | v. sl. s. | sl. s. | s. HCl, KOH, $H_2C_4H_4O_6$ |
| oxide, tri- (senarmontite) | $Sb_2O_3$ | 291.52 | cb., 2.087 | 5.2 | 652 | | | | |
| sulfide, tri- (stibnite) | $Sb_2S_3$ | 339.70 | bk., rhb., 4.046 | 4.64 | 550 | | $0.00017^{18°}$ | d. | s. HCl; alk., $NH_4HS$, $K_2S$; i. ac. |
| sulfide, penta- | $Sb_2S_5$ | 403.82 | golden | $4.120^{0°}$ | –2S, 135 | | i. | i. | s. HCl, alk., $NH_4HS$ |
| telluride, tri- | $Sb_2Te_3$ | 626.35 | gray | | 629 | | | | |
| Antimonyl potassium tartrate (tartar emetic) | $(SbO)KC_4H_4O_6{\cdot}a\,H_2O$ | 333.94 | wh., rhb. | 2.60 | –a $H_2O$, 100 | | $5.26^{8.7°}$ | $35.7^{100°}$ | s. gly.; i. al. |
| sulfate, normal | $(SbO)_2SO_4$ | 371.58 | wh. pd. | 4.89 | | | d. | d. | |
| sulfate, basic | $(SbO)_2SO_4{\cdot}Sb_2(OH)_4$ | 683.13 | wh. pd. | | | | i. | d. | $5.15^{15°}$ gly. |
| Argon | A | 39.94 | col. gas | $1.65^{-288°}$; $1.402^{-185.7°}$; 1.38 (A) | –189.2 | –185.7 | $5.6^{0°}$ cc | $2.23^{50°}$ cc | $24^{25°}$ cc al. |
| Arsenic (crystalline) (α) | $As_4$ | 299.64 | met., hex. | $5.727^{14°}$ | $814^{36atm.}$ | subl. 615 | i. | i. | s. $HNO_3$ |
| Arsenic (black) (β) | $As_4$ | 299.64 | bk., amor. | $4.7^{20°}$ | | | i. | i. | s. $HNO_3$, aq. reg., aq. $Cl_2$, h. alk. |
| Arsenic (yellow)(γ) | $As_4$ | 299.64 | yel., cb. | $2.0^{20°}$ | d. 358 | | | | |
| acid, ortho- | $H_3AsO_4{\cdot}a\,H_2O$ | 150.94 | col., hyg. | 2.0–2.5 | 35.5 | $-H_2O$, 160 | 16.7 | 50 | s. alk. |
| acid, meta- | $HAsO_3$ | 123.92 | wh., hyg. | | d. | | d. to form $H_3AsO_4$ | | |
| acid, pyro- | $H_4As_2O_7$ | 265.85 | col. | | d. 206 | | d. to form $H_3AsO_4$ | | |
| pentoxide | $As_2O_5$ | 229.82 | wh., amor. | 4.086 | | d. | $59.5^{0°}$ | $76.7^{100°}$ | s. alk., al. |
| sulfide, di- (realgar) | $As_2S_2$ | 213.94 | red, mn., 2.68 | (α)$3.506^{19°}$; (β)$3.254^{19°}$ | (α)tr. 267; (β)307 | 565 | i. | d. | s. $K_2S$, $NaHCO_3$ |
| sulfide, penta- | $As_2S_5$ | 310.12 | yel. | | | d. 500 | $0.000136^{0°}$ | i. | s. $HNO_3$, alk. |
| Arsenious chloride (butter of arsenic) | $AsCl_3$ | 181.28 | oily lq. | lq. 2.163 | –18 | 130 | d. | d. | s. HCl, HBr, $PCl_3$ |
| hydride (arsine) | $AsH_3$ | 77.93 | col. gas | 2.695 (A) | –113.5 | –55; d. 230 | 20 cc | sl. s. | sl. s. alk. |
| oxide (arsenolite) | $As_2O_3$ | 197.82 | col., cb., fibrous, 1.755 | $3.865\,\frac{25°}{4}$ | subl. | | sl. s. | sl. s. | i. al., et. |
| oxide (claudetite) | $As_2O_3$ | 197.82 | col., mn., 1.92 | 3.85 | subl. | | sl. s. | sl. s. | i. al., et. |
| oxide | $As_2O_3$ | 197.82 | amor. or vitreous | 3.738 | 315 | | $1.21^{0°}$ | $2.93^{40°}$ | s. HCl, alk., $Na_2CO_3$; i. al., et. |
| Auric chloride | $AuCl_3{\cdot}2H_2O$ | 339.60 | or. cr. | | d. | | v. s. | v. s. | s. HCl, al., et.; sl. s. $NH_3$ |
| cyanide | $Au(CN)_3{\cdot}6H_2O$ | 383.35 | | | d. 50 | | v. s. | v. s. | s. al. |
| Aurous chloride | AuCl | 232.66 | yel. cr. | 7.4 | $AuCl_3$, 170 | d. 290 | d. | d. | s. HCl, HBr; d. al. |
| cyanide | AuCN | 223.22 | yel. cr. | | d. | | i. | i. | s. KCN; i. al., et. |
| *Cf.* also under *Gold* | | | | | | | | | |
| Barium | Ba | 137.36 | silv. met. | 3.5 | 850 | 1140 | d. | d. | s. a.; d. al. |
| acetate | $Ba(C_2H_3O_2)_2$ | 255.45 | col. | 2.468 | | | $58.8^{0°}$ | $75.0^{100°}$ | |
| acetate | $Ba(C_2H_3O_2)_2{\cdot}H_2O$ | 273.46 | wh., tri. pr., 1.517 | 2.19 | $-H_2O$, 41 | | $75^{30°}$(anh.) | $79^{40°}$(anh.) | i. al. |
| bromide | $BaBr_2$ | 297.19 | col. | $4.781\,\frac{24°}{4}$ | 847 | d. | $98^{0°}$ | $149^{100°}$ | v. s. m. al.; v. sl. s. act. |

*Usually the solution.
†See special tables.
‡Usual commercial form.

**TABLE 2-1 Physical Properties of the Elements and Inorganic Compounds** (*Continued*)

| Name | Formula | Formula weight | Color, crystalline form and refractive index | Specific gravity | Melting point, °C | Boiling point, °C | Solubility in 100 parts | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Cold water | Hot water | Other reagents |
| Barium (*Cont.*) | | | | | | | | | |
| bromide | $BaBr_2{\cdot}2H_2O$ | 333.22 | col., mn., 1.7266 | 3.69 | $-2H_2O$, 100 | d. | v. s. | v. s. | s. al. |
| carbonate (witherite) | $BaCO_3$ | 197.37 | wh., rhb., 1.676 | 4.29 | tr. 811 to α | d. 1450 | $0.0022^{15°}$ | $0.0065^{100°}$ | s. a.; i. al. |
| carbonate (α) | $BaCO_3$ | 197.37 | wh., hex. | | tr. 982 to β | | | | |
| carbonate (β) | $BaCO_3$ | 197.37 | wh. | | $1740^{90atm}$ | | $0.0022^{15°}$ | $0.0065^{100°}$ | s. a.; i. al. |
| Barium chlorate | $Ba(ClO_3)_2$ | 304.27 | col. | | 414 | | $20.35^{0°}$ | $84.8^{80°}$ | |
| chlorate | $Ba(ClO_3)_2{\cdot}H_2O$* | 322.29 | col., mn., 1.577 | 3.179 | d. 120 | | s. | s. | sl. s. al., act. |
| chloride | $BaCl_2$ | 208.27 | col., mn., 1.7361 | $3.856\,\frac{24°}{4}$ | tr. 925 | 1560 | $31^{0°}$ | $59^{100°}$ | sl. s. HCl, $HNO_3$; i. al. |
| chloride | $BaCl_2$ | 208.27 | col., cb. | | 962 | 1560 | | | |
| chloride | $BaCl_2{\cdot}2H_2O$† | 244.31 | col., mn., 1.646 | $3.097\,\frac{24°}{4}$ | $-2H_2O$, 100 | | $39.3^{0°}$ | $76.8^{100°}$ | sl. s. HCl, $HNO_3$; i. al. |
| hydroxide | $Ba(OH)_2$ | 171.38 | col., mn. | 4.495 | | | $1.67^{0°}$ | $101.4^{80°}$ | |
| hydroxide | $Ba(OH)_2{\cdot}8H_2O$ | 315.50 | col., mn., 1.5017 | $2.188^{16°}$ | 77.9 | $-8H_2O$, 550 | $5.6^{15°}$ | | v. sl. s. al.; i. et. |
| nitrate (nitrobarite) | $Ba(NO_3)_2$ | 261.38 | col., cb., 1.572 | $3.244^{28°}$ | 592 | d. | $5.0^{0°}$ | $34.2^{100°}$ | sl. s. a.; i. al. |
| oxalate | $BaC_2O_4$ | 225.38 | wh. cr. | 2.658 | | | $0.0016^{8°}$ | $0.0024^{24°}$ | s. a., $NH_4Cl$; i. al. |
| oxide | BaO | 153.36 | col., cb., 1.98 | 5.72 | 1923 | 2000± | $1.5^{0°}$ | $90.8^{80°}$ | s. HCl, $HNO_3$, abs. al.; i. $NH_3$, act. |
| peroxide | $BaO_2$* | 169.36 | gray or wh. pd. | 4.958 | –O, 800 | | v. sl. s. | d. | s. dil. a.; i. act. |
| peroxide | $BaO_2{\cdot}8H_2O$ | 313.49 | pearly sc. | | $-8H_2O$, 100 | | 0.168 | d. | s. dil. a.; i. al., et., act. |
| phosphate, monobasic | $BaH_4(PO_4)_2$ | 331.35 | tri. | $2.9^{4°}$ | | | d. | d. | s. a. |
| phosphate, dibasic | $BaHPO_4$ | 233.35 | wh., rhb. nd., 1.635 | $4.165^{15°}$ | | | 0.015 | | s. a., $NH_4$ salts |
| phosphate, tribasic | $Ba_3(PO_4)_2$ | 602.04 | wh., cb. | $4.1^{16°}$ | | | i. | | s. a. |
| phosphate, pyro- | $Ba_2P_2O_7$ | 448.68 | wh., rhb. | $3.9^{20°}$ | | | 0.01 | | s. a., $NH_4$ salts |
| silicofluoride | $BaSiF_6$ | 279.42 | pr. | $4.279^{15°}$ | | | $0.026^{17°}$ | $0.09^{100°}$ | sl. s. HCl, $NH_4Cl$; i. al. |
| sulfate (barite, barytes) | $BaSO_4$ | 233.42 | col., rhb., 1.636 | $4.499^{15°}$ | 1580 d. | tr. to mn. 1149 | $0.000115^{0°}$ | $0.000285^{30°}$ | s. conc. $H_2SO_4$; 0.006, 3% HCl |
| sulfide, mono- | BaS | 169.42 | col., cb., 2.155 | $4.25^{15°}$ | | | d. | d. | d. HCl; i. al. |
| sulfide, tri- | $BaS_3$ | 233.54 | yel.-gn. | | d. 400 | | s. | s. | |
| sulfide, tetra- | $BaS_4{\cdot}2H_2O$ | 301.63 | red, rhb. | $2.988^{20°}$ | d. 200 | | $41^{15°}$ | v. s. | i. al., $CS_2$ |
| Beryllium (glucinum) | Be(Gl) | 9.02 | gray, met., hex. | 1.816 | 1284 | 2767 | i. | sl. s. d. | s. dil. a., alk. |
| Bismuth | Bi | 209.00 | silv. wh. or reddish, hex. | $9.80^{20°}$ | 271 | 1450 | i. | i. | s. aq. reg., conc. $H_2SO_4$, $HNO_3$ |
| carbonate, sub- | $Bi_2O_3{\cdot}CO_2{\cdot}H_2O$ | 528.03 | wh. pd. | 6.86 | d. | | i. | i. | s. a. |
| chloride, di- | $BiCl_2$(?) | 279.91 | bk. nd. | 4.86 | 163 | d. 300 | d. | | |
| chloride, tri- | $BiCl_3$* | 315.37 | wh. cr. | 4.75 | 230 | 447 | d. | | s. al. |
| nitrate | $Bi(NO_3)_3{\cdot}5H_2O$ | 485.10 | col., tri. | 2.82 | d. 30 | $-5H_2O$, 80 | d. | | $42^{19°}$ act.; s. a.; i. al. |
| nitrate, sub- | $BiONO_3{\cdot}H_2O$ | 305.02 | hex. pl. | $4.928^{15°}$ | d. 260 | | i. | i. | s. a. |
| oxide, tri- | $Bi_2O_3$ | 466.00 | yel., rhb. | 8.9 | 820 | 1900± | i. | i. | s. a. |
| oxide, tri- | $Bi_2O_3$ | 466.00 | yel., tet. | 8.55 | 860 | | i. | i. | s. a. |
| oxide, tri- | $Bi_2O_3$ | 466.00 | yel., cb. | 8.20 | tr. 704 | | i. | i. | s. a. |
| oxychloride | BiOCl | 260.46 | wh., amor. | $7.72^{15°}$ | | | sl. s. | sl. s. | s. a.; i. act., $NH_3$, $H_2C_4H_4O_6$ |
| Boric acid | $H_3BO_3$ | 61.84 | wh., tri. | $1.435^{15°}$ | 185 d. | | $2.66^{0°}$ | $40.2^{100°}$ | $22.2^{20°}$ gly., $0.24^{25°}$ et.; s. al. |
| Boron | B | 10.82 | gray or bk., amor. or mn. | 2.32 | 2300 | 2550 | i. | i. | s. $HNO_3$; i. al. |
| carbide | $B_4C$ | 55.29 | bk. cr. | 2.54 | 2450 | >3500 | i. | i. | i. a. |
| oxide | $B_2O_3$ | 69.64 | col. glass, 1.459 | 1.85 | 577 | >1500 | $1.1^{0°}$ | $15.7^{100°}$ | s. a., al., gly. |
| oxide (sassolite) | $B_2O_3{\cdot}3H_2O$ | 123.69 | tri., 1.456 | 1.49 | d. | | sl. s. | s. | |
| Bromic acid | $HBrO_3$ | 128.92 | col.; in soln. only | | d. 100 | | v. s. | d. | |
| Bromine | $Br_2$ | 159.83 | rhb., or red lq. | $3.119^{20°}$; 5.87 (A) | –7.2 | 58.78 | $4.22^{0°}$ | $3.13^{30°}$ | s. al., et., alk., $CS_2$ |
| hydrate | $Br_2{\cdot}10H_2O$ | 339.99 | red, oct. | | d. 6.8 | | s. | | |
| Cadmium | Cd | 112.41 | silv. met., hex. | $8.65^{20°}$ | 320.9 | 767 | i. | i. | s. a., $NH_4NO_3$ |
| acetate | $Cd(C_2H_3O_2)_2$ | 230.50 | col. | 2.341 | 256 | d. | v. s. | | s. m. al. |
| acetate | $Cd(C_2H_3O_2)_2{\cdot}2H_2O$* | 266.53 | col., mn. | 2.01 | $-H_2O$, 130 | | v. s. | | s. al. |
| carbonate | $CdCO_3$ | 172.42 | wh., trig. | $4.258^{4°}$ | d. <500 | | i. | i. | s. a., KCN, $NH_4$ salts; i. $NH_3$ |
| chloride | $CdCl_2$ | 183.32 | wh., cb. | $4.047\,\frac{25°}{4}$ | 568 | 960 | $90^{0°}$ | $147^{100°}$ | $1.52^{15°}$ al.; i. et., act. |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| chloride | $CdCl_2.2a\ H_2O$ | 228.36 | col., mn., 1.6513 | 3.327 | tr. 34 | | $168^{20°}$ | $180^{100°}$ | $2.05^{15°}$ m. al. |
| cyanide | $Cd(CN)_2$ | 164.45 | | | d. >200 | | $0.0247^{18°}$ | | s. a.; $NH_4OH$, KCN |
| hydroxide | $Cd(OH)_2$ | 146.43 | wh., trig. | $4.79\ \frac{15°}{4}$ | d. 300 | | $0.00026^{25°}$ | | s. a., $NH_4$ salts; i. alk. |
| nitrate | $Cd(NO_3)_2$ | 236.43 | col. | | 350 | | $109.7^{0°}$ | $326^{59.5°}$ | v. s. a. |
| nitrate | $Cd(NO_3)_2.4H_2O$* | 308.49 | col. nd. | $2.455\ \frac{17°}{4}$ | 59.4 | 132 | $215^{0°}$ | | s. al., $NH_3$; i. $HNO_3$ |
| oxide | CdO | 128.41 | brn., cb. | 8.15 | | | i. | i. | s. a., $NH_4$ salts; i. alk. |
| oxide | CdO | 128.41 | brn., amor. 2.49 | 6.95 | d. 900–1000 | | i. | i. | s. a., $NH_4$ salts; i. alk. |
| oxide, sub- | $Cd_2O$ | 240.82 | gn., amor. | $8.192\ \frac{18°}{4}$ | d. | | | | d. a., alk. |
| Cadmium sulfate | $CdSO_4$ | 208.47 | rhb. | $4.691\ \frac{24°}{4}$ | 1000 | | $76.5^{0°}$ | $60.8^{100°}$ | i.act., $NH_3$ |
| sulfate | $CdSO_4.H_2O$ | 226.49 | mn. | $3.786^{20°}$ | tr. 108 | | s. | s. | |
| sulfate | $3CdSO_4.8H_2O$* | 769.54 | col., mn., 1.565 | 3.09 | tr. 41.5 | | $114.2^{0°}$ | $127.6^{60°}$ | i. al. |
| sulfate | $CdSO_4.H_2O$ | 280.53 | col. | 3.05 | | | s. | s. | i. al. |
| sulfate | $CdSO_4.7H_2O$ | 334.58 | mn. | $2.48\ \frac{20°}{4}$ | tr. 4 | | $350^{-5°}$ | | i. al. |
| sulfide (greenockite) | CdS | 144.47 | yel.-or., hex., 2.506 | 4.58 | $1750^{100atm}$ | subl. in $N_2$, 980 | 0.000001 | Colloidal | s. a.; v. s. $NH_4OH$ |
| Calcium | Ca | 40.08 | silv. met., cb. | $1.55^{20°}$ | 810 | 1200 ± 30 | d. | d. | s, a.; sl. s. al. |
| acetate | $Ca(C_2H_2O_2)_2.H_2O$ | 176.18 | wh. nd. | | d. | | $52^{0°}$ | $45.5^{80°}$ | sl. s. al. |
| aluminate | $Ca(AlO_2)_2$ | 158.02 | col., rhb. or mn. | $3.67^{20°}$ | 1600 | | d. | | s. HCl |
| aluminum silicate (anorthite) | $CaO.Al_2O_3.2SiO_2$ | 278.14 | tri., 1.5832 | 2.765 | 1551 | | | | |
| arsenate | $Ca_3(AsO_4)_2$ | 398.06 | wh. pd. | | | | $0.013^{25°}$ | i. | s. dil. a. |
| bromide | $CaBr_2$ | 199.91 | delq. nd. | $3.353\ \frac{25°}{4}$ | 760 | 1810 | $125^{0°}$ | $312^{105°}$ | s. al., act.; sl. s. $NH_3$ |
| carbonate (aragonite) | $CaCO_3$ | 100.09 | col., rhb., 1.6809 | 2.93 | d. 825 | | $0.0012^{20°}$† | $0.002^{100°}$ | s. a., $NH_4Cl$ |
| carbonate (calcite) | $CaCO_3$ | 100.09 | col., hex., 1.550 | $2.711\ \frac{25°}{4}$ | $1339^{103atm.}$ | | $0.0014^{25°}$ | $0.002^{100°}$ | s. a., $NH_4Cl$ |
| chloride (hydrophilite) | $CaCl_2$* | 110.99 | wh., delq., cb, 1.52 | $2.152\ \frac{15°}{4}$ | 772 | >1600 | $59.5^{0°}$ | $347^{260°}$ | s. al. |
| chloride | $CaCl_2.H_2O$ | 129.01 | col., delq. | | | | s. | s. | s. al. |
| chloride | $CaCl_2.6H_2O$ | 219.09 | col., trig., 1.417 | $1.68^{17°}$ | 29.92 | $-6H_2O$, 200 | v. s. | v. s. | s. al. |
| citrate | $Ca_3(C_6H_5O_7)_2.4H_2O$ | 570.50 | col. nd. | | $-2H_2O$, 130 | $-4H_2O$, 185 | $0.085^{18°}$ | $0.096^{26°}$ | $0.0065^{18°}$ al. |
| cyanamide | $CaCN_2$ | 80.11 | col., rhombohedral | | | | s. d. | d. | |
| ferrocyanide | $Ca_2Fe(CN)_6.12H_2O$ | 508.31 | yel., tri., 1.5818 | 1.7 | | | s. | $150^{90°}$ | i. al. |
| fluoride (fluorite) | $CaF_2$ | 78.08 | wh., cb., 1.4339 | $3.180^{20°}$ | 1330 | | $0.0016^{18°}$ | $0.0017^{26°}$ | sl. s. a. |
| formate | $Ca(HCO_2)_2$ | 130.12 | col., rhb. | 2.015 | d. | | $16.1^{0°}$ | $18.4^{100}$ | i. al., et. |
| hydride | $CaH_2$ | 42.10 | wh. cr. or pd. | 1.7 | d. 675 | | d. | | d. a.; i. bz. |
| hydroxide | $Ca(OH)_2$ | 74.10 | col., hex., 1.574 | 2.2 | $-H_2O$, 580 | | $0.185^{0°}$ | $0.077^{100°}$ | s. $NH_4Cl$ |
| hypochlorite | $Ca(ClO)_2.4H_2O$ | 215.06 | wh., feathery cr. | | d. | | delq.; d. | d. | d. a. |
| hypophosphate | $Ca_2P_2O_6.2H_2O$ | 274.15 | granular | | $-2H_2O$, 200 | | i. | | s. HCl, $H_4P_2O_6$ |
| lactate | $Ca(C_3H_5O_3)_2.5H_2O$ | 308.30 | col., eff. | | $-3H_2O$, 100 | | 10.5 | ∞ | ∞h. al.; i. et. |
| magnesium carbonate (dolomite) | $CaO.MgO.2CO_2$ | 184.42 | trig., 1.68174 | 2.872 | d. 730–760 | | $0.032^{18°}$ | | |
| magnesium silicate (diopside) | $CaO.MgO.2SiO_2$ | 216.52 | wh., mn. | 3.3 | 1391 | | i. | i. | |
| nitrate (nitrocalcite) | $Ca(NO_3)_2$ | 164.10 | col., cb. | 2.36 | 561 | | $102^{0°}$ | $376^{151°}$ | $14^{15°}$ al.; s. amyl al., $NH_3$ |
| nitrate | $Ca(NO_3)_2.4H_2O$* | 236.16 | col., mn., 1.498 | 1.82 | 42.7 | | $266^{0°}$ | v. s. | |
| nitride | $Ca_3N_2$ | 148.26 | brn. cr. | $2.63^{17°}$ | 900 | | d. | d. | s. dil. a.; i. abs. al. |
| nitrite | $Ca(NO_2)_2.H_2O$ | 150.11 | delq., hex. | $2.23^{34°}$ | | | $77^{0°}$ | $417^{90°}$ | s. 90% al. |
| oxalate | $CaC_2O_4$ | 128.10 | col., cb. | $2.2^{4°}$ | d. | | $0.00067^{13°}$ | $0.0014^{95°}$ | s. a.; i. ac. |
| oxalate | $CaC_2O_4.H_2O$ | 146.12 | col. | 2.2 | $-H_2O$, 200 | | i. | i. | s. a.; i. ac |
| oxide | CaO | 56.08 | col., cb., 1.837 | 3.32 | 2570 | 2850 | Forms $Ca(OH)_2$ | | s. a.; i. al. |
| peroxide | $CaO_2.8H_2O$ | 216.21 | pearly, tet. | | $-8H_2O$, 100 | expl. 275 | sl. s. | d. | s. a. d.; i. al., et. |
| phosphate, monobasic | $CaH_4(PO_4)_2.H_2O$ | 252.09 | wh., tri. | $2.220\ \frac{16°}{4}$ | $-H_2O$, 100 | d. 200 | | d. | |
| phosphate, dibasic | $CaHPO_4.2H_2O$ | 172.10 | wh., mn. pl. | $2.306\ \frac{16°}{4}$ | d. | | $0.02^{24.5°}$ | $0.075^{100°}$ | |
| phosphate, tribasic | $Ca_3(PO_4)_2$ | 310.20 | wh., amor. | 3.14 | 1670 | | 0.0025 | d. | s. a.; i. al., ac. |
| phosphate, meta- | $Ca(PO_3)_2$ | 198.04 | wh., tet., 1.588 | 2.82 | 975 | | i. | i. | i. a. |
| phosphate, pyro- | $Ca_2P_2O_7$ | 254.12 | col., biaxial, 1.60 | 3.09 | 1230 | | i. | | s. a. |
| phosphate, pyro- (brushite) | $Ca_2P_2O_7.5H_2O$ | 344.20 | wh., mn. | 2.25 | | | sl. s. | | s. a.; i. $NH_4Cl$ |
| phosphide | $Ca_3P_2$ | 182.20 | red cr. | $2.51^{15°}$ | >1600 | | d. | | s. dil. a.; i. al., et. |
| silicate (α) (pseudowollastonite) | $CaSiO_3$ | 116.14 | col., pseudo hex., 1.6150 or mn.(?) | 2.905 | 1540 | | $0.0095^{17°}$ | | s. HCl |
| silicate (β) (wollastonite) | $CaSiO_3$ | 116.14 | col., mn., 1.610 | 2.915 | tr. 1190 to α | | | | |
| sulfate (anhydrite) | $CaSO_4$ | 136.14 | col., rhb., 1.576, or mn, 1.50 | 2.96 | 1450(mn.) | tr. 1193 to rhb. | $0.298^{20°}$ | $0.1619^{100°}$ | s. a., $Na_2S_2O_3$, $NH_4$ salts |

*Usual commercial form.
†The solubility of $CaCO_3$ in $H_2O$ is greatly increased by increasing the amount of $CO_2$ in the $H_2O$.

**TABLE 2-1 Physical Properties of the Elements and Inorganic Compounds** (*Continued*)

| Name | Formula | Formula weight | Color, crystalline form and refractive index | Specific gravity | Melting point, °C | Boiling point, °C | Solubility in 100 parts | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Cold water | Hot water | Other reagents |
| Calcium (*Cont.*) | | | | | | | | | |
| sulfate (gypsum) | $CaSO_4 \cdot 2H_2O$ | 172.17 | col., mn., 1.5226 | 2.32 | −1a $H_2O$, 128 | −2$H_2O$, 163 | $0.223^{0°}$ | $0.257^{50°}$ | s. a., gly., $Na_2S_2O_3$, $NH_4$ salts |
| sulfhydrate | $Ca(SH)_2 \cdot 6H_2O$ | 214.31 | col. pr. | | d. 15 | | v. s. | v. s. | s. al. |
| sulfide (oldhamite) | CaS | 72.14 | col., cb. | $2.8^{15°}$ | | | d. | d. | s. a. |
| sulfite | $CaSO_3 \cdot 2H_2O$ | 156.17 | wh., cr., 1.595 | | −2$H_2O$, 100 | d. 650 | $0.0043^{18°}$ | $0.0027^{90°}$ | s. $H_2SO_3$ |
| tartrate | $CaC_4H_4O_6 \cdot 4H_2O$ | 260.22 | col., rhb. | | d. | | $0.037^{0°}$ | $0.22^{85°}$ | sl. s. al. |
| thiocyanate | $Ca(CNS)_2 \cdot 3H_2O$ | 210.28 | wh., delq. cr. | | | | s. | v. s. | v. s. al. |
| thiosulfate | $CaS_2O_3 \cdot 6H_2O$ | 260.30 | col., tri., 1.56 | $1.873^{16°}$ | d. | | $71.2^{9°}$ | d. | i. al. |
| tungstate (scheelite) | $CaWO_4$ | 288.00 | wh., tet., 1.9200 | 6.06 | | | 0.2 | | s. $NH_4Cl$; i. a. |
| Carbon, *cf.* table of organic compounds | | | | | | | | | |
| Carbon, amorphous | C | 12.01 | bk., amor. | 1.8–2.1 | >3500 | 4200 | i. | i. | i. a., alk. |
| Carbon, diamond | C | 12.01 | col., cb., 2.4195 | $3.51^{20°}$ | >3500 | 4200 | i. | i. | i. a., alk. |
| Carbon, graphite | C | 12.01 | bk., hex. | $2.26^{20°}$ | >3500 | 4200 | i. | i. | i. a., alk. |
| dioxide | $CO_2$ | 44.01 | col. gas | lq. $1.101^{-87°}$; 1.53 (A); solid $1.56^{-79°}$ | $-56.6^{5.2atm.}$ | subl. −78.5 | $179.7^{0°}$ cc | $90.1^{20°}$ cc | s. a., alk. |
| disulfide | $CS_2$ | 76.13 | col. lq. | lq. $1.261\frac{22°}{20}$; 2.63 (A) | −108.6 | 46.3 | $0.2^{0°}$ | $0.014^{50°}$ | s. al.; et. |
| monoxide | CO | 28.01 | col., poisonous, odorless gas | lq. $0.814\frac{-195°}{4}$; 0.968 (A) | −207 | −192 | $0.0044^{0°}$; $3.5^{0°}$ cc | $0.0018^{50°}$ $2.32^{20°}$ cc | s. al., $Cu_2Cl_2$ |
| oxychloride (phosgene) | $COCl_2$ | 98.92 | poisonous gas | $1.392\frac{19°}{4}$ | −104 | $8.2^{756mm}$ | v. s. sl. d. | d. | s. ac., $CCl_4$, bs.; d.a. |
| oxysulfide | COS | 60.07 | gas | lq. $1.24^{-87°}$; 2.10 (A) | −138.2 | $-50.2^{760mm}$ | $133^{0°}$ cc | $40.3^{30°}$ cc | v. s. alk., al. |
| suboxide | $C_3O_2$ | 68.03 | gas | lq. $1.114^{0°}$ | −107 | $7^{761mm}$ | d. | | s. et. |
| thionyl chloride | $CSCl_2$ | 114.98 | yel.-red lq. | $1.509^{15°}$ | | 73.5 | | | |
| Ceric hydroxide | $2CeO_2 \cdot 3H_2O$ | 398.31 | yel., gelatinous | | | | | | s. a.; sl. s. alk. carb.; i. alk |
| hydroxynitrate | $Ce(OH)(NO_3)_3 \cdot 3H_2O$ | 397.21 | red, mn. | | | | d. | | |
| oxide | $CeO_2$ | 172.13 | wh. or pa. yel., cb. | 7.3 | 1950 | | i. | i. | s. $H_2SO_4$, HCl |
| sulfate | $Ce(SO_4)_2 \cdot 4H_2O$ | 404.31 | yel., rhb. | 3.91 | | | s. d. | | s. dil. $H_2SO_4$ |
| Cerium | Ce | 140.13 | steel gray, cb. or hex. | $6.9^{20°}$ cb.; 6.7 hex. | 645 | 1400 | i. | Slowly oxidized | s. dil. a.; i. al. |
| Cerous sulfate | $Ce_2(SO_4)_3$ | 568.44 | wh., mn. or rhb. | 3.91 | | | $18.98^{0°}$ | $0.4^{100°}$ | |
| sulfate | $Ce_2(SO_4)_3 \cdot 8H_2O$ | 712.57 | tri. | $2.886^{17°}$ | −8$H_2O$, 630 | | $25^{0°}$ | $7.6^{40°}$ | |
| Cesium | Ce | 132.91 | silv. met., hex. | $1.90^{20°}$ | 28.5 | 670 | d. | | s. a., al., $NH_3$ |
| Chloric acid | $HClO_3 \cdot 7H_2O$ | 210.58 | lq. | $1.282^{14.2°}$ | <−20 | d. 40 | v. s. | | |
| Chlorine | $Cl_2$ | 70.91 | rhb., or gn.-yel. gas | lq. $1.56^{-33.6°}$; $2.49^{0°}$ (A) | −101.6 | −34.6 | $1.46^{0°}$; $310^{10°}$ cc | $0.57^{30°}$; $177^{30°}$ cc | s. alk. |
| hydrate | $Cl_2 \cdot 8H_2O$ | 215.04 | rhb. | 1.23 | d. 9.6 | | s. | | s. alk. |
| Chloroplatinic acid | $H_2PtCl_6 \cdot 6H_2O$ | 518.08 | red-brn., delq. | 2.431 | 60 | | v. s. | v. s. | s. al., et. |
| Chlorostannic acid | $H_2SnCl_6 \cdot 6H_2O$ | 441.55 | delq. | $1.971^{28°}$ | 19.2 | | s. | | |
| Chlorosulfonic acid | $HO \cdot SO_2 \cdot Cl$ | 116.52 | col. lq. | $1.787^{25°}$ | −80 | $151.5^{765mm}$ | d. | | d. al.; i. $CS_2$ |
| Chromic acetate | $Cr_3(C_2H_3O_2)_6 \cdot 2H_2O$ | 494.32 | gn. | | | | s. | | $4.76^{15°}$ m. al. |
| chloride | $CrCl_3$ | 158.38 | pink, trig. | $2.757^{15°}$ | | 1200–1500 d. | i.§ | sl. s. | i. a., act., $CS_2$ |
| chloride | $CrCl_3 \cdot 6H_2O$* | 266.48 | vl. or gn., hex. pl. | $1.835\frac{25°}{4}$ | subl. 83 | | v. s. d. | | s. al.; i. et. |
| fluoride | $CrF_3$ | 109.01 | gn., rhb. | 3.8 | >1000 | d. | i. | | sl. s. a.; i. al., $NH_3$ |
| hydroxide | $Cr(OH)_3$ | 103.03 | gn. or blue, gelatinous | | | | i. | | s. a., alk.; sl. s. $NH_3$ |
| hydroxide | $Cr(OH)_3 \cdot 2H_2O$ | 139.07 | gn. | | −2$H_2O$, 100 | | i. | i. | s. a., alk. |
| nitrate | $Cr(NO_3)_3 \cdot 9H_2O$* | 400.18 | purple pr. | | 36.5 | d. 100 | s. | s. | s. a., alk., al., act. |
| nitrate | $Cr(NO_3)_3 \cdot 7a\ H_2O$ | 373.15 | purple, mn. | | 100 | d. | s. | s. | |
| oxide | $Cr_2O_3$ | 152.02 | dark gn., hex. | 5.21 | 1900 | | i. | i. | sl. s. a. |
| sulfate | $Cr_2(SO_4)_3$ | 392.20 | rose pd. | 3.012 | | | i.† | | i. a. |
| sulfate | $Cr_2(SO_4)_3 \cdot 5H_2O$ | 482.28 | gn. | | | | s. | | s. al., $H_2SO_4$ |
| sulfate | $Cr_2(SO_4)_3 \cdot 15H_2O$ | 662.44 | vl. | $1.867^{17°}$ | 100 | −10$H_2O$, 100 | s. | d. 67° | sl. s. al. |
| sulfate | $Cr_2(SO_4)_3 \cdot 18H_2O$ | 716.49 | vl., cb., 1.564 | $1.7^{22°}$ | | −12$H_2O$, 100 | $120^{20°}$ | d. | s. al. |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| sulfide | $Cr_2S_3$ | 200.02 | brn.-bk. pd. | $3.77^{19°}$ | –S, 1350 | | i. | d. | s. h. $HNO_3$ |
| Chromium | Cr | 52.01 | gray, met., cb. | 7.1 | 1615 | 2200 | i. | i. | s. HCl, dil. $H_2SO_4$; i. $HNO_3$ |
| trioxide (chromic acid) | $CrO_3$ | 100.01 | red, rhb. | 2.70 | 197 d. | | $164.9^{0°}$ | $206.7^{100°}$ | s. $H_2SO_4$, al., et. |
| Chromous chloride | $CrCl_2$ | 122.92 | wh., delq. | 2.75 | | | v. s. | v. s. | sl. s. al.; i. et. |
| hydroxide | $Cr(OH)_2$ | 86.03 | yel.-brn. | | d. | | d. | | s. conc. a. |
| oxide | CrO | 68.01 | bk. pd. | | | | i. | i. | i. dil. $HNO_3$ |
| sulfate | $CrSO_4 \cdot 7H_2O$ | 274.18 | blue | | | | $12.35^{0}$ | | sl. s. al. |
| sulfide (daubrelite) | CrS | 84.07 | bk. pd. | 3.97 | 1550 | | i. | | v. s. a. |
| Chromyl chloride | $CrO_2Cl_2$ | 154.92 | dark red lq. | 1.92 | –96.5 | 117.6 | d. | | s. et. |
| Cobalt | Co | 58.94 | silv. met., cb. | $8.9^{20°}$ | 1480 | 2900 | i. | i. | s. a. |
| carbonyl | $Co(CO)_4$ | 170.98 | or. cr. | $1.73^{18°}$ | 51 | d. 52 | i. | d. | s. al., et., $CS_2$ |
| sulfide, di- | $CoS_2$ | 123.06 | bk., cb. | 4.269 | | | i. | | s. $HNO_3$, aq. reg. |
| Cobaltic chloride | $CoCl_3$ | 165.31 | red cr. | 2.94 | subl. | | s. | s. | |
| chloride, dichro | $Co(NH_3)_3Cl_3 \cdot H_2O$ | 234.42 | | | | | s. | | s. a.; al. |
| chloride, luteo | $Co(NH_3)_6Cl_3$ | 267.50 | or., mn. | $1.7016^{20°}$ | | | $4.26^{0°}$ | $12.74^{46.5°}$ | i. al., $NH_4OH$ |
| chloride, praseo | $Co(NH_3)_4Cl_3 \cdot H_2O$ | 251.46 | gn., rhb. | 1.847 | | | v. s. | | s. a.; i. al. |
| Cobaltic chloride, purpureo | $Co(NH_3)_5Cl_3$ | 250.47 | rhb. | $1.819\,\frac{25°}{25}$ | | | $0.232^{0°}$ | $1.031^{46.5°}$ | i. al. |
| chloride, roseo | $Co(NH_3)_5Cl_3 \cdot H_2O$ | 268.49 | brick red | | d. 100 | | $16.12^{0°}$ | $24.87^{16°}$ | sl. s. HCl |
| hydroxide | $Co(OH)_3$ | 109.96 | bk. | | –1a $H_2O$, 100 | | i. | i. | s. a.; i. al. |
| oxide | $Co_2O_3$ | 165.88 | bk. | 5.18 | d. 900 | | i. | i. | s. a. |
| sulfate | $Co_2(SO_4)_3$ | 406.06 | blue cr. | | | | d. | | s. $H_2SO_4$ |
| sulfide | $Co_2S_3$ | 214.06 | bk. cr. | 4.8 | | | i. | | d. a. |
| Cobalto-cobaltic oxide | $Co_3O_4$ | 240.82 | bk., cb. | 6.07 | | | i. | i. | s. $H_2SO_4$; i. HCl, $HNO_3$ |
| Cobaltous acetate | $Co(C_2H_3O_2)_2 \cdot 4H_2O$ | 249.09 | red-vl., mn., 1.542 | $1.7053^{18.7°}$ | $-4H_2O$, 140 | | s. | s. | s. a., al. |
| chloride | $CoCl_2$ | 129.85 | blue cr. | 3.356 | subl. | 1049 | $45^{7°}$ | $105^{96°}$ | 31 al.; 8.6 act. |
| chloride | $CoCl_2 \cdot 6H_2O$* | 237.95 | red, mn. | $1.924\,\frac{25°}{25}$ | 86 | $-6H_2O$, 110 | $116.5^{0°}$ | $177^{80°}$ | v. s. et., act. |
| nitrate | $Co(NO_3)_2 \cdot 6H_2O$ | 291.05 | red, mn., 1.4 | $1.883\,\frac{25°}{25}$ | <100 | d. | $84.03^{0°}$(anh.) | $334.9^{90°}$ (anh.) | $100^{12.5°}$ al.; s. act.; sl. s. $NH_3$ |
| oxide | CoO | 74.94 | brn., cb. | 5.68 | d. 1800 | | i. | i. | s. a., $NH_4OH$; i. al. |
| sulfate | $CoSO_4$ | 155.00 | red pd. | $3.710^{25°}$ | d. 880 | | $25.6^{0°}$ | $83^{100°}$ | $1.04^{18°}$ m. al.; i. $NH_8$ |
| sulfate | $CoSO_4 \cdot H_2O$ | 173.02 | red pd., mn.(?), 1.639 | 3.13 | d. | | s. | s. | |
| sulfate (biebeorite) | $CoSO_4 \cdot 7H_2O$* | 281.11 | red, mn., 1.483 | $1.948\,\frac{25°}{25}$ | 96.8 | $-7H_2O$, 420 | $33^{80°}$ | s. | $2.5^{8°}$ al. |
| sulfide (syeporite) | CoS | 91.00 | brn. nd. | $5.45^{18°}$ | >1100 | | $0.00038^{18°}$ | | s. a., aq. reg. |
| Copper | Cu | 63.57 | yel.-red met., cb. | $8.92^{20°}$ | 1083 | 2300 | i. | i. | s. $HNO_3$, h. $H_2SO_4$ |
| Cupric acetate | $Cu(C_2H_3O_2)_2$ | 181.66 | | $1.930\,\frac{20°}{4}$ | | | s. | | |
| acetate | $Cu(C_2H_3O_2)_2 \cdot H_2O$ | 199.67 | dark gn., mn. | 1.882 | 115 | 240 d. | 7.2 | 20 | 7 al.; s. et.; gly. |
| aceto-arsenite (Paris green) | $(CuOAs_2O_3)_3 \cdot Cu(C_2H_3O_2)_2$* | 1013.83 | gn. | | | | i. | | s. a., $NH_4OH$ |
| ammonium chloride | $CuCl_2 \cdot 2NH_4Cl \cdot 2H_2O$ | 277.51 | blue, tet., 1.670, 1.744 | 1.98 | d. 110 | | $33.8^{0°}$ | $99.3^{80°}$ | s. a. |
| ammonium sulfate | $CuSO_4 \cdot 4NH_3 \cdot H_2O$ | 245.77 | blue, rhb. | 1.81 | d. 150 | | $18.05^{21.5°}$ | d. | i. al. |
| carbonate, basic (azurite) | $2CuCO_3 \cdot Cu(OH)_2$ | 344.75 | blue, mn., 1.758 | 3.88 | d. 220 | | i. | d. | s. $NH_4OH$, h. aq. $NaHCO_3$ |
| carbonate, basic (malachite) | $CuCO_3 \cdot Cu(OH)_2$ | 221.17 | dark gn., mn., 1.875 | 3.9 | d. | | i. | d. | s. KCN; 0.03 aq. CO |
| chloride (eriochalcite) | $CuCl_2$ | 134.48 | brn.-yel. pd. | 3.054 | 498 | Forms $Cu_2Cl_2$ 993 | $70.7^{0°}$ | $107.9^{100°}$ | $53^{15°}$ al.; $68^{15°}$ m. al. |
| chloride | $CuCl_2 \cdot 2H_2O$ | 170.52 | gn., rhb., 1.684 | $2.39^{22.4°}$ | $-2H_2O$, 110 | d. | $110.4^{0°}$ | $192.4^{100°}$ | s. al.; et., $NH_4Cl$ |
| chromate, basic | $CuCrO_4 \cdot 2CuO \cdot 2H_2O$ | 374.75 | yel.-brn. | | $-2H_2O$, 260 | | i. | | s. $HNO_3$, $NH_4OH$ |
| cyanide | $Cu(CN)_2$ | 115.61 | yel.-gn. | | d. | | i. | | s. KCN, $C_5H_5N$ |
| dichromate | $CuCr_2O_7 \cdot 2H_2O$ | 315.62 | bk., tri. | $2.286^{18°}$ | $-2H_2O$, 100 | | sl. s. | d. | s. a.; $NH_4OH$ |
| ferricyanide | $Cu_3[Fe(CN)_6]_2$ | 614.63 | yel.-gn. | | | | i. | | s. $NH_4OH$; i. HCl |
| ferrocyanide | $Cu_2Fe(CN)_6 \cdot 7H_2O$ | 465.21 | red-brn. | | | | i. | i. | s. $NH_4OH$; i. a., $NH_8$ |
| formate | $Cu(HCO_2)_2$ | 153.61 | blue, mn. | 1.831 | | | 12.5 | d. | 0.25 al. |
| hydroxide | $Cu(OH)_2$ | 97.59 | blue, gelatinous | 3.368 | $-H_2O$ | | i. | d. | s. a., $NH_4OH$, KCN, al. |
| lactate | $Cu(C_3H_5O_3)_2 \cdot 2H_2O$ | 277.74 | dark blue, mn. | | | | 16.7 | $45^{100°}$ | sl. s. al. |
| nitrate | $Cu(NO_3)_2 \cdot 3H_2O$* | 241.63 | blue, delq. | $2.047^{3.9°}$ | 114.5 | $-HNO_3$, 170 | $381^{40°}$ | $666^{80°}$ | $100^{12.5°}$ al. |
| nitrate | $Cu(NO_3)_2 \cdot 6H_2O$ | 295.68 | blue, rhb. | 2.074 | $-3H_2O$, 26.4 | | $243.7^{0°}$ | ∞ | s. al. |

*Usual commercial form.
†Also a soluble modification.

**TABLE 2-1 Physical Properties of the Elements and Inorganic Compounds** (*Continued*)

| Name | Formula | Formula weight | Color, crystalline form and refractive index | Specific gravity | Melting point, °C | Boiling point, °C | Solubility in 100 parts | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Cold water | Hot water | Other reagents |
| Cupric acetate (*Cont.*) | | | | | | | | | |
| oxide (paramelaconite) | CuO | 79.57 | bk., cb. | 6.40 | d. 1026 | | i. | i. | s. a.; KCN, $NH_4Cl$ |
| oxide (tenorite) | CuO | 79.57 | bk., tri., 2.63 | 6.45 | d. 1026 | | i. | i. | s. a., KCN, $NH_4Cl$ |
| oxychloride | $CuCl_2{\cdot}2CuO{\cdot}4H_2O$ | 365.69 | blue-gn. | | $-3H_2O$, 140 | | i. | | s. a. |
| phosphide | $Cu_3P_2$ | 252.67 | bk. | 6.35 | d. | | i. | | s. $HNO_3$; i. HCl |
| sulfate (hydrocyanite) | $CuSO_4$ | 159.63 | gn.-wh., rhb., 1.733 | $3.606^{15°}$ | d. >600 | Forms CuO, 650 | $14.3^{0°}$ | $75.4^{100°}$ | i. al. |
| sulfate (blue vitriol or chalcanthite) | $CuSO_4{\cdot}5H_2O$* | 249.71 | blue, tri., 1.5368 | $2.286\,\frac{15.6°}{4}$ | $-4H_2O$, 110 | $-5H_2O$, 250 | $24.3^{0°}$ | $205^{100°}$ | $1.1^{8°}$ al. |
| sulfide (covellite) | CuS | 95.63 | blue, hex. or mn., 1.45 | 4.6 | tr. 103 | d. 220 | $0.000033^{18°}$ | | s. $HNO_3$, KCN |
| tartate | $CuC_4H_4O_6{\cdot}3H_2O$ | 265.69 | 1 gn. pd. | | d. | | $0.02^{15°}$ | $0.14^{85°}$ | s. a., KOH |
| Cuprous ammonium iodide | $CuI{\cdot}NH_4I{\cdot}H_2O$ | 353.47 | rhb. pl. | | | | d. | | s. $NH_4I$ |
| carbonate | $Cu_2CO_3$ | 187.15 | yel. | 4.4 | d. | | i. | i. | s. a., $NH_4OH$ |
| chloride (nantokite) | $Cu_2Cl_2$ | 198.05 | wh., cb., 1.973 | 3.53 | 422 | 1366 | $1.52^{25°}$ | | s. HCl, $NH_4OH$, al. |
| cyanide | $Cu_2(CN)_2$ | 179.16 | wh., mn. | 2.9 | 474.5 | d. | i. | i. | s. KCN, HCl, $NH_4OH$; sl. s. $NH_3$ |
| ferricyanide | $Cu_3Fe(CN)_6$ | 402.67 | brn.-red | | | | i. | | s. $NH_4OH$; i. HCl |
| ferrocyanide | $Cu_4Fe(CN)_6$ | 466.24 | brn.-red | | | | i. | | s. $NH_4OH$; i. $NH_4Cl$ |
| fluoride | $Cu_2F_2$ | 165.14 | red cr. | | 908 | subl. 1100 | i. | | s. HF, HCl, $HNO_3$; i. al. |
| hydroxide | CuOH | 80.58 | yel. | 3.4 | –a $H_2O$, 360 | | i. | i. | s. a., $NH_4OH$ |
| oxide (cuprite) | $Cu_2O$ | 143.14 | red, cb., 2.705 | 6.0 | 1235 | –O, 1800 | i. | i. | s. HCl, $NH_4Cl$, $NH_4OH$ |
| Cuprous phosphide | $Cu_6P_2$ | 443.38 | gray-bk. | 6.4 to 6.8 | | | i. | | s. $HNO_3$; i. HCl |
| sulfide (chalcocite) | $Cu_2S$ | 159.20 | bk., rhb. | 5.6 | 1100 | | $0.0005^{18°}$ | | s. $HNO_3$, $NH_4OH$; i. act. |
| sulfide | $Cu_2S$ | 159.20 | bk., cb. | 5.80 | 1130 | | $0.0005^{18°}$ | | s. $HNO_3$, $NH_4OH$; i. act. |
| Cyanogen | $C_2N_2$ | 52.02 | poisonous gas | lq. $0.866^{-17.2°}$; 1.806 (A) | –34.4 | –20.5 | $450^{20°}$ cc | | $2300^{20°}$ cc al.; $500^{18°}$ cc et. |
| Cyanogen compounds, *cf.* table of organic compounds | | | | | | | | | |
| Ferric acetate, basic | $Fe(OH)(C_2H_3O_2)_2$ | 190.95 | brn., amor. | | | | i. | | s. a.; al. |
| ammonium sulfate, *cf.* Alum | | | | | | | | | |
| chloride (molysite) | $FeCl_3$ | 162.22 | bk.-brn., hex. delq. | $2.804^{11°}$ | 282 | 315 | $74.4^{0°}$ | $535.8^{100°}$ | v. s. al.; et. +HCl |
| chloride | $FeCl_3{\cdot}6H_2O$* | 270.32 | red-yel., delq. | | 37 | 280 | $246^{0°}$ | ∞ | s. al., act., gly. |
| ferrocyanide (Prussian blue) | $Fe_4[Fe(CN)_6]_3$ | 859.27 | dark blue | | d. | | i. | d. | s. HCl, conc. $H_2SO_4$; i. al., et. |
| hydroxide | $Fe(OH)_3$ | 106.87 | red-brn. | 3.4 to 3.9 | –1a $H_2O$, 500 | | i. | i. | s. a.; i. al., et. |
| lactate | $Fe(C_3H_5O_3)_3$ | 323.06 | brn., amor., delq. | | | | v. s. | v. s. | i. et. |
| nitrate | $Fe(NO_3)_3{\cdot}6H_2O$ | 349.97 | rhb., delq. | $1.684^{20°}$ | 35 | d. | $150^{0°}$ | ∞ | s. al., act. |
| oxide (hematite) | $Fe_2O_3$ | 159.70 | red or bk., trig., 3.042 | 5.12 | 1560 d. | | i. | | s. HCl |
| sulfate | $Fe_2(SO_4)_3$ | 399.88 | rhb., 1.814 | $3.097^{15°}$ | d. 480 | | sl. s. | d. | i. $H_2SO_4$, $NH_3$ |
| sulfate (coquimbite) | $Fe_2(SO_4)_3{\cdot}9H_2O$ | 562.02 | yel., trig. | 2.1 | | | 440 | d. | s. abs. al. |
| Ferroso-ferric chloride | $FeCl_2{\cdot}2FeCl_3{\cdot}18H_2O$ | 775.49 | yel., delq. | | d. 50 | | s. | s. | |
| ferricyanide (Prussian green) | $Fe''_4Fe''_3[Fe(CN)_6]_6$ | 1662.70 | gn. | | d. 180 | | i. | | s. d. h. HCl |
| oxide (magnetite; magnetic iron oxide) | $Fe_3O_4$ | 231.55 | bk., cb., 2.42 | 5.2 | 1538 d. | | i. | i. | i. al. |
| oxide, hydrated | $Fe_3O_4{\cdot}4H_2O$ | 303.61 | bk. | | d. | | i. | i. | s. a. |
| Ferrous ammonium sulfate | $FeSO_4{\cdot}(NH_4)_2SO_4{\cdot}6H_2O$ | 392.15 | blue-gn., mn., 1.4915 | 1.864 | d. | | $18^{0°}$ | $100^{75°}$ | i. al. |
| chloride (lawrencite) | $FeCl_2$ | 126.76 | gn.-yel., hex., 1.567 | 2.7 | | delq. | $64.4^{10°}$ | $105.7^{100°}$ | 100 al.; s. act.; i. et. |
| chloroplatinate | $FePtCl_6{\cdot}6H_2O$ | 571.92 | yel., hex. | 2.714 | | | v. s. | v. s. | |
| ferricyanide (Turnbull's blue) | $Fe_3[Fe(CN)_6]_2$ | 591.47 | dark blue | | d. | | i. | | i. dil. a., al. |
| ferrocyanide | $Fe_2Fe(CN)_6$ | 323.66 | blue-wh., amor. | | | | i. | | |
| formate | $Fe(HCO_2)_2{\cdot}2H_2O$ | 181.92 | | | d. | | sl. s. | | |
| hydroxide | $Fe(OH)_2$ | 89.87 | lt. gn. | 3.4 | | | 0.00067 | | s. a., $NH_4Cl$ |
| nitrate | $Fe(NO_3)_2{\cdot}6H_2O$ | 287.96 | cr. | | 60.5 | | $200^{0°}$ | $300^{25°}$ | |
| oxide | FeO | 71.85 | bk. | 5.7 | 1420 | | i. | i. | s. a.; i. alk. |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| phosphate (vivianite) | $Fe_3(PO_4)_2 \cdot 8H_2O$ | 501.64 | blue, mn., 1.592, 1.603 | 2.58 | | | i. | i. | s. a.; i. ac. |
| silicate | $FeSiO_3$ | 131.91 | mn. | 3.5 | 1550 | | | | |
| sulfate (siderotilate) | $FeSO_4 \cdot 5H_2O$ | 241.99 | gn., tri., 1.536 | 2.2 | | $-5H_2O$, 300 | s. | s. | i. al. |
| sulfate (copperas) | $FeSO_4 \cdot 7H_2O$* | 278.02 | blue-gn., mn. | $1.899^{14.8°}$ | 64 | $-7H_2O$, 300 | $32.8^{0°}$ | $149^{50°}$ | i. al. |
| sulfide | FeS | 87.91 | bk., hex. | 4.84 | 1193 | d. | $0.000616^{18°}$ | | s. a.; i. $NH_3$ |
| *cf.* also under iron | | | | | | | | | |
| Fluoboric acid | $HBF_4$ | 87.83 | col. lq. | | | 130 d. | ∞ | ∞ | s. al. |
| Fluorine | $F_2$ | 38.00 | gn.-yel. gas | lq. $1.51^{-187°}$; $1.31^{15°}$ (A) | –223 | –187 | d. | | |
| Fluosilicic acid | $H_2SiF_6$ | 144.08 | | | | | s. | s. | |
| Gadolinium | Gd | 156.9 | | | | | | | |
| Gallium bromide | $GaBr_3$ | 309.47 | delq. cr. | | | | s. | s. | |
| Glucinum *cf.* Beryllium | | | | | | | | | |
| Gold | Au | 197.20 | yel. met., cb. | $19.3^{20°}$ | 1063 | 2600 | i. | i. | s. aq. reg., KCN; i. a. |
| Gold, colloidal | Au | 197.20 | blue to vl. | | | | s. | | s. aq. reg., KCN; i. a. |
| Gold salts *cf.* under Auric and Aurous | | | | | | | | | |
| Hafnium | Hf | 178.6 | hex. | 12.1 | >1700 | >3200(?) | | | |
| Helium | He | 4.00 | col. gas | 0.1368 (A) | <–272.2 | –268.9 | $0.97^{0°}$ cc | $1.08^{50°}$ cc | Absorbed by Pt |
| Hydrazine | $N_2H_4$ | 32.05 | col. lq. | $1.011\ \frac{15°}{4}$ | 1.4 | 113.5 | ∞ | ∞ | s. al. |
| formate | $N_2H_4 \cdot 2HCO_2H$ | 124.10 | cb. | | 128 | | s. | | |
| hydrate | $N_2H_4 \cdot H_2O$ | 50.06 | col. | $1.03^{21°}$ | –40 | $118.5^{739.5mm}$ | ∞ | ∞ | ∞ al.; i. et. |
| hydrochloride | $N_2H_4 \cdot HCl$ | 68.51 | yel. lq. | | | | v. s. | v. s. | sl. s. al. |
| hydrochloride, di- | $N_2H_4 \cdot 2HCl$ | 104.98 | wh., cb. | 1.42 | 198 | | s. | v. s. | s. al. |
| nitrate | $N_2H_4 \cdot HNO_3$ | 95.06 | cr. | | 70.7 | subl. 140 | $174.9^{10°}$ | v. s. | |
| nitrate, di- | $N_2H_4 \cdot 2HNO_3$ | 158.08 | nd. | | 104 | d. | v. s. | | |
| sulfate | $N_2H_4 \cdot a\ H_2SO_4$ | 81.09 | delq. pl. | | 85 | | v. s. | | i. al. |
| sulfate | $N_2H_4 \cdot H_2SO_4$ | 130.12 | rhb. | 1.378 | 254 | | $3.055^{22°}$ | $27.65^{60°}$ | v. sl. s. abs. al. |
| Hydrazoic acid (azoimide) | $HN_3$ | 43.03 | col. lq. | | –80 | 37 | ∞ | ∞ | ∞ al. |
| Hydriodic acid | HI | 127.93 | col. gas | $4.4^{0°}$ (A) | –50.8 | –35.5 | $42500^{10°}$ cc | v. s. | s. al. |
| Hydriodic acid | $HI \cdot H_2O$ | 145.94 | col. lq. | $1.7^{15°}$ | | $127^{774mm}$ | ∞ | | ∞ al. |
| Hydriodic acid | $HI \cdot 2H_2O$ | 163.96 | col. lq. | | –43 | | ∞ | | s. al. |
| Hydriodic acid | $HI \cdot 3H_2O$ | 181.98 | col. lq. | | –48 | | ∞ | | s. al. |
| Hydriodic acid | $HI \cdot 4H_2O$ | 199.99 | col. lq. | | –36.5 | | ∞ | | s. al. |
| Hydrobromic acid | HBr | 80.92 | col. gas; 1.325 (lq.) | $2.71^{0°}$ (A) | –86 | –67 | $221^{0°}$ | $130^{100°}$ | s. al. |
| Hydrobromic acid | $HBr \cdot H_2O$ | 98.94 | col. lq. | 1.78 | | | | | Stable at –15.5° and 1 atm., and at –11.3° and 2.5 atm. |
| Hydrobromic acid | HBr (47.8% in $H_2O$) | 80.92 | col. lq. | 1.486 | | 126 | ∞ | | s. al. |
| Hydrobromic acid | $HBr \cdot 2H_2O$ | 116.96 | wh. cr. | $2.11^{-15°}$ | –11 | | s. | s. | |
| Hydrochloric acid | HCl† | 36.47 | col. gas; 1.256 (lq.) | $1.268^{0°}$ (A) | –111 | –85 | $82.3^{0°}$ | $56.1^{60°}$ | s. al., et. |
| Hydrochloric acid | HCl (45.2% in $H_2O$) | 36.47 | col. lq. | 1.48 | –15.35 | | ∞ | | s. al. |
| Hydrochloric acid | $HCl \cdot 2H_2O$ | 72.50 | col. lq. | $1.46\ ^{-18.3°}_{4}$ | 0 | d. | ∞ | | s. al. |
| Hydrochloric acid | $HCl \cdot 3H_2O$ | 90.51 | col. lq. | | –24.4 | d. | ∞ | | s. al. |
| Hydrocyanic acid (prussic acid) | HCN | 27.03 | poisonous gas or col. lq., 1.254 | $0.697^{18°}$ | –14 | 26 | ∞ | | ∞ al., et. |
| Hydrofluoric acid | HF | 20.01 | gas or col. lq. | $0.988^{13.6°}$ | –83 | 19.4 | ∞ 0° to 19.4° | v. s. | |
| Hydrofluoric acid | HF (35.35% in $H_2O$) | 20.01 | col. lq. | 1.15 | –35 | 120 | v. s. | | |
| Hydrogen | $H_2$ | 2.016 | col. gas or cb. | lq. $0.0709^{-252.7°}$ 0.06948 (A) | –259.1 | –252.7 | $2.1^{0°}$ cc | $0.85^{80°}$ cc | sl. s. Fe, Pd, Pt |
| peroxide | $H_2O_2$‡ | 34.02 | col. lq., 1.333 | $1.438\ \frac{20°}{4}$ | –0.89 | $151.4^{760mm}$ | ∞ | | s. a., et.; i. petr. et |
| selenide | $H_2Se$ | 81.22 | col. gas | $2.12^{-42°}$ | –64 | –42 | $377^{4°}$ cc | $270^{22.5°}$ cc | s. $CS_2$, $COCl_2$ |
| sulfide | $H_2S$ | 34.08 | col. gas | 1.1895 (A) | –82.9 | –59.6 | $437^{0°}$ cc | $186^{40°}$ cc | $9.54^{15°}$ cc al.; s. $CS_2$ |
| Hydroxylamine | $NH_2OH$ | 33.03 | rhb., delq. | $1.35^{18°}$ | 34 | $56.5^{22mm}$ | s. | d. | s. a., al. |
| hydrochloride | $NH_2OH \cdot HCl$ | 69.50 | col., mn. | $1.67^{17°}$ | 151 | d. | $83.3^{17°}$ | v. s. | s. al.; i. et. |
| nitrate | $NH_2OH \cdot HNO_3$ | 96.05 | col. cr. | | 48 | d. <100 | v. s. | d. | v. s. abs. al. |
| sulfate | $NH_2OH \cdot a\ H_2SO_4$ | 82.07 | col., mn. | | 170 d. | | $32.9^{0°}$ | $68.5^{90°}$ | v. sl. s. al.; i. et., abs. al. |

*Usual commercial form.
†Usual commercial form about 31 percent.
‡Usual commercial forms 3 or 30 percent.

**TABLE 2-1 Physical Properties of the Elements and Inorganic Compounds** (*Continued*)

| Name | Formula | Formula weight | Color, crystalline form and refractive index | Specific gravity | Melting point, °C | Boiling point, °C | Solubility in 100 parts | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Cold water | Hot water | Other reagents |
| Hypobromous acid | HBrO | 96.92 | yel. | | | $40^{50mm}$ | s. | d. | |
| Illinium | Il | 146(?) | | | | | | | |
| Indium | In | 114.76 | soft, tet. met. | $7.3^{20°}$ | 155 | 1450 | i. | i. | s. a. |
| Iodic acid | $HIO_8$ | 175.93 | col., rhb. | $4.629^{0°}$ | 110 d. | | $286^{0°}$ | $576^{101°}$ | v. s. 87% al.; i. abs. al. et., chl. |
| Iodine | $I_2$ | 253.84 | blue-bk., rhb. | $4.93^{20°}$ | 113.5 | 184.35 | $0.0162^{0°}$ | $0.09566^{60°}$ | s. al., KI, et. |
| oxide, penta- | $I_2O_5$ | 333.84 | wh., trimetric | $4.799\,\frac{25°}{4}$ | d. 300 | | $187.4^{12°}$ | | i. abs. al., et., chl. |
| Iodoplatinic acid | $H_2PtI_6{\cdot}9H_2O$ | 1120.91 | brn., delq. mn. | | | | s. d. | | |
| Iridium | Ir | 193.10 | wh. met., cb. | $22.4^{20°}$ | 2350 | >4800 | i. | i. | sl. s. aq. reg., aq. $Cl_2$ |
| Iron, cast† | Fe | 55.85 | gray | 7.03 | 1275 | | i. | i. | s. a.; i. alk. |
| pure | Fe | 55.85 | silv. met., cb. | $7.86^{20°}$ | 1535 | 3000 | i. | i. | s. a.; i. alk. |
| steel | Fe | 55.85 | silv. gray | 7.6 to 7.8 | 1375 | | i. | i. | s. a.; i. alk. |
| white pig | Fe | 55.85 | gray | 7.6 to 7.8 | 1075 | | i. | i. | s. a.; i. alk. |
| wrought | Fe | 55.85 | gray | 7.86 | 1505 | | i. | i. | s. a.; i. alk. |
| carbide (cementite) | $Fe_2C$ | 179.56 | pseudo hex. | 7.4 | 1837 | | i. | i. | s. a. |
| carbonyl | $Fe(CO)_5$ | 195.90 | pa. yel. lq. | $1.457^{21°}$ | –21 | $102.5^{760mm}$ | i. | | s. al., $H_2SO_4$, alk. |
| nitride | $Fe_2N$ | 125.71 | gray | 6.35 | d. >560 | | d. | | s. HCl, $H_2SO_4$ |
| silicide | FeSi | 83.91 | yel.-gray, oct. | $6.1\,\frac{20°}{4}$ | | | i. | i. | i. aq. reg. |
| sulfide, di- (marcasite) | $FeS_2$ | 119.97 | yel., rhb. | 4.87 | tr. 450 | d. | 0.00049 | | i. dil. a. |
| sulfide, di- (pyrite) | $FeS_2$ | 119.97 | yel., cb. | 5.0 | 1171 | d. | 0.0005 | | i. dil. a. |
| sulfide (pyrrhotite) | $Fe_7S_8$ | 647.43 | hex. | $4.6\,\frac{20°}{4}$ | d. >700 | | i. | | |
| *Cf.* also under ferric and ferrous | | | | | | | | | |
| Krypton | Kr | 83.70 | col. gas | 2.818 (A) | –169 | –151.8 | $11.05^{0°}$ cc | $3.57^{60°}$ cc | sl. s. al., bz. |
| Lanthanum | La | 138.92 | lead gray | $6.15^{20°}$ | 826 | 1800 | d. | | s. a. |
| Lead | Pb | 207.21 | silv. met., cb. | $11.337\,\frac{20°}{20}$ | 327.5 | 1620 | i. | i. | s. $HNO_3$; i. c. HCl, $H_2SO_4$ |
| acetate | $Pb(C_2H_3O_2)_2$ | 325.30 | wh. cr. | $3.251\,\frac{20°}{4}$ | 280 | | $19.7^{0°}$ | $221^{50°}$ | s. gly.; v. sl. s. al. |
| acetate (sugar of lead) | $Pb(C_2H_3O_2)_2{\cdot}3H_2O$† | 379.35 | wh., mn. | 2.55 | $-3H_2O$, 75 | | $45.64^{15°}$ | $200^{100°}$ | s. gly.; sl. s. al. |
| acetate | $Pb(C_2H_3O_2)_2IOH_2O$ | 505.46 | wh., rhb. | 1.689 | 22 | | s. | s. | |
| acetate, basic | $Pb_2(C_2H_3O_2)_3OH$ | 608.56 | wh. | | | | v. s. | | sl. s. al. |
| acetate, basic | $Pb(C_2H_3O_2)_2{\cdot}Pb(OH)_2{\cdot}H_2O$ | 584.54 | wh. nd. | | | | v. s. | | s. al. |
| acetate, basic | $Pb(C_2H_3O_2)_2{\cdot}2Pb(OH)_2$ | 807.75 | wh. nd. | | | | 5.55 | 18.2 | s. al. |
| arsenate, monobasic | $PbH_4(AsO_4)_2$ | 489.06 | tri., 1.82 | $4.46^{15°}$ | d. 140 | | d. | | s. $HNO_3$ |
| arsenate, dibasic (schultenite) | $PbHAsO_4$ | 347.13 | wh., mn., 1.9097 | 5.94 | d. >200 | $-H_2O$, 280 | i. | sl. s. | s. $HNO_3$, NaOH |
| arsenate, meta- | $Pb(AsO_3)_2$ | 453.03 | hex. | $6.42^{15°}$ | | | d. | | s. $HNO_3$ |
| arsenate, pyro- | $Pb_2As_2O_7$ | 676.24 | rhb., 2.03 | $6.85\,\frac{15°}{15}$ | 802 | | i. | d. | s. HCl, $HNO_3$; i. sc. |
| Lead azide | $PbN_6$ | 291.26 | col. nd. | | expl. 350 | | i. | $0.05^{100°}$ | v. s. ac.; i. $NH_4OH$ |
| bromide | $PbBr_2$ | 367.05 | col., rhb. | 6.66 | 373 | 918 | $0.4554^{0°}$ | $4.75^{100°}$ | s. a., KBr.; sl. s. $NH_3$; i. al. |
| carbonate (cerussite) | $PbCO_3$ | 267.22 | wh., rhb., 2.0763 | 6.6 | d. 315 | | $0.00011^{20°}$ | d. | s. a., alk.; i. $NH_3$, al. |
| carbonate, basic (hydrocerussite; white lead) | $2PbCO_3{\cdot}Pb(OH)_2$† | 775.67 | wh., hex. | 6.14 | d. 400 | | i. | i. | s. ac.; sl. s. aq. $CO_2$ |
| chloride (cotunnite) | $PbCl_2$ | 278.12 | wh., rhb., 2.2172 | 5.80 | 501 | $954^{760mm}$ | $0.673^{0°}$ | $3.34^{100°}$ | sl. s. dil. HCl, $NH_3$, i. al. |
| chromate (crocoite) | $PbCrO_4$ | 323.22 | yel., mn., 2.42 | 6.12 | 844 | d. | $0.000007^{20°}$ | i. | s. a., alk.; i. $NH_3$, ac. |
| chromate, basic | $PbCrO_4{\cdot}PbO$ | 546.43 | or.-yel. nd. | | | | i. | i. | s. a., alk. |
| formate | $Pb(HCO_2)_2$ | 297.25 | wh., rhb. | 4.56 | d. 190 | | $1.6^{16°}$ | $18^{100°}$ d. | i. al. |
| hydroxide | $3PbO{\cdot}H_2O$ | 687.65 | cb. | 7.592 | $-H_2O$, 130 | | 0.014 | | s. a., alk. |
| nitrate | $Pb(NO_3)_2$ | 331.23 | col., cb. or mn., 1.7815 | 4.53 | d. 470 | | $38.8^{0°}$ | $138.8^{100°}$ | $8.8^{22°}$ al. |
| oxide, sub- | $Pb_2O$ | 430.42 | bk., amor. | 8.34 | d. red heat | | i. | i. | s. a., alk. |
| oxide, mono- (litharge) | PbO | 223.21 | yel., tet. | 9.53 | 888 | | $0.0068^{18°}$ | | s. alk., PbAc, $NH_4Cl$, $CaCl_2$ |
| oxide, mono (massicotite) | PbO | 223.21 | yel., rhb., 2.61 | 8.0 | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| oxide, mono- | PbO | 223.21 | amor. | 9.2 to 9.5 | | | i. | i. | s. alk., PbAc, $NH_4Cl$, $CaCl_2$ |
| oxide, red (minium) | $Pb_3O_4$ | 685.63 | red, amor. | 9.1 | d. 500 | | i. | i. | s. ac., h. HCl |
| oxide, sesqui- | $Pb_2O_3$ | 462.42 | red-yel., amor. | | d. 360 | | i. | i. | s. a., alk. |
| oxide, di- (plattnerite) | $PbO_2$ | 239.21 | brn., tet., 2.229 | 9.375 | d. 290 | | i. | i. | s. ac., h. alk.; i. al. |
| silicate | $PbSiO_3$ | 283.27 | col., mn., 1.961 | 6.49 | 766 | | i. | | s. a. |
| sulfate (anglesite) | $PbSO_4$ | 303.27 | wh., mn. or rhb., 1.8823 | 6.2 | 1170 | | $0.0028^{0°}$ | $0.0056^{40°}$ | s. conc. a., $NH_4$ salts; i. al. |
| sulfate, acid | $Pb(HSO_4)_2 \cdot H_2O$ | 419.36 | cr. | | d. | | $0.0001^{18°}$ | | sl. s. $H_2SO_4$ |
| sulfate, basic (lanarkite) | $PbSO_4 \cdot PbO$ | 526.48 | col., mn. | 6.92 | 977 | | $0.0044^{18°}$ | | sl. s. $H_2SO_4$ |
| sulfide (galena) | PbS | 239.27 | lead gray, cb., 3.912 | 7.5 | 1120 | | $0.00009^{18°}$ | i. | s. a.; i. alk. |
| thiocyanate | $Pb(CNS)_2$ | 323.37 | col., mn. | 3.82 | d. 190 | | $0.05^{20°}$ | s. | s. KCNS, $HNO_3$ |
| Lithium | Li | 6.94 | silv. met. cb. | $0.53^{20°}$ | 186 | 1336 ± 5 | d. | d. | s. a., $NH_3$ |
| benzoate | $LiC_7H_5O_2$ | 128.05 | wh. leaflets | | | | $33^{25°}$ | $40^{100°}$ | $7.7^{25°}$, $10^{78°}$ al. |
| bromide | LiBr | 86.86 | wh., delq., cb., 1.784 | $3.464\,\frac{25°}{4}$ | 547 | 1265 | $143^{0°}$ ($2H_2O$) | $266^{100°}$ ($1H_2O$) | s. al., act. |
| bromide | $LiBr \cdot 2H_2O$ | 122.89 | wh. pr. | | 44 | | $246^{20°}$ | | s. al. |
| carbonate | $Li_2CO_3$ | 73.89 | col., mn., 1.567 | $2.11^{0°}$ | 618 | d. | $1.54^{0°}$ | $0.72^{100°}$ | s. dil. a.; i. al., act., $NH_3$ |
| chloride | LiCl | 42.40 | wh., delq., cb., 1.662 | $2.068\,\frac{25°}{4}$ | 614 | 1360 | $67^{0°}$ | $127.5^{100°}$ | $2.48^{15°}$ al.; s. et. |
| citrate | $Li_3C_6H_5O_7 \cdot 4H_2O$ | 281.98 | wh. cr. | | d. | | $61.2^{15°}$ | $66.7^{100°}$ | sl. s. al., et. |
| fluoride | LiF | 25.94 | wh., cb., 1.3915 | $2.295^{21.5°}$ | 870 | 1670 | $0.27^{18°}$ | $0.135^{35°}$ | s. HF; i. act. |
| formate | $LiHCO_2 \cdot H_2O$ | 69.97 | col., rhb. | 1.46 | $-H_2O$, 94 | | $49.2^{0°}$ | $346.6^{104°}$ | sl. s. al., et. |
| hydride | LiH | 7.95 | wh., cb. | 0.820 | 680 | | d. | | i. et. |
| hydroxide | LiOH | 23.95 | wh. cr. | 2.54 | 445 | 925± | $12.7^{0°}$ | $17.5^{100°}$ | sl. s. al. |
| hydroxide | $LiOH \cdot H_2O$ | 41.96 | col., mn. | 1.83 | | d. | $22.3^{10°}$ | $26.8^{80°}$ | sl. s. al. |
| nitrate | $LiNO_3$ | 68.95 | col., trig., 1.735 | 2.38 | 261 | | $53.4^{0°}$ | $194^{70°}$ | s. al., $NH_3$ |
| nitrate | $LiNO_3 \cdot 3H_2O$ | 123.00 | col. | | 29.88 | | v. s. | ∞ | |
| oxide | $Li_2O$ | 29.88 | col., 1.644 | $2.013\,\frac{25°}{4}$ | | subl. <1000 | forms LiOH | | |
| phosphate, monobasic | $LiH_2PO_4$ | 103.94 | col. | 2.461 | >100 | | | | |
| phosphate, tribasic | $Li_3PO_4$ | 115.80 | wh., rhb. | $2.537^{17.5°}$ | 837 | | $0.034^{18°}$ | v. sl. s. | s. a., $NH_4Cl$; i. act. |
| phosphate, tribasic | $Li_3PO_4 \cdot 12H_2O$ | 331.99 | wh., trig. | 1.645 | 100 | | v. sl. s. | v. sl. s. | |
| salicylate | $LiC_7H_5O_3$ | 144.05 | col. | | d. | | $128^{26°}$ | | v. s. al. |
| sulfate | $Li_2SO_4$ | 109.94 | col., mn., 1.465 | 2.22 | 860 | | $35.34^{0°}$ | $29.9^{100°}$ | i. act., 80% al. |
| sulfate | $Li_2SO_4 \cdot H_2O$† | 127.96 | col., mn., 1.477 | 2.06 | $-H_2O$, 130 | | $43.6^{0°}$ | $35^{100°}$ | i. 80% al. |
| sulfate, acid | $LiHSO_4$ | 104.01 | pr. | $2.123^{13°}$ | 170.5 | | d. | | |
| Lutecium | Lu | 174.99 | | | | | | | |
| Magnesium | Mg | 24.32 | silv. met., hex. | $1.74^{20°}$ | 651 | 1110 | i. | sl. s. d. | s. a., $NH_4$ salts |
| acetate | $Mg(C_2H_3O_2)_2$ | 142.41 | wh. | 1.42 | 323 | | v. s. | v. s. | $5.25^{15°}$ m. al. |
| acetate | $Mg(C_2H_3O_2)_2 \cdot 4H_2O$† | 214.47 | wh., mn. pr., 1.491 | 1.454 | 80 | | v. s. | v. s. | v. s. al. |
| aluminate (spinel) | $MgO \cdot Al_2O_3$ | 142.26 | col. cb., 1.718–23 | 3.6 | 2135 | | i. | | v. sl. s. dil. HCl; i. dil. $HNO_3$ |
| ammonium chloride | $MgCl_2 \cdot NH_4Cl \cdot 6H_2O$ | 256.83 | wh., rhb., delq. | 1.456 | $-4H_2O$, 195 | | 16.7 | s. | |
| ammonium phosphate (struvite) | $MgNH_4PO_4 \cdot 6H_2O$ | 245.44 | col., rhb., 1.496 | 1.715 | d. 100 | | $0.0231^{0°}$ | $0.0195^{80°}$ | s. a.; i. al. |
| ammonium sulfate (boussingaultite) | $MgSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$ | 360.62 | col., mn. | 1.72 | >120 | | $16.86^{0°}$ | $130^{100°}$ | |
| benzoate | $Mg(C_7H_5O_2)_2 \cdot 3H_2O$ | 320.59 | wh. pd. | | $-3H_2O$, 110 | | $4.5^{25°}$ (anh.) | s. | s. act. |
| carbonate (magnesite) | $MgCO_3$ | 83.43 | wh., trig. 1.700 | 3.037 | d. 350 | | 0.0106 | | s. a., aq. $CO_2$; i. act., $NH_3$ |
| carbonate (nesquehonite) | $MgCO_3 \cdot 3H_2O$ | 138.38 | col., rhb., 1.501 | 1.852 | $-H_2O$, 100 | | $0.1518^{19°}$ | d. | s. a., aq. $CO_2$ |
| carbonate, basic (hydromagnesite) | $3MgCO_3 \cdot Mg(OH)_2 \cdot 3H_2O$ | 365.37 | wh., rhb., 1.530 | 2.16 | d. | | 0.04 | 0.011 | s. a., $NH_4$ salts; i. al. |
| Magnesium chloride (chloromagnesite) | $MgCl_2$ | 95.23 | col., hex., 1.675 | $2.325^{25°}$ | 712 | 1412 | $52.8^{0°}$ | $73^{100°}$ | 50 al. |
| chloride (bischofite) | $MgCl_2 \cdot 6H_2O$† | 203.33 | wh., delq., mn., 1.507 | 1.56 | 118 d. | d. | $281^{0°}$ | $918^{100°}$ | 50 al. |
| hydroxide (brucite) | $Mg(OH)_2$ | 58.34 | wh., trig., 1.5617 | 2.4 | d. | | $0.0009^{18°}$ | | s. $NH_4$ salts, dil. a. |
| nitride | $Mg_3N_2$ | 100.98 | gn.-yel., amor. | | d. | | i. | d. | s. a.; i. al. |
| oxide (magnesia; periclase) | MgO | 40.32 | col., cb., 1.7364 | 3.65 | 2800 | 3600 | 0.00062 | | s. a., $NH_4$ salts; i. al. |
| perchlorate | $Mg(ClO_4)_2$† | 223.23 | wh., delq. | $2.60^{25°}$ | d. | | $99.6^{25°}$ | v. s. | $24^{25}$ al., $51.8^{25°}$ m. al.; 0.29 et. |

*See also a table of alloys.
†Usual commercial form.

**TABLE 2-1 Physical Properties of the Elements and Inorganic Compounds** (*Continued*)

| Name | Formula | Formula weight | Color, crystalline form and refractive index | Specific gravity | Melting point, °C | Boiling point, °C | Solubility in 100 parts | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Cold water | Hot water | Other reagents |
| Magnesium chloride (*Cont.*) | | | | | | | | | |
| peroxide | $MgO_2$ | 56.32 | wh. pd. | | expl. 275 | | i. | i. | s. a. |
| phosphate, pyro- | $Mg_2P_2O_7$ | 222.60 | col., mn., 1.604 | $2.598^{22°}$ | 1383 | | i. | i. | s. a.; i. alk. |
| phosphate, pyro- | $Mg_2P_2O_7{\cdot}3H_2O$ | 276.65 | wh., amor. | 2.56 | $-3H_2O$, 100 | | i. | sl. s. | s. a.; i. al. |
| potassium chloride (carnallite) | $MgCl_2{\cdot}KCl{\cdot}6H_2O$ | 277.88 | delq., rhb., 1.475 | $1.60\,\frac{19.4°}{4}$ | 265 | | $64.5^{19°}$ d. | d. | d. al. |
| potassium sulfate (picromerite) | $MgSO_4{\cdot}K_2SO_4{\cdot}6H_2O$ | 402.73 | mn., 1.4629 | 2.15 | d. 72 | | $19.26^{0°}$ | $81.7^{75°}$ | |
| silicofluoride | $MgSiF_6{\cdot}6H_2O$ | 274.48 | col., trig., 1.3439 | $1.788\,\frac{17.5°}{4}$ | d. | | $64.8^{17.5°}$ | s. | d. HF |
| sodium chloride | $MgCl_2{\cdot}NaCl{\cdot}H_2O$ | 171.70 | col. | | | | s. | s. | |
| sulfate | $MgSO_4$ | 120.38 | col. | 2.66 | 1185 | | $26.9^{0°}$ | $68.3^{100°}$ | s. al. |
| sulfate (epsom salt; epsomite) | $MgSO_4{\cdot}7H_2O$° | 246.49 | col., rhb., 1.4554 | 1.68 | 70 d. | | $72.4^{0°}$ | $178^{40°}$ | s. al. |
| Manganese | Mn | 54.93 | gray-pink met. | $7.2^{20°}$ | 1260 | 1900 | d. | | s. dil. a. |
| acetate | $Mn(C_2H_3O_2)_2$ | 173.02 | | $1.74\,\frac{20°}{4}$ | | | s. | s. | |
| acetate | $Mn(C_2H_3O_2)_2{\cdot}4H_2O$° | 245.08 | pa. pink, mn. | 1.589 | | | s. | $64.5^{50°}$ | s. al., m. al. |
| carbonate (rhodocrosite) | $MnCO_3$ | 114.94 | rose, trig., 1.817 | 3.125 | d. | | $0.0065^{25°}$ | | s. aq. $CO_2$, dil. a.; l. $NH_3$, al. |
| chloride (scacchite) | $MnCl_2$ | 125.84 | rose, delq., cb. | $2.977\,\frac{25°}{4}$ | 650 | 1190 | $63.4^{0°}$ | $123.8^{100°}$ | s. al.; i. et., $NH_3$ |
| chloride | $MnCl_2{\cdot}4H_2O$° | 197.91 | rose red, delq., mn. 1.575 | 2.01 | 58.0 | $-H_2O$, 106; $-4H_2O$, 200 | $151^{8°}$ | ∞ | s. al.; i. et. |
| chloride, per- | $MnCl_4$ | 196.76 | gn. | | | | s. | s. | s. al., et. |
| hydroxide (ous) (pyrochroite) | $Mn(OH)_2$ | 88.95 | wh., trig. | $3.258^{18°}$ | d. | | $0.002^{20°}$ | i. | s. a., $NH_4$ salts; i. alk. |
| hydroxide (ic) (manganite) | $Mn_2O_3{\cdot}H_2O$ | 175.88 | brn., rhb., 2.24 | 3.258 | d. | | i. | i. | s. h. $H_2SO_4$ |
| nitrate | $Mn(NO_3)_2{\cdot}6H_2O$ | 287.04 | rose red, mn. | $1.82^{21°}$ | 25.8 | 129.5 | $426^{0°}$ | ∞ | v. s. al. |
| oxide (ous) (manganosite) | MnO | 70.93 | gray-gn., cb., 2.16 | 5.18 | 1650 | | i. | i. | s. a., $NH_4Cl$ |
| oxide (ic) | $Mn_2O_3$ | 157.86 | brn.-bk., cb. | 4.81 | –0, 1080 | | i. | i. | s. a.; i. act. |
| oxide, di- (pyrolusite; polianite) | $MnO_2$* | 86.93 | bk., rhb. | 5.026 | –0, >230 | | i. | i. | s. HCl; i. $HNO_3$, act. |
| sulfate (ous) | $MnSO_4$ | 150.99 | red-wh. | 3.235 | 700 | d. 850 | $53^{0°}$ | $73^{50°}$ | s. al.; i. et. |
| sulfate (ous) (szmikite) | $MnSO_4{\cdot}H_2O$ | 169.01 | pa. pink, mn., 1.595 | 2.87 | Stable 57 to 117 | | $98.47^{48°}$ | $79.77^{100°}$ | |
| sulfate (ous) | $MnSO_4{\cdot}2H_2O$ | 187.02 | | $2.526^{15°}$ | Stable 40 to 57 | | $85.27^{35°}$ | $106.8^{55°}$ | |
| sulfate (ous) | $MnSO_4{\cdot}3H_2O$ | 205.04 | | $2.356^{15°}$ | Stable 30 to 40 | | $74.22^{5°}$ | $99.31^{57°}$ | |
| sulfate (ous) | $MnSO_4{\cdot}4H_2O$° | 223.05 | pink, rhb. or mn., 1.518 | 2.107 | Stable 18 to 30 | $-4H_2O$, 450 | $136^{16°}$ | $169^{50°}$ | i. al. |
| sulfate (ous) | $MnSO_4{\cdot}5H_2O$ | 241.07 | pink, tri., 1.508 | $2.103^{15°}$ | Stable 8 to 18 | | $142^{5°}$ | $200^{35°}$ | |
| sulfate (ous) | $MnSO_4{\cdot}6H_2O$ | 259.09 | | | Stable –5 to +8 | | $204^{0°}$ | $247^{9°}$ | |
| sulfate (ous) | $MnSO_4{\cdot}7H_2O$ | 277.10 | pink, mn. or rhb. | 2.092 | Stable –10 to –5; 19 d. | $-7H_2O$, 280 | $176^{0°}$ | $251^{14°}$ | |
| sulfate (ic) | $Mn_2(SO_4)_3$ | 398.04 | gn., delq. cr. | 3.24 | d. 160 | | v. s. | d. | s. HCl, dil. $H_2SO_4$; l. conc. $H_2SO_4$, $HNO_3$ |
| Masurium | Ma | 98–99.5 | | 11.5 | 2300 (?) | | | | |
| Mercuric acetate | $Hg(C_2H_3O_2)_2$ | 318.70 | wh. pl. | 3.270 | d. | | $25^{10°}$ | $100^{100°}$ | s. al. sl. d. |
| bromide | $HgBr_2$ | 360.44 | wh., rhb. | 6.053 | 237 | 322 | $0.5^{20°}$ | $25^{100°}$ | $25.2^{0°}$ al.; v. sl. s. et. |
| carbonate, basic | $HgCO_3{\cdot}2HgO$ | 693.84 | brn.-red | | | | i. | | s. aq. $CO_2$, $NH_4Cl$ |
| chloride (corrosive sublimate) | $HgCl_2$ | 271.52 | wh., rhb., 1.859 | 5.44 | 277 | 304 | $3.6^{0°}$ | $61.3^{100°}$ | $33^{25°}$ 99% al.; 33 et. |
| fulminate | $Hg(CNO)_2$ | 284.65 | cb. | 4.42 | expl. | | sl. s. | | s. $NH_4OH$, al. |
| hydroxide | $Hg(OH)_2$ | 234.63 | | | $-H_2O$, 175 | | i. | i. | s. a. |
| oxide (montroydite) | HgO | 216.61 | yel. or red, rhb., 2.5 | 11.14 | d. 100 | | $0.0052^{25°}$ | $0.041^{100°}$ | s. a.; i. al. |
| oxychloride (kleinite) | $HgCl_2{\cdot}3HgO$ | 921.35 | yel., hex. | 7.93 | d. 260 | | i. | d. | s. HCl |
| silicofluoride, basic | $HgSiF_6{\cdot}HgO{\cdot}3H_2O$ | 613.33 | yel. nd. | | | | d. | | s. a. |
| sulfate | $HgSO_4$ | 296.67 | wh., rhb. | 6.47 | d. | | d. | | s. a.; i. al., act., $NH_8$ |
| sulfate, basic (turpeth) | $HgSO_4{\cdot}2HgO$ | 729.89 | yel., tet. | 6.44 | | | 0.005 | $0.167^{100°}$ | s. a.; i. al. |
| Mercurous acetate | $HgC_2H_3O_2$ | 259.65 | wh. sc. | | d. | | $0.75^{13°}$ | d. | s. $H_2SO_4$, $HNO_3$; i. al. |
| bromide | HgBr | 280.53 | wh., tet. | 7.307 | subl. 345 | | $7 \times 10^{-9}$ | i. | s. a.; i. al., act. |
| carbonate | $Hg_2CO_3$ | 461.23 | yel. pd. | | d. 130 | | i. | d. | s. $NH_4Cl$ |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| chloride (calomel) | HgCl | 236.07 | wh., tet., 1.9733 | 7.150 | 302 | 383.7 | $0.0014^{0°}$ | $0.0007^{43°}$ | s. aq. reg., $Hg(NO_3)_2$; sl. s. $HNO_3$, HCl; i. al., etc. |
| iodide | HgI | 327.53 | yel., tet. | 7.70 | 290 d. | subl. 140; 310d. | $2 \times 10^{-8}$ | v. sl. s. | s. KI; i. al. |
| nitrate | $HgNO_3 \cdot H_2O$ | 280.63 | wh. mn. | $4.785^{3.9°}$ | 70 | expl. | v. s. | d. | s. $HNO_3$; i. al., et. |
| Mercurous oxide | $Hg_2O$ | 417.22 | bk. | 9.8 | d. 100 | | i. | 0.0007 | s. h. ac.; i. alk., dil. HCl, $NH_3$ |
| sulfate | $Hg_2SO_4$ | 497.28 | wh., mn. | 7.56 | d. | | $0.055^{16.5°}$ | $0.092^{100°}$ | s. $H_2SO_4$, $HNO_3$ |
| Mercury† | Hg | 200.61 | silv. lq. or hex.(?) | $13.546^{20°}$ | –38.87 | 356.9 | i. | i. | s. $HNO_3$; i. HCl |
| Molybdenum | Mo | 95.95 | gray, cb. | 10.2 | 2620 ± 10 | 3700 | i. | i. | s. h. conc. $H_2SO_4$; i. HCl, HF, $NH_3$, dil. $H_2SO_4$, Hg |
| chloride, di- | $MoCl_2$ | 166.85 | yel., amor. | $3.714\,\frac{25°}{4}$ | d. | | i. | i. | s. HCl, $H_2SO_4$, $NH_4OH$, al., et. |
| chloride, tri- | $MoCl_3$ | 202.32 | dark red pd. | $3.578\,\frac{25°}{4}$ | d. | | i. | d. | s. $HNO_3$, $H_2SO_4$; v. sl. s. al., et. |
| chloride, tetra- | $MoCl_4$ | 237.78 | brn., delq. | | volt. | d. | s. | d. | s. $HNO_3$, $H_2SO_4$; sl. s. al., et. |
| chloride, penta- | $MoCl_5$ | 273.24 | bk. cr. | $2.928\,\frac{25°}{4}$ | 194 | 268 | s. | d. | s. $HNO_3$, $H_2SO_4$; i. abs. al., et. |
| oxide, tri- (molybdite) | $MoO_3$ | 143.95 | col., rhb. | $4.50^{19.5°}$ | 795 | subl. | $0.107^{18°}$ | $2.106^{79°}$ | s. a., $NH_4OH$ |
| sulfide, di- (molybdenite) | $MoS_2$ | 160.07 | bk., hex., 4.7 | $4.801^{14°}$ | 1185 | | i. | i. | s. $H_2SO_4$, aq. reg. |
| sulfide, tri- | $MoS_3$ | 192.13 | red-brn. | | d. | | sl. s. | s. | s. alk. sulfides |
| sulfide, tetra- | $MoS_4$ | 224.19 | brn. pd. | | d. | | i. | i. | s. alk. sulfides; i. $NH_3$ |
| Molybdic acid | $H_2MoO_4$ | 161.97 | yel-wh., hex. | | d. 115 | | v. sl. s. | sl. s. | s. $NH_4OH$, $H_2SO_4$; i. NH |
| Molybdic acid | $H_2MoO_4 \cdot H_2O$ | 179.98 | yel., mn. | $3.124^{15°}$ | $-H_2O$, 70 | $-2H_2O$, 200 | $0.133^{18°}$ | $2.13^{70°}$ | s. a., $NH_4OH$, $NH_4$, salts |
| Neodymium | Nd | 144.27 | yellowish | $6.9^{20°}$ | 840 | | d. | | |
| Neon | Ne | 20.18 | col. gas | lq. $1.204^{-245.9°}$ 0.674 (A) | –248.67 | –245.9 | $2.6^{0°}$ cc | $1.1^{45°}$ cc | s. lq. $O_2$, al., act., bz. |
| Neptunium | $Np^{239}$ | 239 | | | Produced by Neutron bombardment of $U^{238}$ | | | | |
| Nickel | Ni | 58.69 | silv. met., cb. | $8.90^{20}$ | 1452 | 2900 | i. | i. | s. dil. $HNO_3$; sl. s. $H_2SO_4$, HCl; i. $NH_3$ |
| acetate | $Ni(C_2H_3O_2)_2$ | 176.78 | gn. pr. | 1.798 | d. | | 16.6 | | i. al. |
| ammonium chloride | $NiCl_2 \cdot NH_4Cl \cdot 6H_2O$ | 291.20 | gn., delq., mn. | 1.645 | | | $150^{25°}$ | v. s. | |
| ammonium sulfate | $NiSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$ | 394.99 | blue-gn., mn., 1.5007 | 1.923 | | | $2.5^{3.5°}$ | $39.2^{88°}$ | v. sl. s. $(NH_4)_2SO_4$ |
| bromate | $Ni(BrO_3)_2 \cdot 6H_2O$ | 422.62 | gn., cb. | 2.575 | d. | | 28 | | s. $NH_4OH$ |
| bromide | $NiBr_2$ | 218.52 | yel., delq. | $4.64\,\frac{28°}{4}$ | d. | | $112.8^{0°}$ | $156^{100°}$ | s. al., et., $NH_4OH$ |
| bromide | $NiBr_2 \cdot 3H_2O$ | 272.57 | gn., delq. | | $-3H_2O$, 200 | | $199^{9°}$ | $316^{100°}$ | s. al., et., $NH_4OH$ |
| bromide, ammonia | $NiBr_2 \cdot 6NH_3$ | 320.71 | vl. pd. | 1.837 | | | v. s. | d. | i. c. $NH_4OH$ |
| bromoplatinate | $NiPtBr_6 \cdot 6H_2O$ | 841.51 | trig. | 3.715 | | | | | |
| carbonate | $NiCO_3$ | 118.70 | lt. gn., rhb. | | d. | | $0.0093^{25°}$ | i. | s. a. |
| carbonate, basic | $2NiCO_3 \cdot 3Ni(OH)_2 \cdot 4H_2O$ | 587.58 | lt. gn. | | d. | | i. | d. | s. a., $NH_4$ salts |
| carbonyl | $Ni(CO)_4$ | 170.73 | lq. | $1.31^{17°}$ | –25 | $43^{751mm}$ | $0.018^{9.8°}$ | i. | s. aq. reg., $HNO_3$, al., et. |
| chloride | $NiCl_2$ | 129.60 | yel., delq. | 3.544 | subl. | 973 | $53.8^{0°}$ | $87.6^{100°}$ | s. $NH_4OH$, al.; i. $NH_3$ |
| chloride | $NiCl_2 \cdot 6H_2O$* | 237.70 | gn., delq., mn., 1.57± | | | | 180 | v. s. | v. s. al. |
| chloride, ammonia | $NiCl_2 \cdot 6NH_3$ | 231.80 | | | | | s. | d. | s. $NH_4OH$; i. al. |
| cyanide | $Ni(CN)_2 \cdot 4H_2O$ | 182.79 | gn. pl. | | $-4H_2O$, 200 | d. | i. | i. | s. KCN; i. dil. KCl |
| dimethylglyoxime | $NiC_8H_{14}O_4N_4$ | 288.91 | scarlet red cr. | | subl. 250 | | i. | i. | s. abs. al., a.; i. ac., $NH_4OH$ |
| formate | $Ni(HCO_2)_2 \cdot 2H_2O$ | 184.76 | gn. cr. | 2.154 | d. | | s. | | |
| hydroxide (ic) | $Ni(OH)_3$ | 109.71 | bk. | | d. | | i. | i. | s. a., $NH_4OH$, $NH_4Cl$ |
| hydroxide (ous) | $Ni(OH)_2 \cdot d\ H_2O$ | 97.21 | lt. gn. | 4.36 | d. | | v. sl. s. | v. sl. s. | s. a., $NH_4OH$; i. alk. |
| nitrate | $Ni(NO_3)_2 \cdot 6H_2O$ | 290.80 | gn., mn. | 2.05 | 56.7 | 136.7 | $243.0^{0°}$ | $\infty^{56.7°}$ | s. $NH_4OH$; i. abs. al. |
| nitrate, ammonia | $Ni(NO_3)_2 \cdot 4NH_3 \cdot 2H_2O$ | 286.87 | | | | | v. s. | | i. al. |
| oxide, mono- (bunsenite) | NiO | 74.69 | gn.-bk., cb., 2.37 | 7.45 | Forms $Ni_2O_3$ at 400 | | i. | i. | s. a., $NH_4OH$ |
| potassium cyanide | $Ni(CN)_2 \cdot 2KCN \cdot H_2O$ | 258.97 | red yel., mn. | $1.875^{11°}$ | $-H_2O$, 100 | | s. | | d. a. |
| sulfate | $NiSO_4$ | 154.75 | yel., cb. | 3.68 | $-SO_3$, 840 | | $27.2^{0°}$ | $76.7^{100°}$ | i. al., et., act. |

*Usual commercial form.
†See also Tables 2-28 and 2-280.

**TABLE 2-1 Physical Properties of the Elements and Inorganic Compounds** (*Continued*)

| Name | Formula | Formula weight | Color, crystalline form and refractive index | Specific gravity | Melting point, °C | Boiling point, °C | Solubility in 100 parts | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Cold water | Hot water | Other reagents |
| Nickel (*Cont.*) | | | | | | | | | |
| sulfate | $NiSO_4 \cdot 6H_2O$° | 262.85 | gn. mn. or blue, tet., 1.5109 | 2.07 | tr. 53.3 | $-6H_2O$, 280 | $131^{50°}$ | $280^{100°}$ | v. s. $NH_4OH$, al. |
| sulfate (morenosite) | $NiSO_4 \cdot 7H_2O$ | 280.86 | gn., rhb., 1.4893 | 1.948 | 98–100 | $-6H_2O$, 103 | $63.5^{0°}$ | $117.8^{30°}$ | s. al. |
| Nitric acid | $HNO_3$ | 63.02 | col. lq. | 1.502 | –42 | 86 | ∞ | ∞ | expl. with al. |
| Nitric acid | $HNO_3 \cdot H_2O$ | 81.03 | col. lq. | | –38 | | ∞ | ∞ | d. al. |
| Nitric acid | $HNO_3 \cdot 3H_2O$ | 117.06 | col. lq. | | –18.5 | | $263^{-20°}$ | ∞ | d. al. |
| Nitro acid sulfite | $NO_2HSO_3$ | 127.08 | col., rhb. | | 73 d. | | d. | | s. $H_2SO_4$ |
| Nitrogen | $N_2$ | 28.02 | col. gas or cb. cr. | $1.026^{-252.5°}$ $0.808^{-195.8°}$ $12.5^{0°}$ (D) | –209.86 | –195.8 | $2.35^{0°}$ cc | $1.55^{20°}$ cc | sl. s. al. |
| Nitrogen oxide, mono- (ous) | $N_2O$ | 44.02 | col. gas | lq. $1.226^{-89°}$ 1.530 (A) | –102.3 | –90.7 | $130.52^{0°}$ cc | $60.82^{24°}$ cc | s. $H_2SO_4$, al. |
| oxide, di- (ic) | NO or $(NO)_2$ | 30.01 (60.02) | col. gas | lq. $1.269^{-150.2°}$ 1.0367 (A) | –161 | –151 | $7.34^{0°}$ cc | $0.0^{100°}$ | 26.6 cc al.; 3.5 cc $H_2SO_4$; s. aq. $FeSO_4$ |
| oxide, tri- | $N_2O_3$ | 76.02 | red-brn. gas or blue lq. or solid | $1.447^{2°}$ | –102 | 3.5 | s. | | s. a., et. |
| oxide, tetra- (per- or di-) | $NO_2$ or $(NO_2)_2$ | 46.01 (92.02) | yel. lq., col. solid, red-brn. gas | $1.448^{20°}$ | –9.3 | 21.3 | d. | | s. $HNO_3$, $H_2SO_4$, chl., $CS_2$ |
| oxide, penta- | $N_2O_5$ | 108.02 | wh., rhb. | $1.63^{18°}$ | 30 | 47 | s. | Forms $HNO_3$ | |
| oxybromide | NOBr | 109.92 | brn. lq. | >1.0 | –55.5 | –2 | d. | | |
| oxychloride | NOCl | 65.47 | red-yel. lq. or gas | $1.417^{-12°}$ 2.31 (A) | –64.5 | –5.5 | d. | | s. fuming $H_2SO_4$ |
| Nitroxyl chloride | $NO_2Cl$ | 81.47 | yel.-brn. gas | lq. $1.32^{14°}$ | <–30 | 5 | d | | |
| Osmium | Os | 190.2 | blue, hex. | $22.48^{20°}$ | 2700 | >5300 | i. | i. | sl. s. aq. reg., $HNO_3$; i. $NH_3$ |
| chloride, di- | $OsCl_2$ | 261.11 | gn., delq. | | | | s. d. | | s. NaCl, al., et. |
| chloride, tri- | $OsCl_3$ | 296.57 | brn., cb. | | d. 560–600 | | sl. s. | | s. a., alk., al.; sl. s. et. |
| chloride, tetra- | $OsCl_4$ | 332.03 | red-yel. nd. | | | | s. d. | | s. HCl, al. |
| Oxygen | $O_2$ | 32.00 | col. gas or hex. solid | $1.14^{-188°}$ $1.426^{-252.5°}$ 1.1053 (A) | –218.4 | –183 | $4.89^{0°}$ cc | $2.6^{30°}$ cc $1.7^{100°}$ cc | sl. s. al., s. fused Ag |
| Ozone | $O_3$ | 48.00 | col. gas | $1.71^{-183°}$ $3.03^{-80°}$ 1.658 (A) | –251 | –112 | $0.494^{0°}$ cc | $0^{60°}$ cc | s. oil turp., oil cinn. |
| Palladium | Pd | 106.70 | silv. met., cb. | $12.0^{20°}$ $11^{1550°}$ | 1555 | 2200 | i. | i. | s. aq. reg., h. $H_2SO_4$; i. $NH_3$ |
| bromide (ous) | $PdBr_2$ | 266.53 | brn. | | | | i. | i. | s. HBr |
| chloride | $PdCl_2$ | 177.61 | brn., cb. | | 500 d. | | s. | s. | s. HCl, act., al. |
| chloride | $PdCl_2 \cdot 2H_2O$ | 213.65 | brn. pr. | | | | s. | s. | s. HCl, act., al. |
| cyanide | $Pd(CN)_2$ | 158.74 | yel. | | d. | | i. | i. | s. HCN, KCN, $NH_4OH$; i. dil. a. |
| hydride | $Pd_2H$ | 214.41 | met. | 11.06 | d. | | | | |
| Palladous dichlorodiammine | $Pd(NH_3)_2Cl_2$ | 211.68 | red or yel., tet. | 2.5 | | | s. | | s. a., $NH_4OH$ |
| Perchloric acid | $HClO_4$ | 100.46 | unstable, col. lq | $1.768\,\frac{22°}{4}$ | –112 | $16^{18mm}$ | s. | | |
| Perchloric acid | $HClO_4 \cdot H_2O$ | 118.48 | fairly stable nd. | 1.88 | 50 | d. | s. | | |
| Perchloric acid | $HClO_4 \cdot 2H_2O$° 73.6% anh. | 136.50 | stable lq., col. | $1.71\,\frac{25°}{4}$ | –17.8 | 200 | v. s. | | s. al. |
| Periodic acid | $HIO_4$ | 191.93 | wh. cr. | | d. 138 | subl. 110 | s. | | |
| Periodic acid | $HIO_4 \cdot 2H_2O$ | 227.96 | delq., mn. | | d. 110 | | v. s. | v. s. | sl. s. al., et. |
| Permanganic acid | $HMnO_4$ | 119.94 | exists only in solution | | | | v. s. | d. | d. al. |
| Permolybdic acid | $HMoO_4 \cdot 2H_2O$ | 196.99 | wh. cr. | | | | v. s. | v. s. | |
| Persulfuric acid | $H_2S_2O_8$ | 194.14 | hyg. cr. | | <60 | | v. s. | d. | |
| Phosphamic acid | $PONH_2 \cdot (OH)_2$ | 97.02 | cb. | | d. | | v. s. | v. s. d. | i. al. |
| Phosphatomolybdic acid | $H_7P(Mo_2O_7)_6 \cdot 28H_2O$ | 2365.88 | yel. cb. | | 78 | $-25H_2O$, 140 | s. | | s. $HNO_8$ |
| Phosphine | $PH_3$ | 34.00 | col. gas | lq. $0.746^{-90°}$ 1.146 (A) | –132.5 | –85 | $26^{17°}$ cc | $i.^{100°}$ | s. $Cu_2Cl_2$, al., et. |
| Phosphonium chloride | $PH_4Cl$ | 70.47 | wh., cb. | | $28^{46atm}$ | subl. | d. | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Phosphoric acid, hypo- | $H_4P_2O_6$ | 161.99 | cr. | | 55 | d. 70 | s. | $450^{62°}$ | |
| Phosphoric acid, meta- | $HPO_3$ | 79.99 | vitreous, delq. | 2.2–2.5 | subl. | | s. | Forms $H_3PO_4$ | i. lq. $CO_2$ |
| Phosphoric acid, ortho- | $H_3PO_4$† | 98.00 | col., rhb. | $1.834^{18.2°}$ | 42.35 | –a $H_2O$, 213 | $2340^{26°}$ | v. s. | s. al. |
| Phosphoric acid, pyro- | $H_4P_2O_7$ | 177.99 | wh. nd. | | 61 | | $800^{28°}$ | Forms $H_3PO_4$ | v. s. al., et. |
| Phosphorous acid, hypo- | $H_3PO_2$ | 66.00 | syrupy | $1.493^{18.8°}$ | 26.5 | d. | ∞ | ∞ | |
| Phosphorous acid, ortho- | $H_3PO_3$ | 82.00 | col. | $1.651^{21.2°}$ | 74 | d. 200 | $307.3^{0°}$ | $730^{40°}$ | |
| Phosphorous acid, pyro- | $H_4P_2O_6$ | 145.99 | nd. | | 38 | d. 130 | d. | | |
| Phosphorus, black | $P_4$ | 123.92 | rhombohedral | 2.69 | | ign. in air, 400 | i. | i. | i. $CS_2$ |
| Phosphorus, red | $P_4$ | 123.92 | red, cb. | $2.20^{20°}$ | $590^{43atm}$ | ign. in air, 725 | i. | i. | s. alk.; i. $CS_2$, $NH_3$, et. |
| Phosphorus, yellow | $P_4$ | 123.92 | yel., hex., 2.1168 | $1.82^{20°}$; lq. $1.745^{44.5°}$ | 44.1; ign. 34 | 280 | 0.0003 | sl. s. | 0.4 al.; $1000^{10°}$ $CS_2$; $1.5^{0°}$, $10^{81°}$ bs.; s. $NH_3$ |
| chloride, tri- | $PCl_3$ | 137.35 | col., fuming lq. | $1.574\,\frac{20.8°}{4}$ | –111.8 | $75.95^{760mm}$ | d. | | s. et., chl., $CS_2$ |
| chloride, penta- | $PCl_5$ | 208.27 | delq., tet. | solid 1.6; $3.60^{295°}$ (A) | 148 under pressure | subl. 160 | d. | | s. $CS_2$, $C_6H_5COCl$ |
| oxide, penta- | $P_2O_5$ | 141.96 | wh., delq., amor. | 2.387 | subl. 250 | | Forms $H_3PO_4$ | v. s. | s. $H_2SO_4$; i. $NH_3$, act. |
| oxychloride | $POCl_3$ | 153.35 | col., fuming lq. | 1.675 | 2 | $107.2^{760mm}$ | d. | | d. al. |
| Phosphotungstic acid | $P_2O_5{\cdot}2WO_3{\cdot}42H_2O$ | 3681.67 | yel.-gn. cr. | | | | s. | | s. al., et. |
| Platinum | Pt | 195.23 | silv. met., cb. | $21.45^{20°}$ lq. $19^{1755°}$ | 1755 | 4300 | i. | i. | s. aq. reg., fused alk. |
| chloride (ic) | $PtCl_4$ | 337.06 | brn. | | d. 370 | | $140^{25°}$ | v. s. | s. al., act.; sl. s. $NH_2$; i. et. |
| chloride (ous) | $PtCl_2$ | 266.14 | brn. | $5.87^{11°}$ | d. 581 | | i. | i. | s. HCl, $NH_4OH$; sl. s. $NH_3$; i. al., et. |
| chloride (ic) | $PtCl_4{\cdot}8H_2O$ | 481.19 | red, mn. | 2.43 | –4$H_2O$, 100 | | v. s. | v. s. | s. al., et. |
| cyanide (ous) | $Pt(CN)_2$ | 247.27 | yel.-brn. | | | | i. | i. | i. alk. |
| Plutonium | Pu | 238 | | Produced by deuteron bombardment on $U^{238}$ | | | | | |
| Plutonium | Pu | 239 | | Produced by neutron bombardment on $U^{238}$ | | | | | |
| Potassium | K | 39.10 | silv. met., cb. | $0.86^{20°}$ lq. $0.83^{42°}$ | 62.3 | 760 | d. | Forms KOH | s. a., al., Hg |
| acetate | $KC_2H_3O_2$ | 98.14 | wh. pd. | 1.8 | 292 | | $217^{0°}$ | $396^{90°}$ | 33 al.; i. et. |
| acetate, acid | $KH(C_2H_3O_2)_2$ | 158.19 | delq. nd. or pl. | | 148 | d. 200 | d. | | s. ac. |
| aluminate | $K_2(AlO_2)_2{\cdot}3H_2O$ | 250.18 | cr. | | | | s. | d. | s. alk.; i al. |
| amide | $KNH_2$ | 55.12 | yel.-grn. | | 338 | subl. 400 | d. | | d. al.; $3.6^{25°}$ $NH_3$ |
| arsenate (monobasic) | $KH_2AsO_4$ | 180.02 | col., tet., 1.5674 | 2.867 | 288 | | $18.87^{6°}$ | v. s. | i. al. |
| auricyanide | $KAu(CN)_4{\cdot}1{\cdot}5H_2O$ | 367.39 | pl. | | d. 200 | | s. | v. s. | s. al. |
| aurocyanide | $KAu(CN)_2$ | 288.33 | rhb. | | | | 14.3 | $200^{100°}$ | sl. s. al.; i. et. |
| bicarbonate | $KHCO_3$ | 100.11 | mn., 1.482 | 2.17 | d. 100–200 | | $22.4^{0°}$ | $60^{60°}$ | i. satd. $K_2CO_3$, al. |
| bisulfate | $KHSO_4$ | 136.16 | rhb., or mn., 1.480 | 2.35 | 210 | d. | $36.3^{0°}$ | $121.6^{100°}$ | d. al. |
| bromate | $KBrO_3$ | 167.01 | trig. | $3.27^{17.5°}$ | 370 d. | | $3.11^{0°}$ | $49.75^{100°}$ | sl. s. al.; i. act. |
| bromide | KBr | 119.01 | col., cb., 1.5594 | $2.75^{25°}$ | 730 | 1380 | $53.5^{0°}$ | $104^{100°}$ | sl. s. al., et. |
| carbonate | $K_2CO_3$ | 138.20 | wh., delq. pd., 1.531 | 2.29 | 891 | d. | $105.5^{0°}$ | $156^{100°}$ | i. al. |
| carbonate | $K_2CO_3{\cdot}2H_2O$ | 174.23 | rhb. | 2.043 | | | $183^{0°}$ | $331^{100°}$ | |
| carbonate | $2K_2CO_3{\cdot}3H_2O$ | 330.45 | mn. | 2.13 | | | $129.4^{0°}$ | $268^{100°}$ | |
| chlorate | $KClO_3$ | 122.56 | col., mn., 1.5167 | 2.32 | 368 | d. 400 | $3.3^{0°}$ | $57^{100°}$ | 0.83 al.; s. alk. |
| chloride (sylvite) | KCl | 74.56 | col., cb., 1.4904 | 1.988 | 790 | 1500 | $27.6^{0°}$ | $56.7^{100°}$ | s. al., alk. |
| chloroplatinate | $K_2PtCl_6$ | 486.16 | yel., cb., 1.825± | 3.499 | d. 250 | | $0.74^{0°}$ | $5.2^{100°}$ | i. al., et. |
| chromate (tarapacaite) | $K_2CrO_4$ | 194.20 | yel., rhb., 1.7261 | $2.732^{18°}$ | 975 | | $58.0^{0°}$ | $75.6^{100°}$ | i. al. |
| cyanate | KCNO | 81.11 | wh., tet. | 2.048 | | | s. | d. | v. sl. s. al. |
| cyanide | KCN | 65.11 | wh., cb., delq., 1.410 | $1.52^{16°}$ | 634.5 | | s. | $122.2^{108.8°}$ | s. gly.; $0.9^{19.5°}$ al.; 1.3 h. al. |
| dichromate | $K_2Cr_2O_7$ | 294.21 | red, tri. | 2.69 | 398 | d. | $4.9^{0°}$ | $80^{100°}$ | i. al. |
| ferricyanide | $K_3Fe(CN)_6$ | 329.25 | red, mn. pr., 1.5689 | 1.84 | d. | | $33^{4.4°}$ | $77.5^{100°}$ | s. act.; sl. s. al.; i. $NH_3$ |
| ferrocyanide | $K_4Fe(CN)_6{\cdot}3H_2O$ | 422.39 | yel., mn., 1.5772 | $1.853^{17°}$ | –3$HO_2$, 70 | | $27.8^{12.2°}$ | $90.6^{96.8°}$ | s. act.; i. $NH_3$, al., et. |
| formate | $KHCO_2$ | 84.11 | col., rhb. | 1.91 | 167.5 | d. | $331^{18°}$ | $657^{90°}$ | sl. s. al.; i. et. |
| hydride | KH | 40.10 | cb., 1.453 | 0.80 | d. | | d. | | i. et., bz., $CS_2$ |
| hydrosulfide | KHS | 72.16 | wh., delq., rhb. | 2.0 | 455 | | s. | s. d. | s. al. |
| hydroxide | KOH | 56.10 | wh., delq., rhb. | 2.044 | 380 | 1320 | $97^{0°}$ | $178^{100°}$ | v. s. al., et.; i. $NH_3$ |
| iodate | $KIO_3$ | 214.02 | col., mn. | 3.89 | 560 | | $4.73^{0°}$ | $32.2^{100°}$ | s. KI; i. al., $NH_3$ |
| iodide | KI | 166.02 | wh., cb., 1.6670 | 3.13 | 723 | 1330 | $127.5^{0°}$ | $208^{100°}$ | $4^{20°}$ al.; s. $NH_3$; sl. s. et. |

*One commercial form 70 to 72 per cent.
†Common commercial form 85 per cent $H_3PO_4$ in aqueous solution.

**TABLE 2-1 Physical Properties of the Elements and Inorganic Compounds** (*Continued*)

| Name | Formula | Formula weight | Color, crystalline form and refractive index | Specific gravity | Melting point, °C | Boiling point, °C | Solubility in 100 parts | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Cold water | Hot water | Other reagents |
| Potassium (*Cont.*) | | | | | | | | | |
| iodide, tri- | $KI_3$ | 419.86 | dark blue, delq., mn. | 3.498 | 45 | d. 225 | v. s. | | s. KI, al. |
| iodoplatinate | $K_2PtI_6$ | 1034.94 | cb. | 5.18 | | | s. | | |
| manganate | $K_2MnO_4$ | 197.12 | gn., rhb. | | d. 190 | | d. | | s. KOH |
| metabisulfite | $K_2S_2O_5$ | 222.31 | mn., pl. | | d. 150 | | $25^{0°}$ | $120^{94°}$ | sl. s. al.; i. et. |
| nitrate (saltpeter) | $KNO_3$ | 101.10 | col., rhb., 1.5038 | $2.11^{10.6°}$ | tr. 129; 333 | d. 400 | $13.3^{0°}$ | $246^{100°}$ | $0.1^{30°}$ al.; i. et. |
| nitrite | $KNO_2$ | 85.10 | pr. | 1.915 | 297 | d. 350 | $281^{0°}$ | $413^{100°}$ | v. s. $NH_3$; sl. s. al. |
| oxalate | $K_2C_2O_4{\cdot}H_2O$ | 184.23 | wh., mn. | 2.13 | d. | | $28.7^{0°}$ | $83.2^{100°}$ | |
| oxalate, acid | $KHC_2O_4{\cdot}$ | 128.12 | mn., 1.545 | 2.0 | d. | | $14.3^{50°}$ | $48.1^{100°}$ | |
| oxalate, acid | $KHC_2O_4{\cdot}$a $H_2O$ | 137.13 | trimetric | | d. | | $2.2^{0°}$ | $51.5^{100°}$ | |
| oxide | $K_2O$ | 94.19 | wh., cb. | $2.32\,\frac{20°}{4}$ | | | Forms KOH | v. s. | s. al., et. |
| perchlorate | $KClO_4$ | 138.55 | col., rhb., 1.4737 | $2.524\,\frac{11°}{4}$ | d. 400 | | $0.75^{0°}$ | $21.8^{100°}$ | $0.105^{20°}$ m. al.; i. et. |
| permanganate | $KMnO_4$ | 158.03 | purple, rhb. | 2.703 | d. <240 | | $2.83^{0°}$ | $32.35^{75°}$ | s. $H_2SO_4$; d. al. |
| persulfate | $K_2S_2O_3$ | 270.31 | wh., tri., 1.4669 | | d. <100 | | $1.77^{0°}$ | $10^{40°}$ | i. al. |
| phosphate, monobasic | $KH_2PO_4$ | 136.09 | col., delq., tet., 1.5095 | 2.338 | 256 | | $14.8^{0°}$ | $83.5^{90°}$ | i. al. |
| phosphate, dibasic | $K_2HPO_4$ | 174.18 | wh., delq. | | d. | | $33^{25°}$ | v. s. | sl. s. al. |
| phosphate, tribasic | $K_3PO_4$ | 212.27 | wh., rhb. | $2.564^{17°}$ | 1340 | | $193.1^{25°}$ | v. s. | i. al. |
| phosphate, meta- | $KPO_3$ | 118.08 | wh. pd. | $2.258^{14.5°}$ | tr. 450; 798 | 1320 | s. | s. | |
| phosphate, meta- | $K_4P_4O_{12}{\cdot}2H_2O$ | 508.34 | amor. | $2.264^{14.5°}$ | $-2H_2O$, 100 | d. | s. | 83 | s. a. |
| phosphate, pyro- | $K_4P_2O_7{\cdot}3H_2O$ | 384.39 | delq. | 2.33 | $-2H_2O$, 180 | $-3H_2O$, 300 | s. | v. s. | i. al. |
| phthalate, acid | $KHC_8H_4O_4$ | 204.22 | wh. cr. | 1.63 | d. | | $10.2^{25°}$ | 36 | |
| platinocyanide | $K_2Pt(CN)_4{\cdot}3H_2O$ | 431.54 | yel., rhb., 1.62± | $2.45^{16°}$ | | | sl. s. | v. s. | s. al., et. |
| silicate | $K_2SiO_3$ | 154.25 | hyg. 1.521± | | 976 | | s. | s. | i. al. |
| silicate, tetra- | $K_2Si_4O_9{\cdot}H_2O$ | 352.45 | rhb., 1.530 | 2.417 | d. 400 | | s. | s. | i. al. |
| sulfate (arcanite) | $K_2SO_4$ | 174.25 | col., rhb., 1.4947 | 2.662 | tr. 588 | | $7.35^{0°}$ | $24.1^{100°}$ | i. al., act., $CS_2$ |
| Potassium sulfate, pyro- | $K_2S_2O_7$ | 254.31 | col. | 2.277 | 300 | | s. | d. | |
| sulfide, mono- | $K_2S{\cdot}5H_2O$ | 200.33 | rhb., delq. | | 60 | $-3H_2O$, 150 | s. | | s. al., gly.; i. et. |
| sulfite | $K_2SO_3{\cdot}2H_2O$ | 194.28 | wh., rhb. | | d. | | 100 | >100 | sl. s. al.; i. $NH_3$ |
| sulfite, acid | $KHSO_3$ | 120.16 | wh., mn. | | d. 190 | | $45.5^{15°}$ | $91.5^{75°}$ | i. abs. al. |
| tartrate | $K_2C_4H_4O_6{\cdot}$a $H_2O$ | 235.27 | col., mn., 1.526 | 1.98 | | d. | $12.5^{17.5°}$ | $278^{100°}$ | sl. s. al. |
| tartrate, acid | $KHC_4H_4O_6{\cdot}$ | 188.18 | col., rhb. | 1.956 | | | $0.37^{0°}$ | $6.1^{100°}$ | s. a., alk.; i. al., ac. |
| thiocyanate | KCNS | 97.17 | col., delq., mn., 1.660± | 1.886 | 172.3 | d. 500 | $177^{0°}$ | $217^{20°}$ | $20.8^{22°}$ act.; s. al. |
| thiosulfate | $K_2S_2O_3$ | 190.31 | col., cb. | | d. 400 | | $96.1^{0°}$ | $311.2^{90°}$ | |
| thiosulfate | $3K_2S_2O_3{\cdot}H_2O$ | 588.95 | delq., mn. | 2.23 | $-H_2O$, 180 | d. | | | i. al. |
| Praseodymium | Pr | 140.92 | yel. | $6.5^{20°}$ | 940 | | d. | | |
| Radium | Ra | 226.05 | wh., met. | 5? | 960 | 1140 | d. $+H_2$ | | d. a. |
| bromide | $RaBr_2$ | 385.88 | wh., mn. | 5.79 | 728 | subl. 900 | $70^{20°}$ | s. | s. al. |
| Radon (Niton) | Rn | 222.0 | gas | lq. 5.5; 111 (D) | −71 | −62 | $51^{0°}$ cc | $8.5^{60°}$ cc | |
| Rhenium | Re | 186.31 | hex. | | 3440 | | | | i. HF, HCl; s. $H_2SO_4$; $HNO_3$ |
| Rhodium | Rh | 102.91 | gray-wh., cb. | 12.5 | 1955 | >2500 | i. | i. | sl. s. aq. reg., a. |
| chloride | $RhCl_3$ | 209.28 | red | | d. 450 | subl. 800± | i. | i. | v. sl. s. alk.; i. aq. reg., a. |
| chloride | $RhCl_3{\cdot}4H_2O$ | 281.35 | dark red | | | | v. s. | | s. HCl, al.; i. et. |
| Rubidium | Rb | 85.48 | silv. wh. | lq. $1.475^{88.5°}$; $1.53^{20°}$ | 38.5 | 700 | d. | | s. a., al. |
| Ruthenium | Ru | 101.70 | bk., porous | 8.6 | >1950 | | i. | i. | sl. s. aq. reg., a. |
| Ruthenium | Ru | 101.70 | gray, hex. | $12.2^{20°}$ | 2450 | >2700 | i. | i. | |
| Samarium | Sm (also Sa) | 150.43 | | 7.7 | >1300 | | | | |
| Scandium | Sc | 45.10 | | 2.5? | 1200 | 2400 | | | |
| Selenic acid | $H_2SeO_4$ | 144.98 | hex. pr. | $2.950\,\frac{15°}{4}$ | 58 | 260 | $1300^{30°}$ | $\infty^{60°}$ | s. $H_2SO_4$; d. al.; i. $NH_3$ |
| Selenic acid | $H_2SeO_4{\cdot}H_2O$ | 162.99 | nd. | $2.627\,\frac{15°}{4}$ | 26 | 205 | v. s. | | |
| Selenium | $Se_8$ | 631.68 | red pd., amor., 2.92 | $4.26^{25°}$ | 50 | 688 | i. | i. | s. $CS_2$, $H_2SO_4$, $CH_2I_2$ |
| Selenium | $Se_8$ | 631.68 | gray, trig., 3.00; red, hex. | 4.80; 4.50 | 220 | 688 | i. | i. | s. $CS_2$, $H_2SO_4$ |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Selenium | $Se_8$ | 631.68 | steel gray | $4.8^{25°}$ | 217 | 688 | i. | i. | i. $CS_2$; s. $H_2SO_4$ |
| Selenous acid | $H_2SeO_3$ | 128.98 | hex. | $3.004\ \frac{15°}{4}$ | d. | | $90^{0°}$ | $400^{90°}$ | v. s. al.; i. $NH_3$ |
| Silicic acid, meta- | $H_2SiO_3$ | 78.08 | amor., 1.41 | 2.1–2.3 | | | i. | i. | s. alk.; i. $NH_4Cl$ |
| Silicic acid, ortho- | $H_4SiO_4$ | 96.09 | amor. | $1.576^{17°}$ | | | sl. s. | sl. s. | s. alk.; i. $NH_4Cl$ |
| Silicon, crystalline | Si | 28.06 | gray, cb., 3.736 | $2.4^{20°}$ | 1420 | 2600 | i. | i. | s. $HNO_3$ + HF, Ag; sl. s. Pb, Zn; i. HF |
| Silicon, graphitic | Si | 28.06 | cr. | 2.0–2.5 | | 2600 | i. | i. | s. $HNO_3$ + HF, fused alk.; i. HF. |
| Silicon, amorphous | Si | 28.06 | brn., amor. | 2 | | 2600 | i. | i. | s. HF, KOH |
| carbide | SiC | 40.07 | blue-bk., trig., 2.654 | 3.17 | >2700 | subl. 2200 | i. | i. | s. fused alk.; i. a. |
| chloride, tri- | $Si_2Cl_6$ | 268.86 | lf. or lq. | $1.58^{0°}$ | –1 | $144^{760mm}$ | d. | | d. alk. |
| chloride, tetra- | $SiCl_4$ | 169.89 | col., fuming lq., 1.412 | 1.50 | –70 | 57.6 | d. | | d. conc. $H_2SO_4$, al. |
| fluoride | $SiF_4$ | 104.06 | gas | 3.57 (A) | –95.7 | $–65^{1810mm}$ | v. s. d. | | s. $HNO_3$, al., et. |
| hydride (silane) | $SiH_4$ | 32.09 | col. gas | lq. $0.68^{–185°}$ | –185 | $–112^{760mm}$ | i. | | i. al., et.; d. KOH |
| oxide, di- (opal) | $SiO_2{\cdot}xH_2O$ | | iridescent, amor. | 2.2 | 1600–1750 | subl. 1750 | i. | i. | s. HF, h. alk., fused $CaCl_2$ |
| oxide, di- (cristobalite) | $SiO_2$ | 60.06 | col., cb. or tet., 1.487 | 2.32 | 1710 | 2230 | i. | i. | s. HF; i. alk. |
| oxide, di- (lechatelierite) | $SiO_2$ | 60.06 | | 2.20 | | 2230 | i. | i. | s. HF; i. alk. |
| oxide, di- (quartz) | $SiO_2$ | 60.06 | hex., 1.5442 | $2.650^{20°}$ | tr. <1425 | 2230 | i. | i. | s. HF; i. alk. |
| oxide, di- (tridymite) | $SiO_2$ | 60.06 | trig., rhb., 1.469 | 2.26 | tr. 1670 | 2230 | i. | | s. HF; i. alk. |
| Silver | Ag | 107.88 | silv. met., cb. | $10.5^{20°}$ | 960.5 | 1950 | i. | i. | s. $HNO_3$, h. $H_2SO_4$; i. alk. |
| bromide (bromyrite) | AgBr | 187.80 | pa. yel., cb., 2.252 | $6.473\ \frac{25°}{4}$ | 434 | d. 700 | $0.00002^{20°}$ | $0.00037^{100°}$ | $0.51^{18°}$ $NH_4OH$; s. KCN, $Na_2S_2O_3$ |
| carbonate | $Ag_2CO_3$ | 275.77 | yel. pd. | 6.077 | 218 d. | | $0.003^{20°}$ | $0.05^{100°}$ | s. $NH_4OH$, $Na_2S_2O_3$; i. al. |
| chloride (cerargyrite) | AgCl | 143.34 | wh., cb., 2.071 | 5.56 | 455 | 1550 | $0.000089^{10°}$ | $0.00217^{100°}$ | s. $NH_4OH$, KCN; sl. s. HCl |
| cyanide | AgCN | 133.90 | wh., 1.685± | 3.95 | $–(CN)_2$, 320 | | $0.000022^{20°}$ | | s. $NH_4OH$, KCN, $HNO_3$ |
| nitrate (lunar caustic) | $AgNO_3$ | 169.89 | col., rhb., 1.744 | $4.352\ \frac{19°}{4}$ | 212 | 444 d. | $122^{0°}$ | $952^{100°}$ | s. gly.; v. sl. s. al. |
| Sodium | Na | 22.997 | silv. met, cb. | $0.97^{20°}$ | 97.5 | 880 | d., forms NaOH | | i. bz.; d. al. |
| acetate | $NaC_2H_3O_2$ | 82.04 | wh., mn., 1.464 | 1.528 | 324 | | $46.5^{20°}$ | $170^{100°}$ | $2.1^{18°}$ al. |
| acetate | $NaC_2H_3O_2{\cdot}3H_2O$ | 136.09 | wh., mn. | 1.45 | 58 | $–3H_2O$, 120 | v. s. | v. s. | $7.8^{25°}$ abs. al. |
| aluminate | $NaAlO_2$ | 81.97 | amor. | | 1650 | | s. | v. s. | i. al. |
| amide | $NaNH_2$ | 39.02 | olive gn. | | 210 | 400 | d. | | d. al. |
| Sodium ammonium phosphate | $NaNH_4HPO_4{\cdot}4H_2O$ | 209.09 | col., mn. | 1.574 | 79 d. | | 16.7 | 100 | i. al. |
| antimonate, meta- | $2NaSbO_3{\cdot}7H_2O$ | 511.63 | cb. | | | | $0.031^{12.8°}$ | | sl. s. al., $NH_4$ salts; i. ac. |
| arsenate | $Na_3AsO_4{\cdot}12H_2O$ | 424.09 | hex., 1.4589 | 1.759 | 86.3 | | $26.7^{17°}$ | | 1.67 al., $50^{15°}$ gly. |
| arsenate, acid (monobasic) | $NaH_2AsO_4{\cdot}H_2O$ | 181.94 | rhb., 1.5535 | 2.535 | d. 100 | | s. | | |
| arsenate, acid (dibasic) | $Na_2HAsO_4{\cdot}7H_2O$* | 312.02 | col., mn., 1.4658 | 1.871 | 125 | $–7H_2O$, 100 | $61^{15°}$ | v. s. | sl. s. al. |
| arsenate, acid (dibasic) | $Na_2HAsO_4{\cdot}12H_2O$ | 402.10 | mn., 1.4496 | 1.72 | 28 | $–12H_2O$, 100 | $5.59^{0.1°}$ | $140.7^{30°}$ | sl. s. al. |
| arsenite, acid | $Na_2HAs0_3$ | 169.91 | col. | 1.87 | | | v. s. | | |
| benzoate | $NaC_7H_5O_2$ | 144.11 | col. cr. | | | | $62.5^{25°}$ | $76.9^{100°}$ | $2.3^{25°}$, $8.3^{78°}$ al. |
| bicarbonate | $NaHCO_3$ | 84.01 | wh., mn., 1.500 | 2.20 | $–CO_2$, 270 | | $6.9^{0°}$ | $16.4^{60°}$ | i. al. |
| bifluoride | $NaHF_2$ | 62.00 | col. cr. | | d. | | $3.7^{20°}$ | s. | |
| bisulfate | $NaHSO_4$ | 120.06 | col., tri. | 2.742 | >315 | d., $–H_2O$ | $50^{0°}$ | $100^{100°}$ | d. al.; i. $NH_3$ |
| bisulfite | $NaHSO_3$ | 104.06 | col., mn., 1.526 | 1.48 | d. | | sl. s. | s. | i. al., act. |
| borate, tetra- | $Na_2B_4O_7$ | 201.27 | | 2.367 | 741 | | $1.3^{0°}$ | $8.79^{40°}$ | i. al. |
| borate, tetra | $Na_2B_4O_7{\cdot}5H_2O$ | 291.35 | col., rhb., 1.461 | 1.815 | | | $22^{62°}$ (anh.) | $52.3^{100°}$ (anh.) | |
| borate, tetra- (borax) | $Na_2B_4O_7{\cdot}10H_2O$* | 381.43 | wh., mn., 1.4694 | 1.73 | 75 | $–10H_2O$, 200 | $1.3^{0.5}$ (anh). | $20.3^{80°}$ (anh.) | s. gly.; i. abs. al. |
| bromate | $NaBrO_3$ | 150.91 | col., cb. | $3.339^{17.5°}$ | 381 | | $27.5^{0°}$ | $90.9^{100°}$ | i. al. |
| bromide | NaBr | 102.91 | col., cb., 1.6412 | $3.205^{17.5°}$ | 755 | 1390 | $90^{20°}$ | $121^{100°}$ | sl. s. al. |
| bromide | $NaBr{\cdot}2H_2O$ | 138.95 | col., mn. | 2.176 | 50.7 | | $79.5^{0°}$ (anh.) | $118.3^{80°}$ (anh.) | sl. s. al. |
| carbonate (soda ash) | $Na_2CO_3$ | 106.00 | wh. pd., 1.535 | 2.533 | 851 | d. | $7.1^{0°}$ | $48.5^{104°}$ | i. al., et. |
| carbonate | $Na_2CO_3{\cdot}H_2O$ | 124.02 | wh., rhb., 1.506–1.509 | 1.55 | $–H_2O$, 100 | | s. | s. | s. gly.; i. al., et. |
| carbonate | $Na_2CO_3{\cdot}7H_2O$ | 232.12 | rhb. or trig. | 1.51 | d. 35.1 | | s. | s. | |
| carbonate (sal soda) | $Na_2CO_3{\cdot}10H_2O$ | 286.16 | wh., mn., 1.425 | 1.46 | | | $21.5^{0°}$ | $238^{30°}$ | i. al. |

*Usual commercial form.

**TABLE 2-1 Physical Properties of the Elements and Inorganic Compounds** (*Continued*)

| Name | Formula | Formula weight | Color, crystalline form and refractive index | Specific gravity | Melting point, °C | Boiling point, °C | Solubility in 100 parts | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Cold water | Hot water | Other reagents |
| Sodium ammonium phosphate (*Cont.*) | | | | | | | | | |
| carbonate, sesqui- (trona) | $Na_3H(CO_3)_2{\cdot}2H_2O$ | 226.05 | wh., mn., 1.5073 | 2.112 | d. | | $13^{0°}$ | $42^{100°}$ | |
| chlorate | $NaClO_3$ | 106.45 | wh., cb., or trig., 1.5151 | $2.490^{15°}$ | 248 | d. | $79^{0°}$ | $230^{100°}$ | s. al. |
| chloride | NaCl | 58.45 | col., cb., 1.5443 | 2.163 | 800.4 | 1413 | $35.7^{0°}$ | $39.8^{100°}$ | sl. s. al.; i. conc. HCl |
| chromate | $Na_2CrO_4$ | 162.00 | yel., rhb. | 2.723 | 392 | | $32^{0°}$ | $126^{100°}$ | |
| chromate | $Na_2CrO_4{\cdot}10H_2O$ | 342.16 | yel., delq., mn. | 1.483 | 19.9 | | v. s. | ∞ | sl. s. al. |
| citrate | $2Na_3C_6H_5O_7{\cdot}11H_2O$ | 714.36 | wh., rhb. | $1.857\frac{23.5°}{4}$ | $-11H_2O$, 150 | d. | $91^{25°}$ | $250^{100°}$ | i. al. |
| cyanide | NaCN | 49.02 | wh., cb., 1.452 | | 563.7 | 1496 | $48^{10°}$ | $82^{35°}$ | s. $NH_3$; sl. s. al. |
| dichromate | $Na_2Cr_2O_7{\cdot}2H_2O$ | 298.05 | red, mn., 1.6994 | $2.52^{18°}$ | $-2H_2O$, 84.6; 356 (anh.) | d. 400 | $238^{0°}$ | $508^{80°}$ | |
| ferricyanide | $Na_3Fe(CN)_6{\cdot}H_2O$ | 298.97 | red, delq. | | | | $18.9^{0°}$ | $67^{100°}$ | i. al. |
| ferrocyanide | $Na_4Fe(CN)_6{\cdot}10H_2O$ | 484.11 | yel., mn. | 1.458 | | | $17.9^{20°}$ (anh.) | $63^{98.5°}$ (anh.) | i. al. |
| fluoride (villiaumite) | NaF | 42.00 | tet., 1.3258 | 2.79 | 992 | | $4^{0°}$ | $5^{100°}$ | v. sl. s. al. |
| formate | $NaHCO_2$ | 68.01 | wh., mn. | 1.919 | 253 | | $44^{0°}$ | $160^{100°}$ | sl. s. al.; i. et. |
| hydride | NaH | 24.005 | silv. nd., 1.470 | 0.92 | d. 800 | | d. | | i. bz., $CS_2$, $CCl_4$, $NH_3$; s. molten metal |
| hydrosulfide | $NaSH{\cdot}2H_2O$ | 92.10 | col., delq., nd. | | d. | | s. | s. | s. al.; d. a. |
| hydrosulfide | $NaSH{\cdot}3H_2O$ | 110.11 | rhb. | | 22 | d. | s. | s. | s. al.; d. a. |
| hydrosulfite | $Na_2S_2O_4{\cdot}2H_2O$ | 210.15 | col. cr. | | d. | | $22^{20°}$ | d. | i. al. |
| hydroxide | NaOH | 40.00 | wh., delq. | 2.130 | 318.4 | 1390 | $42^{0°}$ | $347^{100°}$ | v. s. al., et., gly.; i. act. |
| hydroxide | $NaOH{\cdot}3a\ H_2O$ | 103.06 | mn. | | 15.5 | | s. | v. s. | |
| hypochlorite | NaOCl | 74.45 | pa. yel., in soln. only | | d. | | $26^{0°}$ | $158^{56°}$ | |
| iodide | NaI° | 149.92 | col., cb., 1.7745 | $3.667^{0°}$ | 651 | 1300 | $158.7^{0°}$ | $302^{100°}$ | v. s. al., act. |
| iodide | $NaI{\cdot}2H_2O$ | 185.95 | col., mn. | 2.448 | | | v. s. | v. s. | v. s. $NH_3$ |
| lactate | $NaC_3H_5O_3$ | 112.07 | col., amor. | | d. | | v. s. | v. s. | s. al.; i. et. |
| nitrate (soda niter) | $NaNO_3$ | 85.01 | col., trig., 1.5874 | 2.257 | 308 | d. 380 | $73^{0°}$ | $180^{100°}$ | s. $NH_3$; sl. s. gly., al. |
| nitrite | $NaNO_2$ | 69.01 | pa. yel., rhb. | $2.168^{0°}$ | 271 | d. 320 | $72.1^{0°}$ | $163.2^{100°}$ | $0.3^{20°}$ et.; 0.3 abs. al.; $4.4^{20°}$ m. al.; v. s. $NH_3$ |
| oxide | $Na_2O$ | 61.99 | wh., delq. | 2.27 | subl. | | Forms NaOH | | d. al. |
| perborate | $NaBO_3{\cdot}H_2O$ | 99.83 | wh. pd. | | d. 40 | | sl. s. | d. | s. gly., alk. |
| perchlorate | $NaClO_4$ | 122.45 | rhb., 1.4617 | | 482 d. | | $170^{0°}$ | $320^{100°}$ | s. al.; 51 m. al.; 52 act.; i. et. |
| perchlorate | $NaClO_4{\cdot}H_2O$ | 140.47 | hex. | 2.02 | d. 130 | | $209^{15°}$ | $284^{50°}$ | s. al. |
| peroxide | $Na_2O_2$° | 77.99 | yel.-wh. pd. | 2.805 | d. | | s. d. | d. | s. dil. a. |
| peroxide | $Na_2O_2{\cdot}8H_2O$ | 222.12 | wh., hex. | | d. 30 | | s. d. | d. | |
| phosphate, monobasic | $NaH_2PO_4{\cdot}H_2O$° | 138.01 | col., rhb., 1.4852 | 2.040 | $-H_2O$, 100 | d. 200 | $71^{0°}$ | $390^{83°}$ | i. al. |
| phosphate, monobasic | $NaH_2PO_4{\cdot}2H_2O$ | 156.03 | col., rhb., 1.4629 | 1.91 | 60 | | $91.1^{0°}$ | $308^{40°}$ | |
| phosphate, dibasic | $Na_2HPO_4{\cdot}7H_2O$ | 268.09 | col., mn., 1.4424 | 1.679 | d. | | $185^{40°}$ | $2000^{100°}$ | |
| phosphate, dibasic | $Na_2HPO_4{\cdot}12H_2O$ | 358.17 | col., mn., 1.4361 | 1.52 | 34.6 | $-12H_2O$, 180 | $4.3^{0°}$ | $76.7^{30°}$ | i. al. |
| phosphate, tribasic | $Na_3PO_4$ | 163.97 | wh. | $2.537^{17.5°}$ | 1340 | | $4.5^{0°}$ | $77^{100°}$ | |
| phosphate, tribasic | $Na_3PO_4{\cdot}12H_2O$° | 380.16 | wh., trig., 1.4458 | 1.62 | 73.4 | $-11H_2O$, 100 | $28.3^{15°}$ | ∞ | i. $CS_2$ |
| phosphate, meta- | $Na_4P_4O_{12}$ | 407.91 | col. | 2.476 | 616 d. | | s. | s. | s. a., alk. |
| phosphate, pyro- | $Na_4P_2O_7$° | 265.95 | wh. | 2.45 | 988 | | $2.26^{0°}$ | $45^{96°}$ | d. a. |
| phosphate, pyro- | $Na_4P_2O_7{\cdot}10H_2O$ | 446.11 | mn., 1.4525 | 1.82 | d. | | $5.4^{0°}$ | $93^{100°}$ | i. al., $NH_3$ |
| phosphate (pyrodisodium) | $Na_2H_2P_2O_7$ | 221.97 | col., mn., 1.510 | 1.862 | d. 220 | | $4.5^{0°}$ | $21^{40°}$ | |
| phosphate (pyrodisodium) | $Na_2H_2P_2O_7{\cdot}6H_2O$ | 330.07 | col., mn., 1.4645 | 1.848 | | | $6.9^{0°}$ | $36^{40°}$ | |
| potassium tartrate | $NaKC_4H_4O_6{\cdot}4H_2O$ | 282.23 | rhb., 1.493 | 1.790 | 70 to 80 | $-4H_2O$, 215 | $26^{0°}$ | $66^{26°}$ | sl. s. al. |
| silicate, meta- | $Na_2SiO_3$ | 122.05 | col., rhb., 1.520 | | 1088 | | s. | s. d. | i. Na or K salts, al. |
| Sodium silicate, meta- | $Na_2SiO_3{\cdot}9H_2O$ | 284.20 | rhb. | | 47 | $-6H_2O$, 100 | v. s. | v. s. | $29^{18°}$, a N NaOH |
| silicate, ortho- | $Na_4SiO_4$ | 184.05 | col., hex., 1.530 | | 1018 | | s. | s. | |
| silicofluoride | $Na_2SiF_6$ | 188.05 | wh., hex., 1.312 | 2.679 | d. | | $0.44^{0°}$ | $2.45^{100°}$ | i. al. |
| stannate | $Na_2SnO_3{\cdot}3H_2O$ | 266.74 | hex. tablets | | d. 140 | | $50^{0°}$ | $67^{50°}$ | i. al., act. |
| sulfate (thenardite) | $Na_2SO_4$ | 142.05 | col., rhb., 1.477 | 2.698 | tr. 100 to mn. | | $5^{0°}$ | $42^{100°}$ | i. al. |
| sulfate | $Na_2SO_4$ | 142.05 | col., mn. | | tr. 500 to hex. | | $48.8^{40°}$ | $42.5^{100°}$ | d. HI; s. $H_2SO_4$ |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| sulfate | $Na_2SO_4$ | 142.05 | col., hex. | | 884 | | $19.4^{20°}$ | $45.3^{60°}$ | |
| sulfate | $Na_2SO_4.7H_2O$ | 268.17 | tet. | | | | $44.9^{0°}$ | $202.6^{26°}$ | |
| sulfate (Glauber's salt) | $Na_2SO_4.10H_2O$ | 322.21 | col., mn., 1.396 | 1.464 | 32.4 | $-10H_2O$, 100 | $36^{15°}$ | $412^{34°}$ | i. al. |
| sulfide, mono- | $Na_2S$ | 78.05 | pink or wh., amor. | 1.856 | | | $15.4^{10°}$ | $57.3^{90°}$ | sl. s. al.; i. et. |
| sulfide, tetra- | $Na_2S_4$ | 174.23 | yel., cb. | | 275 | | s. | s. | s. al. |
| sulfide, penta- | $Na_2S_5$ | 206.29 | yel. | | 251.8 | | s. | s. | s. al. |
| sulfite | $Na_2SO_3$ | 126.05 | hex. pr., 1.565 | $2.633\,\frac{15°}{4}$ | d. | | $13.9^{0°}$ | $28.3^{84°}$ | i. al., NH |
| sulfite | $Na_2SO_3.7H_2O$ | 252.17 | mn. | 1.561 | $-7H_2O$, 150 | d. | $34.7^{2°}$ | $67.8^{18°}$ | i. al. |
| tartrate | $Na_2C_4H_4O_6.2H_2O$ | 230.10 | rhb. | 1.818 | | | $29^{6°}$ | $66^{43°}$ | i. al. |
| thiocyanate | NaCNS | 81.08 | delq., rhb., 1.625± | | 287 | | $110^{10°}$ | $225^{100°}$ | v. s. al. |
| thiosulfate | $Na_2S_2O_3$ | 158.11 | mn. | 1.667 | | | $50^{0°}$ | $231^{80°}$ | |
| thiosulfate (hypo) | $Na_2S_2O_3.5H_2O$* | 248.19 | mn. pr., 1.5079 | 1.685 | d. 48.0 | | $74.7^{0°}$ | $301.8^{60°}$ | s. $NH_3$; v. sl. s. al. |
| tungstate | $Na_2WO_4$ | 293.91 | wh., rhb. | 4.179 | 692 | | $57.58^{0°}$ | $97^{100°}$ | |
| tungstate | $Na_2WO_4.2H_2O$* | 329.95 | wh., rhb. | 3.245 | $-2H_2O$, 100 | | $88^{0°}$ | $123.5^{100°}$ | sl. s. $NH_3$; i. a., al. |
| tungstate, para- | $Na_6W_7O_{24}.16H_2O$ | 2097.68 | wh., tri. | $3.987^{14°}$ | $-16H_2O$, 300 | | 8 | d. | |
| uranate | $Na_2UO_4$ | 348.06 | yel. | | | | i. | i. | s. alk. carb., dil. a. |
| vanadate | $Na_3VO_4.16H_2O$ | 472.20 | col. nd. | | 866 (anh.) | | v. s. | d. | i. al. |
| vanadate, pyro- | $Na_4V_2O_7$ | 305.89 | hex. | | 654 | | s. | | i. al. |
| Stannic chloride | $SnCl_4$ | 260.53 | col., fuming lq. | 2.226 | –30.2 | 114.1 | s. | d. | s. abs. al., act., $NH_3$; s. ∞ $CS_2$ |
| oxide (cassiterite) | $SnO_2$ | 150.70 | wh., tet., 1.9968 | 7.0 | 1127 | | i. | i. | s. conc. $H_2SO_4$; i. alk.; $NH_4OH$, $NH_3$ |
| sulfate | $Sn(SO_4)_2.2H_2O$ | 346.85 | col., delq., hex. | | | | v. s. | d. | s. dil. $H_2SO_4$, HCl; d. abs. al. |
| Stannous bromide | $SnBr_2$ | 278.53 | yel., rhb. | $5.12^{17°}$ | 215.5 | 620 | s. | d. | s. $C_6H_5N$ |
| chloride | $SnCl_2$ | 189.61 | wh., rhb. | | 246.8 | 623 | $83.9^{0°}$ | $269.8^{15°}$ | s. alk., abs. al., et. |
| chloride (tin salt) | $SnCl_2.2H_2O$* | 225.65 | wh., tri. | $2.71^{15.5°}$ | 37.7 | d. | $118.7^{0°}$ | ∞ | s. tart. a., alk., al. |
| sulfate | $SnSO_4$ | 214.76 | wh. cr. | | $-SO_2$, 360 | | $19^{19°}$ | $18^{100°}$ | s. $H_2SO_4$ |
| Strontium | Sr | 87.63 | silv. met. | 2.6 | 800 | 1150 | d. | Forms $Sr(OH)_2$ | s. al., a. |
| acetate | $Sr(C_2H_3O_2)_2$ | 205.72 | wh. cr. | 2.099 | | d. | $36.9^{0°}$ | $36.4^{97°}$ | $0.26^{15°}$ m. al. |
| carbonate (strontianite) | $SrCO_3$ | 147.64 | wh., rhb., 1.664 | 3.70 | $1497^{60atm}$ | $-CO_2$, 1350 | $0.0011^{18°}$ | $0.065^{100°}$ | s. a., $NH_4$ salts, aq. $CO_2$ |
| chloride | $SrCl_2$ | 158.54 | wh., cb., 1.6499 | 3.052 | 873 | | $43.5^{0°}$ | $100.8^{100°}$ | v. sl. s. act., abs. al.; i. $NH_3$ |
| chloride | $SrCl_2.6H_2O$* | 266.64 | wh., rhb., 1.5364 | $1.933^{17°}$ | $-4H_2O$, 61 | $-6H_2O$, 100 | $104^{0°}$ | $198^{40°}$ | |
| hydroxide | $Sr(OH)_2$ | 121.65 | wh., delq. | 3.625 | 375 | | $0.41^{0°}$ | $21.83^{100°}$ | s. $NH_4Cl$ |
| hydroxide | $Sr(OH)_2.8H_2O$* | 265.77 | col., tet., 1.499 | 1.90 | $-7H_2O$ in dry air | | $0.90^{0°}$ | $47.7^{100°}$ | s. $NH_4Cl$; i. act. |
| nitrate | $Sr(NO_3)_2$* | 211.65 | col., cb., 1.5878 | 2.986 | 570 | | $40^{0°}$ | $100^{89°}$ | s. $NH_3$; 0.012 abs. al. |
| nitrate | $Sr(NO_3)_2.4H_2O$ | 283.71 | wh., mn. | 2.2 | | | $62.2^{0°}$ | $124^{20°}$ | i. $HNO_3$ |
| oxide (strontia) | SrO | 103.63 | col., cb., 1.870 | 4.7 | 2430 | | Forms $Sr(OH)_2$ | | sl. s. al.; i. et. |
| peroxide | $SrO_2$ | 119.63 | wh. pd. | | d. | | $0.008^{20°}$ | d. | s. al., $NH_4Cl$; i. act. |
| peroxide | $SrO_2.8H_2O$ | 263.76 | wh. cr. | | $-8H_2O$, 100 | d. | $0.018^{20°}$ | d. | s. al.; i. $NH_4OH$ |
| sulfate (celestite) | $SrSO_4$ | 183.69 | col., rhb., 1.6237 | 3.96 | 1580 d. | | $0.0113^{0°}$ | $0.0114^{32°}$ | sl. s. a.; i. dil. $H_2SO_4$, al. |
| sulfate, acid | $Sr(HSO_4)_2$ | 281.77 | col., granular | | d. | | | | $14^{70°}$ $H_2SO_4$ |
| Sulfamic acid | $NH_2SO_3H$ | 97.09 | wh., rhb. | $2.03\,\frac{12°}{4}$ | 205 d. | | $20^{0°}$ | $40^{70°}$ | sl. s. al., act.; i. et. |
| Sulfur, amorphous | S | 32.06 | pa. yel. pd., 2.0–2.9 | 2.046 | 120 | 444.6 | i. | i. | sl. s. $CS_2$ |
| Sulfur, monoclinic | $S_8$ | 256.48 | pa. yel., mn. | 1.96 | 119.0 | 444.6 | i. | i. | s. $CS_2$, al. |
| Sulfur, rhombic | $S_8$ | 256.48 | pa. yel., rhb. | 2.07 | 112.8 | 444.6 | i. | i. | $24^{0°}$, $181^{55°}$ $CS_2$ |
| Sulfur bromide, mono- | $S_2Br_2$ | 223.95 | red, fuming lq. | 2.635 | –46 | $54^{0.18mm}$ | d. | | |
| chloride, mono- | $S_2Cl_2$ | 135.03 | red-yel. lq. | 1.687 | –80 | 138 | d. | | s. $CS_2$, et., bz. |
| chloride, di- | $SCl_2$ | 102.97 | dark red fuming lq. | $1.621\,\frac{15°}{15}$ | –78 | 59 | d. | | d. al. |
| chloride, tetra- | $SCl_4$ | 173.89 | yel.-brn. lq. | | –30 | d. > –20 | d. | | |
| oxide, di- | $SO_2$ | 64.06 | col. gas | lq., $1.434^{0°}$; 2.264 (A) | –75.5 | –10.0 | $22.8^{0°}$ | $4.5^{50°}$ | s. $H_2SO_4$; al., ac. |
| oxide, tri-(α) | $SO_3$ | 80.06 | col. pr. | lq., 1.923; 2.75 (A) | 16.83 | 44.6 | d. | | s. $H_2SO_4$ |
| oxide, tri-(β) | $(SO_3)_2$ | 160.12 | col., silky, nd. | $1.97^{20°}$ | 50 | | Forms $H_2SO_4$ | | s. $H_2SO_4$ |
| Sulfuric acid | H2SO4* | 98.08 | col., viscous lq. | $1.834\,\frac{18°}{4}$ | 10.49 | d. 340 | ∞ | ∞ | d. al. |
| Sulfuric acid | $H_2SO_4.H_2O$ | 116.09 | pr. or lq. | $1.842\,\frac{15°}{4}$ | 8.62 | 290 | ∞ | ∞ | d. al. |

*Usual commercial form.

**TABLE 2-1 Physical Properties of the Elements and Inorganic Compounds** (*Concluded*)

| Name | Formula | Formula weight | Color, crystalline form and refractive index | Specific gravity | Melting point, °C | Boiling point, °C | Solubility in 100 parts | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Cold water | Hot water | Other reagents |
| Sulfuric acid | $H2SO4{\cdot}2H2O$ | 134.11 | col. lq. | $1.650^{\frac{0°}{4}}$ | –38.9 | 167 | ∞ | ∞ | d. al. |
| Sulfuric acid, pyro- | $H_2S_2O_7$ | 178.14 | cr. | $1.9^{20°}$ | 35 | d. | d. | | d. al. |
| Sulfuric oxychloride | $SO_2Cl_2$ | 134.97 | col. lq. | $1.667\,\frac{20°}{4}$ | –54.1 | $69.1^{760mm}$ | d. | | s. ac.; d. al. |
| Sulfurous oxybromide | $SOBr_2$ | 207.89 | or.-yel. lq. | $2.68^{18°}$ | –50 | $68^{40mm}$ | d. | | s. bz., $CS_2$, $CCl_4$; d. act. |
| oxychloride | $SOCl_2$ | 118.97 | col. lq. | 1.638 | –104.5 | 78.8 | d. | | s. bz., chl. |
| Tantalum | Ta | 180.88 | bk.-gray, cb. | 16.6 | 2850 | >4100 | i. | i. | s. fused alk., HF; i. HCl, $HNO_3$, $H_2SO_4$ |
| Tellurium | Te | 127.61 | met., hex. | (α) 6.24; (β) 6.00 | 452 | 1390 | i. | i. | s. $H_2SO_4$, $HNO_3$, KCN, KOH, aq. reg.; i. $CS_2$ |
| Terbium | Tb | 159.20 | | | | | | | |
| Thallium | Tl | 204.39 | blue-wh., tet. | 11.85 | 303.5 | 1650 | i. | i. | s. $HNO_3$, $H_2SO_4$; i. $NH_3$ |
| acetate | $TlC_2H_3O_2$ | 263.43 | silky nd. | 3.68 | 110 | | v. s. | | v. s. al. |
| chloride, mono- | TlCl | 239.85 | wh., cb. | 7.00 | 430 | 806 | $0.21^{0°}$ | $1.8^{100°}$ | sl. s. HCl; i. al., $NH_4OH$ |
| chloride, sesqui- | $Tl_2Cl_3$ | 515.15 | yel., hex. | 5.9 | 400–500 | d. | $0.26^{15°}$ | $1.9^{100°}$ | |
| chloride, tri- | $TlCl_3$ | 310.76 | hex. pl. | | 25 | d. | v. s. | | s. al., et. |
| chloride, tri- | $TlCl_3{\cdot}4H_2O$ | 382.83 | nd. | | 37 | $–4H_2O$, 100 | $86.2^{17°}$ | d. | s. al., et. |
| sulfate (ic) | $Tl_2(SO_4)_3{\cdot}7H_2O$ | 823.07 | lf. | | $–6H_2O$, 200 | d. | d. | d. | s. dil. $H_2SO_4$ |
| sulfate (ous) | $Tl_2SO_4$ | 504.84 | col., rhb., 1.8671 | 6.77 | 632 | d. | $2.70^{0°}$ | $18.45^{100°}$ | |
| sulfate, acid | $TlHSO_4$ | 301.46 | trimorphous | | 115 d. | | | | v. sl. s. dil. $H_2SO_4$ |
| Thio, *cf.* sulfo or sulfur | | | | | | | | | |
| Thorium | Th | 232.12 | cb. | 11.2 | 1845 | >3000 | i. | i. | s. HCl, $H_2SO$; sl. s. $HNO_3$; i. HF, alk. |
| oxide, di- (thorianite) | $ThO_2$ | 264.12 | wh., cb. | 9.69 | >2800 | 4400 | i. | | s. h. $H_2SO_4$; i. alk. |
| sulfate | $Th(SO_4)_2$ | 424.24 | | $4.225^{17°}$ | | | $0.74^{0°}$ | $5.22^{50°}$ | |
| sulfate | $Th(SO_4)_2{\cdot}9H_2O$ | 586.38 | mn. pr. | 2.77 | $–9H_2O$, 400 | | sl. s. | sl. s. | |
| Thulium | Tm | 169.40 | | | | | i. | i. | |
| Tin | Sn | 118.70 | silv. met., tet. | 7.31 | 231.85 | 2260 | i. | i. | s. HCl, $H_2SO_4$, dil. $HNO_3$ h. aq KOH |
| Tin | Sn | 118.70 | gray, cb. | 5.750 | Stable –163 to +18 | 2260 | i. | i. | s. a., h. alk. solns. |
| Tin salts, *cf.* stannic and stannous | | | | | | | | | |
| Titanic acid | $H_2TiO_3$ | 97.92 | wh. pd. | | | | i. | i. | s. alk.; v. sl. s. dil. a.; i. al. |
| Titanium | Ti | 47.90 | dark gray, cb. | $4.50^{17.5°}$ | 1800 | >3000 | i. | d. | s. a. |
| chloride, di- | $TiCl_2$ | 118.81 | bk., delq. | | Unstable in air | | d. | | i. $CS_2$, et., chl. |
| chloride, tri- | $TiCl_3$ | 154.27 | vl., delq. | | d. 440 | | s. | s. | |
| chloride, tetra- | $TiCl_4$° | 189.73 | col. lq. | lq., 1.726 | –30 | 136.4 | s. | d. | s. dil. HCl |
| oxide, di- (anatase) | $TiO_2$ | 79.90 | brn. or bk., tet., 2.534–2.564 | 3.84 | | | i. | i. | sl. s. alk. |
| oxide, di- (brookite) | $TiO_2$ | 79.90 | brn. or bk., rhb., 2.586 | 4.17 | | | i. | i. | |
| oxide, di- (rutile) | $TiO_2$ | 79.90 | col. if pure, tet., 2.615 | 4.26 | 1640 d. | <3000 | i. | i. | s. $H_2SO_4$, alk. |
| Tungsten | W | 183.92 | gray-bk., cb. | 19.3 | 3370 | 5900 | i. | i. | s. h. conc. KOH; sl. s. $NH_3$, $HNO_3$, aq. reg. |
| carbide | WC | 195.93 | gray pd., cb. | $15.7^{18°}$ | 2777 | 6000 | i. | i. | s. $F_2$; i. a. |
| carbide | $W_2C$ | 379.85 | iron gray | $16.06^{18°}$ | 2877 | 6000 | i. | i. | s. h. $HNO_3$; sl. s. HCl, $H_2SO_4$ |
| oxide, tri- | $WO_3$ | 231.92 | yel., rhb. | 7.16 | >2130 | | i. | i. | s. alk.; i. a. |
| Tungstic acid (tungstite) | $H_2WO_4$ | 249.94 | yel., rhb. 2.24 | 5.5 | –a $H_2O$, 100; 1473 | | i. | sl. s. | s. HF, alk., $NH_3$ |
| Uranic acid | $H_2UO_4$ | 304.09 | yel. pd. | $5.926^{15°}$ | $–H_2O$, 250 to 300 | | i. | i. | s. a., alk. carb.; i. alk. |
| Uranium | U | 238.07 | wh. cr. | $18.485\,\frac{13°}{4}$ | 1133 | 3500 | i. | i. | s. a.; i. alk. |
| carbide | $U_2C_3$ | 512.14 | cr. | 11.28 | 2400 | | d. | | d. a. |
| oxide, di- (uraninite) | $UO_2$ | 270.07 | bk., rhb. | 10.9 | 2176 | | i. | i. | s. $HNO_3$, conc. $H_2SO_4$ |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| oxide (pitchblende) | $U_3O_8$ | 842.21 | olive gn. | 7.31 | d. | | i. | i. | s. $HNO_3$, $H_2SO_4$ |
| sulfate (ous) | $U(SO_4)_2{\cdot}4H_2O$ | 502.25 | gn., rhb. | | $-4H_2O$, 300 | | $23^{11°}$ | $9^{63°}$ | s. dil. a. |
| Uranyl acetate | $UO_2(C_2H_3O_2)_2{\cdot}2H_2O$ | 424.19 | yel., rhb. | $2.89^{15°}$ | $-2H_2O$, 110 | | $9.2^{17°}$ | d. | s. al., act. |
| carbonate (rutherfordine) | $UO_2CO_3$ | 330.08 | tet. | 5.6 | | | | | |
| nitrate | $UO_2(NO_3)_2{\cdot}6H_2O$ | 502.18 | yel., rhb., 1.4967 | 2.807 | 60.2 | 118 | $170.3^{0°}$ | $\infty^{60°}$ | v. s. ac., al., et.; i. dil., alk. |
| sulfate | $UO_2SO_4{\cdot}3H_2O$ | 420.18 | yel. cr. | $3.28^{16.5°}$ | d. 100 | | $18.9^{13.2°}$ | $230^{25°}$ | 4 al.; s. a. |
| Vanadic acid, meta- | $HVO_3$ | 99.96 | yel. scales | | | | i. | | s. a., alk.; i. $NH_3$ |
| Vanadic acid, pyro- | $H_4V_2O_7$ | 217.93 | pa. yel., amor. | | | | i. | | s. a., alk., $NH_4OH$ |
| Vanadium | V | 50.95 | lt. gray, cb. | 5.96 | 1710 | 3000 | i. | i. | s. $HNO_3$, $H_2SO_4$; i. aq., alk. |
| chloride, di- | $VCl_2$ | 121.86 | gn., hex., delq. | $3.23^{18°}$ | | | s. | d. | s. al., et. |
| chloride, tri- | $VCl_3$ | 157.23 | pink, tabular, delq. | $3.00^{18°}$ | d. | | s. | d. | s. abs. al., et. |
| chloride, tetra- | $VCl_4$ | 192.78 | red lq. | $1.816^{30°}$ | −109 | $148.5^{755mm}$ | s. d. | | s. abs. al., et., chl., ac. |
| oxide, di- | $V_2O_2$ | 133.90 | lt. gray cr. | 3.64 | ign. | | i. | i. | s. a. |
| oxide, tri- | $V_2O_3$ | 149.90 | bk. cr. | $4.87\,\frac{18°}{4}$ | 1970 | | sl. s. | s. | s. $HNO_3$, HF, alk. |
| oxide, tetra- | $V_2O_4$ | 165.90 | blue cr. | 4.399 | 1967 | | i. | i. | s. a., alk. |
| oxide, penta- | $V_2O_5$ | 181.90 | red-yel., rhb. | $3.357\,\frac{18°}{4}$ | 800 | d. 1750 | $0.8^{20°}$ | | s. a., alk.; i. abs. al. |
| oxychloride, mono- | VOCl | 102.41 | brn. pd. | 2.824 | | | i. | | v. s. $HNO_3$ |
| Vanadyl chloride | $(VO)_2Cl$ | 169.36 | yel. cr. | 3.64 | d. in air | | i. | | s. $HNO_3$ |
| chloride, di- | $VOCl_2$ | 137.86 | gn., delq. | $2.88^{13°}$ | | | d. | | s. abs. al., dil. $HNO_3$ |
| chloride, tri- | $VOCl_3$ | 173.32 | yel. lq. | 1.829 | <−15 | 127.19 | s. d. | | s. al., et., $\infty Br_2$ |
| Water† | $H_2O$ | 18.016 | col. lq., $1.33300^{20°}$; hex. solid, 1.309 | $1.00^{4°}$ (lq.); $0.915^{0°}$ (ice) | 0 | 100 | | | ∞ al.; sl. s. et. |
| Water, heavy | $D_2O$ | 20.029 | col. lq., $1.32844^{20°}$ | $1.107^{20°}$ | 3.82 | 101.42 | ∞ | ∞ | ∞ al.; sl. s. et. |
| Xenon | Xe | 131.30 | col. gas | lq., $3.06^{-109.1}$ $2.7^{-140°}$ 4.53 (A) | −140 | −109.1 | $24.2^{0°}$ cc | $7.3^{50°}$ cc | |
| Ytterbium | Yb | 173.04 | | | | | | | |
| Yttrium | Y | 88.92 | dark gray, hex. | 5.51 | 1490 | 2500 | sl. d. | d. | v. s. dil. a., h. KOH |
| Zinc | Zn | 65.38 | silv. met., hex. | 7.140 | 419.4 | 907 | i. | i. | s. a., ac., alk. |
| acetate | $Zn(C_2H_3O_2)_2$ | 183.47 | mn. | 1.840 | 242 | subl. in vac. | $30^{25°}$ | $44.6^{100°}$ | $2.8^{25°}$, $166^{79°}$ al. |
| acetate | $Zn(C_2H_3O_2)_2{\cdot}2H_2O$* | 219.50 | wh., mn., 1.494 | 1.735 | 237 | $-2H_2O$, 100 | $40^{25°}$ | $66.6^{100°}$ | v. s. al. |
| bromide | $ZnBr_2$ | 225.21 | rhb. | $4.219^{4°}$ | 394 | 650 | $390^{0°}$ | $670^{100°}$ | v. s. $NH_4OH$, al., et. |
| carbonate | $ZnCO_3$ | 125.39 | wh., trig., 1.818 | 4.42 | $-CO_2$, 300 | | $0.001^{15°}$ | | s. a., alk., $NH_4$ salts; i. act., $NH_3$ |
| chloride | $ZnCl_2$ | 136.29 | wh., delq., 1.687, uniaxial | $2.91\,\frac{25°}{4}$ | 283 | 732 | $432^{25°}$ | $615^{100°}$ | $100^{12.5°}$ al.; v. s. et.; i. $NH_3$ |
| cyanide | $Zn(CN)_2$ | 117.42 | col., rhb. | | d. 80 | | $0.0005^{18°}$ | sl. s. | s. KCN, $NH_3$, alk.; i. al. |
| hydroxide | $Zn(OH)_2$ | 99.40 | col., rhb. | 3.053 | d. 125 | | $0.00052^{18°}$ | | s. a., alk., $NH_4OH$ |
| iodide | $ZnI_2$ | 319.22 | cb. | $4.666\,\frac{14.2°}{4}$ | 446 | 624 | $430^{0°}$ | $510^{100°}$ | s. a., al., $NH_3$, aq. $(NH_4)_2CO_3$ |
| nitrate | $Zn(NO_3)_2{\cdot}6H_2O$ | 297.49 | col., tet. | $2.065\,\frac{14°}{4}$ | 36.4 | $-6H_2O$, 105 | 324.5 | $\infty^{36.4°}$ | v. s. al. |
| oxide (zincite) | ZnO | 81.38 | wh., hex., 2.004 | 5.606 | >1800 | | $0.00042^{18°}$ | | s. a., alk., $NH_4Cl$; i. $NH_3$ |
| oxide | ZnO | 81.38 | wh., amor. | 5.47 | >1800 | | $0.00042^{18°}$ | | |
| peroxide | $ZnO_2$ | 97.38 | yel. | 1.571 | expl. 212 | | 0.0022 | | i. $NH_4OH$; d. a. |
| phosphide | $Zn_3P_2$ | 258.10 | steel gray, cb. | $4.55\,\frac{13°}{4}$ | >420 | 1100 | i. | | s. dil. a. |
| silicate | $ZnSiO_3$ | 141.44 | hex. or rhb.; glass, 1.650 | 3.52 | 1437 | | i. | | |
| sulfate (zincosite) | $ZnSO_4$ | 161.44 | wh., rhb., 1.669 | $3.74\,\frac{15°}{4}$ | d. 740 | | $42^{0°}$ | $61^{100°}$ | sl. s. al.; s. gly. |
| sulfate | $ZnSO_4{\cdot}H_2O$ | 179.46 | col. | $3.28\,\frac{15°}{4}$ | d. 238 | | s. | $89.5^{100°}$ | |
| sulfate | $ZnSO_4{\cdot}6H_2O$ | 269.54 | mn. | $2.072\,\frac{15°}{4}$ | $-5H_2O$, 70 | | s. | s. | sl. s. al.; i. act.; $NH_3$ |
| sulfate (goslarite) | $ZnSO_4{\cdot}7H_2O$* | 287.55 | rhb., 1.4801 | $1.966^{16.5°}$ | tr. 39 | $-7H_2O$, 280 | $115.2^{0°}$ | $653.6^{100°}$ | sl. s. al.; i. act.; $NH_3$ |
| sulfide (α) (wurzite) | ZnS | 97.44 | wh., hex., 2.356 | 4.087 | $1850^{150atm}$ | subl. 1185 | $0.00069^{18°}$ | i. | v. s. a.; i. ac. |
| sulfide (β) (sphalerite) | ZnS | 97.44 | wh., cb.; glass (?) 2.18–2.25 | $4.102\,\frac{25°}{4}$ | tr. 1020 | | i. | i. | s. a. |
| sulfide (blende) | ZnS | 97.44 | wh., granular | 4.04 | | | i. | i. | v. s. a.; i. ac. |
| sulfite | $ZnSO_3{\cdot}2a\ H_2O$ | 190.48 | mn. | | $-2a\ H_2O$, 100 | d. 200 | 0.16 | d. | s. $H_2SO_3$, $NH_4OH$; i. al. |
| Zirconium | Zr | 91.22 | cb., pd. ign. easily | 6.4 | 1700 | >2900 | i. | i. | s. HF, aq. reg.; sl. s. a. |
| oxide, di- (baddeleyite) | $ZrO_2$ | 123.22 | yel. or brn., mn., 2.19 | 5.49 | 2700 | | i. | i. | s. $H_2SO_4$, HF |
| oxide, di- (free from Hf) | $ZrO_2$ | 123.22 | wh., mn. | 5.73 | | 4300 | i. | i. | s. $H_2SO_4$, HF |

*Usual commercial form.
†*Cf.* special tables on water and steam, Tables 2-3, 2-4, 2-5, 2-185, 2-186 and 2-351 through 2-357.
NOTE: °F = ⅘ °C + 32.

## TABLE 2-2 Physical Properties of Organic Compounds*

Abbreviations Used in the Table

(A), density referred to air
al., ethyl alcohol
amor., amorphous
aq., aqua, water
brn., brown
bz., benzene
c., cubic
cc., cubic centimeter
chl., chloroform
col., colorless
cr., crystalline
d., decomposes
d-, dextrorotatory
dl-, dextro-laevorotatory
et., ethyl ether
expl., explodes
gn., green
h., hot
hex., hexagonal
i-, iso-, containing the group $(CH_3)_2CH$-
i., insoluble
ign., ignites
l-, laevorotatory
lf., leaflets
lq., liquid
m-, meta
mn., monoclinic
n-, normal
nd., needles
o-, ortho
or., orange
p-, para
pd., powder
pet., petroleum ether
pl., plates
pr., prisms
rhb., rhombic
s., soluble
s-, sec-, secondary
silv., silvery
sl., slightly
subl., sublimes
sym., symmetrical
t-, tertiary
tet., tetragonal
tri., triclinic
uns., unsymmetrical
v., very
v. s., very soluble
v. sl. s., very slightly soluble
wh., white
yel., yellow
(+), right rotation
>, greater than
<, less than
∞, infinitely

This table of the physical properties includes the organic compounds of most general interest. For the properties of other organic compounds, reference must be made to larger tables in Lange's *Handbook of Chemistry* (Handbook Publishers), *Handbook of Chemistry and Physics* (Chemical Rubber Publishing Co.), Van Nostrand's *Chemical Annual, International Critical Tables* (McGraw-Hill), and similar works.

The **molecular weights** are based on the 1941 atomic weight values. The **densities** are given for the temperature indicated and are usually referred to water at 4°C, *e.g.,* $1.028^{95/4}$ a density of 1.028 at 95°C referred to water at 4°C, the 4 being omitted when it is not clear whether the reference is to water at 4°C or at the temperature indicated by the upper figure. The melting and boiling points given have been selected from available data as probably the most accurate. The **solubility** is given in grams of the substance in 100 g. of the solvent. In the case of gases, the solubility is often expressed in some manner as "$5^{10}$ cc." which indicates that, at 10°C, 5 cc. of the gas are soluble in 100 g. of the solvent.

| Name | Synonym | Formula | Formula weight | Form and color | Specific gravity | Melting point, °C | Boiling point, °C | Solubility in 100 parts | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Water | Alcohol | Ether |
| Abietic acid | sylvic acid, abietinic acid | $C_{20}H_{30}O_2$ | 302.44 | lf. | | 182 | | i. | v. s. | v. s. |
| Acenaphthene | naphthylene ethylene | $C_{10}H_6(CH_2)_2$ | 154.20 | rhb./al. | $1.069^{95/95}$ | 95 | 278–9 | i. | s. h. | s. chl. |
| Acetal | acetaldehyde diethylacetal | $CH_3CH(OC_2H_5)_2$ | 118.17 | lq. | $0.821^{22/4}$ | | 102.2 | $6^{25}$ | ∞ | ∞ |
| Acet-aldehyde | ethanal | $CH_3CHO$ | 44.05 | col. lq. | $0.783^{18/4}$ | –123.5 | 20.2 | ∞ | ∞ | ∞ |
| -aldehyde, par- | paraldehyde | $(C_2H_4O)_3$ | 132.16 | col. cr. | $0.994^{20/4}$ | 10.5–12 | $124.4^{752}$ | $12^{13}$ | ∞ | ∞ |
| -aldehyde ammonia | | $CH_3CHOHNH_2$ | 61.08 | col. cr. | | 97 | 100–10 d. | v. s. | v. s. | sl. s. |
| -amide | ethanamide | $CH_3CONH_2$ | 59.07 | col. cr. | 1.159 | 81(69.4) | 222 | s. | s. | v. sl. s. |
| -anilide | antifebrin | $C_6H_5NHCOCH_3$ | 135.16 | rhb./al. | $1.21^4$ | 113–4 | 305 | $0.5^6$ | $21^{20}$ | $7^{25}$ |
| -phenetidide (*o-*) | *o*-ethoxyacetanilide | $CH_3CONHC_6H_4OC_2H_5$ | 179.21 | lf./al. | | 79 | >250 | i. | s. | |
| (*m-*) | acetyl-*m*-phenetidine | $CH_3CONHC_6H_4OC_2H_5$ | 179.21 | lf./al. | | 96–7 | | sl. s. | s. | |
| -toluidide (*o-*) | N-tolylacetamide | $CH_3C_6H_4NHCOCH_3$ | 149.19 | rhb. | $1.168^{15}$ | 110 | 296 | $0.86^{19}$ | s. | s. |
| (*p-*) | N-tolylacetamide | $CH_3C_6H_4NHCOCH_3$ | 149.19 | rhb. or mn. | $1.212^{15}$ | 153 | 306–7 | $0.09^{22}$ | $10^{25}$ | s. |
| Acetic acid | ethanoic acid, vinegar acid | $CH_3CO_2H$ | 60.05 | col. lq. | $1.049^{20/4}$ | 16.7 | 118.1 | ∞ | ∞ | ∞ |
| anhydride | acetyl oxide, acetic oxide | $(CH_3CO)_2O$ | 102.09 | col. lq. | $1.082^{20/4}$ | –73 | 139.6 | 12 c. | ∞ | ∞ |
| nitrile | methyl cyanide | $CH_3CN$ | 41.05 | col. lq. | $0.783^{20/4}$ | –41 | 81.6–2.0 | ∞ | ∞ | ∞ |
| Acetone | propanone, dimethyl ketone | $CH_3COCH_3$ | 58.08 | col. lq. | $0.792^{20/4}$ | –94.6 | 56.5 | ∞ | ∞ | ∞ |
| Acetonyl urea | dimethyl hydantoin | $<NHCONHCOC>(CH_3)_2$ | 128.13 | tri./al. | | 175 | subl. | s. | s. | s. |
| Acetophenone benzoyl hydride | methyl-phenyl ketone | $CH_3COC_6H_5$ | 120.14 | lf. | $1.033^{15/15}$ | 20.5 | $202.3^{749}$ | i. | s. | s. |
| Acetyl-chloride | ethanoyl chloride | $CH_3COCl$ | 78.50 | col. lq. | $1.105^{20/4}$ | –112.0 | 51–2 | d. | d. | ∞ |
| -phenylenediamine (*-p*) | amino-acetanilide (*p*) | $C_2H_3ONHC_6H_4NH_2$ | 150.18 | nd./aq. | | 162 | | s. h. | v. s. | v. s. |
| Acetylene | ethyne; ethine | $HC{\vdots}CH$ | 26.04 | col. gas | (A) 0.906 | $-81.5^{891}$ | $-84^{760}$ | 100 cc.[18] | 600 cc.[18] | |
| dichloride (*cis*) | 1,2-dichloroethene | CHCl:CHCl | 96.95 | col. lq. | $1.291^{15/4}$ | –80.5 | 60.3 | $0.35^{20}$ | ∞ | ∞ |
| (*trans*) | dioform | CHCl:CHCl | 96.95 | col. lq. | $1.265^{15/4}$ | –50 | 48.4 | $0.63^{20}$ | ∞ | ∞ |
| Aconitic acid | equisetic acid; citridic acid | $C_3H_3(CO_2H)_3$ | 174.11 | cr./aq. | | 192 d. | | $33^{15}$ | sl. s. | v. sl. s. |
| Acridine | | $C_6H_4<(CH)(N)>C_6H_4$ | 179.21 | rhb./aq. al. | | 110–1 | 346 | sl. s. h. | s. | s. |
| Acrolein ethylene aldehyde | acrylic aldehyde, propenal | $CH_2{:}CH{\cdot}CHO$ | 56.06 | col. lq. | $0.841^{20/4}$ | –87.7 | 52.5 | 40 | s. | s. |
| Acrylic acid | propenoic acid | $CH_2{:}CH{\cdot}CO_2H$ | 72.06 | col. lq. | $1.062^{16/4}$ | 12–13 | 141–2 | ∞ | ∞ | |
| nitrile | vinyl cyanide | $CH_2{:}CH{\cdot}CN$ | 53.06 | col. lq. | $0.811^{20}$ | –82 | 78–9 | s. | | |
| Adipic acid | hexandioc acid, adipinic acid | $(CH_2CH_2CO_2H)_2$ | 146.14 | mn. pr. | $1.360^{25/4}$ | 151–3 | $265^{10}$ | $1.4^{15}$ | v. s. | $0.6^{15}$ |
| amide | | $(CH_2CH_2CONH_2)_2$ | 144.17 | cr. pd. | | 226–7 | | $0.4^{12}$ | | |
| nitrile | tetramethylene | $(CH_2CH_2CN)_2$ | 108.14 | col. oil | $0.951^{19/19}$ | 1 | 295 | v. sl. s. | s. | v. sl. s. |
| Adrenaline (1-) (3,4,1) | 1-suprarenine | $C_6H_3(OH)_2(CHOHCH_2NHCH_3)$ | 183.20 | col. pd. | | d. 207–11 | | $0.03^{20}$ | v. sl. s. | i. |
| Alanine (α) (*dl-*) | | $CH_3CH(NH_2)CO_2H$ | 89.09 | nd./aq. | | 295 d. | subl. >200 | $22^{17}$ | v. sl. s. | i. |
| Aldol acetaldol | 2-hydroxybutyraldehyde | $CH_3CH(OH)CH_2CO_2H$ | 88.10 | col. lq. | $1.103^{20/4}$ | | $83^{20}$ | ∞ | ∞ | s. |
| Alizarin | Anthraquinoic acid | $C_6H_4(CO)_2C_6H_2(OH)_2$ | 240.20 | red rhb. | | 289–90 | 430 | $0.03^{100}$ | v. s. | v. s. |
| Allyl alcohol | propen-1-ol-3,propenyl alcohol | $CH_2{:}CH{\cdot}CH_2OH$ | 58.08 | col. lq. | $0.854^{20/4}$ | –129 | 96.6 | ∞ | ∞ | ∞ |
| bromide | 3-bromo-propene-1 | $CH_2{:}CH{\cdot}CH_2Br$ | 120.99 | lq. | $1.398^{20/4}$ | –119.4 | $70–1^{753}$ | i. | ∞ | ∞ |
| chloride | 3-chloro-propene-1 | $CH_2{:}CH{\cdot}CH_2Cl$ | 76.53 | col. lq. | $0.938^{20/4}$ | –136.4 | 44.6 | <0.1 | ∞ | ∞ |
| thiocyanate (*i*) | mustard oil | $CH_2{:}CH{\cdot}CH_2NCS$ | 99.15 | col. oil | $1.013^{20/4}$ | –80 | 152 | 0.2 | ∞ | ∞ |
| thiourea | thiosinamide | $CH_2{:}CH{\cdot}CH_2NHCSNH_2$ | 116.18 | col. pr. | $1.219^{20/20}$ | 77–8 | | $3^0$ | s. | v. sl. s. |
| Aluminum ethoxide | | $Al(OCH_2CH_3)_3$ | 164.15 | pd. | $1.142^{20/0}$ | 150–60 | 200–$5^{10}$ | d. | i. | v. sl. s. |
| Amino-anthraquinone (α) | | $C_6H_4(CO)_2C_6H_3NH_2$ | 223.22 | red nd. | | 256 | subl. | i. | s. | s. |
| (β) | | $C_6H_4(CO)_2C_6H_3NH_2$ | 223.22 | red nd. | | 302 | subl. | i. | s. | i. |
| -azobenzene | | $C_6H_5{\cdot}N{:}N{\cdot}C_6H_4NH_2$ | 197.23 | yel. mn. | | 126–7 | $225^{120}$ | sl. s. h. | s. h. | s. |
| -benzoic acid (*m-*) | | $H_2N{\cdot}C_6H_4CO_2H$ | 137.13 | nd./aq. | $1.511^{4°}$ | 173–4 | | v. sl. s. | $2^{10}$ | $1.8^6$ |
| (*p-*) | aminodracylic acid | $H_2N{\cdot}C_6H_4CO_2H$ | 137.13 | mn. pr. | | 187–8 | | $0.3^{13}$ | $11^{10}$ | $8.2^6$ |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Amino-diphenylamine (*p*-) | | $H_2N{\cdot}C_6H_4NH{\cdot}C_6H_5$ | 184.23 | nd./aq. al. | | 67 | 354 | sl. s. | s. | s. |
| -G-acid (2-)(6-,8-), $Na_2$ salt | | $C_{10}H_5(NH_2)(SO_3Na)_2$ | 347.28 | | | | | v. sl. s. | | |
| -mono-potassium salt | | $C_{10}H_5(NH_2)S_2O_6HK$ | 341.39 | | | | | $12.8^{20}$ | | |
| -sodium salt | | $C_{10}H_5(NH_2)S_2O_6HNa$ | 325.29 | | | | | $2.7^{18}$ | | |
| -J-acid (2-)(5-,7-) | | $C_{10}H_5(NH_2)(SO_3H)_2$ | 303.30 | | | | | $10.0^{20}$ | | |
| -mono-potassium salt | | $C_{10}H_5(NH_2)S_2O_6HK$ | 341.39 | | | | | $3.4^{18}$ | | |
| -naphthol sulfonic (1-,2-,4-)(α-) | | $C_{10}H_5OHNH_2SO_3Ha\ H_2O$ | 248.25 | | | | | v. s. | | |
| (1-,8-,4-) | | $NH_2(OH)C_{10}H_5SO_3H$ | 239.24 | | | | | v. sl. s. | | |
| -phenol (*o*-) | 2-aminophenol | $H_2N{\cdot}C_6H_4{\cdot}OH$ | 109.12 | col. nd. | | 173 | subl. | $1.7^{0}$ | $4.3^{0}$ | v. s. |
| (*m*-) | 3-aminophenol | $H_2N{\cdot}C_6H_4{\cdot}OH$ | 109.12 | pr. | | 122–3 | | $2.6^{0}$ | s. | sl. s. |
| (*p*-) | *p*-hydroxyaniline | $H_2N{\cdot}C_6H_4{\cdot}OH$ | 109.12 | lf. | | 184–6 d. | subl. | $1.1^{0}$ | $4^{0}$ | i. bz. |
| -toluene sulfonic acid (1-,2-,3-) | | $C_6H_3(CH_3)(NH_2)SO_3H$ | 187.21 | nd. | | | | $0.97^{11}$ | | |
| (1-,4-,2-) | | $C_6H_3(CH_3)(NH_2)SO_3H{\cdot}H_2O$ | 205.23 | mn. | | d. | | $0.5^{20}$ | i. | |
| (1-,4-,3-) | | $C_6H_3(CH_3)(NH_2)SO_3H{\cdot}a\ H_2O$ | 196.22 | nd. | | | | 0.47 | | |
| (1-,2-,5-) | | $C_6H_3(CH_3)(NH_2)SO_3H{\cdot}H_2O$ | 205.23 | tri./aq. | | $-H_2O$, 120 | | $3^{11}$ | i. | |
| Amyl acetate (*n*-) | | $CH_3CO_2CH_2(CH_2)_3CH_3$ | 130.18 | col. lq. | $0.879^{20/20}$ | −70.8 | $148.4^{737}$ | v. sl. s. | ∞ | ∞ |
| (*i*-) | common amyl acetate | $CH_3CO_2CH_2CH_2CH(CH_3)_2$ | 130.18 | col. lq. | $0.876^{15/4}$ | | $142^{757}$ | $0.3^{15}$ | ∞ | ∞ |
| | | $CH_3CO_2CH_2CH(CH_3)C_2H_5$ | 130.18 | col. lq. | $0.880^{13}$ | | 141–2 | v. sl. s. | ∞ | ∞ |
| (*s*-) | α-Me-Bu-acetate | $CH_3CO_2CH(CH_3)CH_2C_2H_5$ | 130.18 | col. lq. | $0.922^{0}$ | | 133.5 | sl. s. | ∞ | ∞ |
| (*s*-) | di Et-carbinol acetate | $CH_3CO_2CH(C_2H_5)_2$ | 130.18 | col. lq. | $0.871^{20/4}$ | | 133 | sl. s. | ∞ | ∞ |
| (*t*-) | | $CH_3CO_2C(CH_3)_2C_2H_5$ | 130.18 | col. lq. | $0.874^{19}$ | | $124.5^{749}$ | v. sl. s. | ∞ | ∞ |
| alcohol (*n*-) fusel oil, | pentanol-1 | $CH_3(CH_2)_3CH_2OH$ | 88.15 | col. lq. | $0.817^{20/20}$ | −78.5 | 137.9 | $2.7^{22}$ | ∞ | ∞ |
| (*s*-,*n*-) methyl-propyl carbinol, | pentanol-2 | $C_2H_5CH_2CH(OH)CH_3$ | 88.15 | col. lq. | $0.810^{20/20}$ | | 119.5 | $4^{20}$ | ∞ | ∞ |
| (prim.-,*i*-) isobutyl carbinol, | 2-methyl-butanol-4 | $(CH_3)_2CHCH_2CH_2OH$ | 88.15 | col. lq. | $0.813^{15/4}$ | −117.2 | 132.0 | $2^{14}$ | ∞ | ∞ |
| | | $(C_2H_5)_2CHOH$ | 88.15 | col. lq. | $0.815^{25/4}$ | | 115.6 | $5.5^{30}$ | ∞ | ∞ |
| (*s*-,*i*-) | 2-methyl-butanol-3 | $(CH_3)_2CHCH(OH)CH_3$ | 88.15 | col. lq. | $0.819^{19}$ | | 113–4 | $2.8^{30}$ | ∞ | ∞ |
| (*t*-) | 2-methyl-butanol-2 | $(CH_3)_2C(OH)C_2H_5$ | 88.15 | col. lq. | $0.809^{20/4}$ | −11.9 | 102 | sl. s. | s. | s. |
| | | $(CH_3)_3CCH_2OH$ | 88.15 | cr. | | 52–3 | 113–4 | sl. s. | ∞ | ∞ |
| (*d*-) | active amyl alcohol | $C_2H_5CH(CH_3)CH_2OH$ | 88.15 | col. lq. | $0.816^{20/4}$ | | 128 | $3.6^{30}$ | ∞ | ∞ |
| -amine (*n*-) | | $CH_3(CH_2)_4NH_2$ | 87.16 | col. lq. | $0.766^{19}$ | −55 | 103–4 | s. | s. | s. |
| (*s*-,*n*-) | | $(C_3H_7)(CH_3)CHNH_2$ | 87.16 | col. lq. | $0.749^{20/4}$ | | 91–2 | ∞ | ∞ | ∞ |
| (*i*-) | | $(CH_3)_2CH(CH_2)_2NH_2$ | 87.16 | col. lq. | $0.751^{18/4}$ | | 95 | ∞ | ∞ | ∞ |
| (*t*-) | | $(C_2H_5)(CH_3)_2CNH_2$ | 87.16 | col. lq. | $0.731^{25/4}$ | −105 | 77–8 | ∞ | ∞ | ∞ |
| | 1-$NH_2$-2-Me-butane | $C_2H_5CH(CH_3)CH_2NH_2$ | 87.16 | col. lq. | $0.755^{18}$ | | 95–6 | ∞ | ∞ | ∞ |
| | 3-amino pentane | $(C_2H_5)_2CHNH_2$ | 87.16 | col. lq. | $0.749^{20/4}$ | | 90–1 | ∞ | ∞ | ∞ |
| | 3-$NH_2$-2-Me-butane | $(CH_3)_2CHCH(CH_3)NH_2$ | 87.16 | col. lq. | $0.757^{18}$ | | 83–4 | ∞ | ∞ | ∞ |
| aniline (*i*-) | | $C_6H_5NHC_5H_{11}$ | 163.25 | lq. | $0.928^{15/4}$ | | 254.5 | i. | | |
| benzoate (*i*-) | | $C_6H_5CO_2C_5H_{11}$ | 192.25 | col. lq. | $0.992^{14/14}$ | | $261^{746}$ | i. | ∞ | ∞ |
| bromide (*n*-) | 1-bromopentane | $CH_3(CH_2)_3CH_2Br$ | 151.05 | col. lq. | $1.218^{20/4}$ | −95 | 129.7 | i. | s. | |
| (*i*-) | 4-Br-2-Me-butane | $(CH_3)_2CH(CH_2)_2Br$ | 151.05 | col. lq. | $1.220^{17/15}$ | | $120^{745}$ | $0.02^{16}$ | s. | s. |
| (*t*-) | 2-Br-2-Me-butane | $(CH_3)_2C(Br)C_2H_5$ | 151.05 | lq. | $1.216^{19/0}$ | | $108^{765}$ | i. | s. | s. |
| *n*-butyrate (*n*-) | | $C_3H_5CH_2CO_2(CH_2)_4CH_3$ | 158.23 | col. lq. | $0.871^{15/4}$ | −73.2 | 186.4 | $0.05^{50}$ | ∞ | ∞ |
| (*i*-) | | $C_2H_5CH_2CO_2{\cdot}C_5H_{11}$ | 158.23 | col. lq. | $0.866^{19/15}$ | | 178.6 | i. | ∞ | ∞ |
| (*t*-) | | $C_3H_7CO_2C(CH_3)_2C_2H_5$ | 158.23 | col. lq. | $0.865^{15/0}$ | | 164 | sl. s. | ∞ | ∞ |
| *i*-butyrate (*i*-) | | $(CH_3)_2CHCO_2C_5H_{11}$ | 158.23 | lq. | $0.876^{0/4}$ | | 168.8 | i. | s. | s. |
| chloride (*n*-) | 1-chloropentane | $CH_3(CH_2)_3CH_2Cl$ | 106.60 | col. lq. | $0.878^{20/4}$ | −99 | 108.4 | i. | s. | s. |
| (*s*-) | 2-chloropentane | $C_2H_5CH_2CHClCH_3$ | 106.60 | lq. | $0.870^{20/4}$ | | 96.7 | i. | s. | s. |
| (*s*-) | 3-chloropentane | $(C_2H_5)_2CHCl$ | 106.60 | col. lq. | $0.895^{21}$ | | 97.3 | i. | ∞ | ∞ |
| (*i*-) | 4-Cl-2-Me-butane | $(CH_3)_2CH(CH_2)_2Cl$ | 106.60 | col. lq. | $0.893^{20/4}$ | | $99.7^{758}$ | i. | s. | ∞ |
| (*s*-,*i*-) | 3-Cl-2-Me-butane | $(CH_3)CHCHClCH_3$ | 106.60 | lq. | $0.883^{0}$ | | $91^{753}$ | i. | s. | s. |
| (*t*-) | 2-Cl-2-Me-butane | $(CH_3)_2CClC_2H_5$ | 106.60 | lq. | $0.871^{20/4}$ | −72.9 | 85.7 | i. | s. | s. |
| | 1-Cl-2-Me-butane | $(CH_3)(C_2H_5)CHCH_2Cl$ | 106.60 | lq. | $0.881^{17.5}$ | | 98–9 | i. | s. | s. |
| *i*-cyanide (*i*-) | iso-caproic iso-nitrile | $(CH_3)_2CH(CH_2)_2NC$ | 97.16 | lq. | | | 137–9 | i. | s. | s. |
| formate (*n*-) | | $HCO_2CH_2(CH_2)_3CH_3$ | 116.16 | lq. | $0.902^{0}$ | −73.5 | 132 | v. sl. s. | ∞ | ∞ |
| (*i*-) | | $HCO_2CH_2CH_2CH(CH_3)_2$ | 116.16 | lq. | $0.882^{20/4}$ | −93.5 | 123.5 | $0.3^{22}$ | ∞ | ∞ |
| iodide (*n*-) | 1-iodopentane | $CH_3(CH_2)_3CH_2I$ | 198.06 | lq. | $1.510^{20/4}$ | −86 | 157.0 | i. | s. | ∞ |
| (*i*-) | 4-I-2-Me-butane | $(CH_3)_2CHCH_2CH_2I$ | 198.06 | lq. | $1.515^{18/4}$ | | $147^{765}$ | i. | ∞ | ∞ |
| (*s*-,*n*-) | 2-iodopentane | $C_2H_5CH_2CHICH_3$ | 198.06 | lq. | $1.507^{17/4}$ | | 144–5 | i. | ∞ | ∞ |
| (*t*-) | 2-I-2-Me-butane | $(CH_3)_2CIC_2H_5$ | 198.06 | lq. | $1.471^{19/15}$ | | $127^{765}$ | i. | ∞ | ∞ |
| | | $C_2H_5CH(CH_3)CH_2I$ | 198.06 | lq. | $1.524^{20/4}$ | | 148 | i. | ∞ | ∞ |
| mercaptan (*n*-) | pentanthiol-1 | $CH_3(CH_2)_3CH_2SH$ | 104.21 | lq. | $0.857^{20}$ | | $126^{767}$ | i. | ∞ | ∞ |
| (*n*-) | pentanthiol-3 | $(C_2H_5)_2CHSH$ | 104.21 | col. lq. | | | 105 | i. | ∞ | ∞ |
| (*i*-) | 2-Me-butanthiol-4 | $(CH_3)_2CH(CH_2)_2SH$ | 104.21 | lq. | $0.835^{20/4}$ | | 120 | i. | ∞ | ∞ |
| phenol (*t*-)(*p*-) | pentaphen | $C_5H_{11}{\cdot}C_6H_4OH$ | 164.24 | cr. | | 93 | 265–7 | sl. s. | s. | s. |
| propionate (*n*-) | | $C_2H_5CO_2(CH_3)_4CH_3$ | 144.21 | lq. | $0.876^{15/4}$ | −73.1 | 168.7 | i. | ∞ | ∞ |
| (*i*-) | | $C_2H_5CO_2(CH_2)_2CH(CH_3)_2$ | 144.21 | col. lq. | $0.870^{20/4}$ | | 160.2 | $0.1^{25}$ | ∞ | ∞ |
| (act.) | | $C_2H_5CO_2C_5H_{11}$ | 144.21 | col. lq. | $0.866^{20/4}$ | | $58^{16}$ | v. sl. s. | ∞ | ∞ |
| salicylate (*n*-) | | $HOC_6H_4CO_2C_5H_{11}$ | 208.25 | lq. | $1.065^{15}$ | | 265 | i. | ∞ | ∞ |
| Amyl *i*-valerate (*i*) | | $C_4H_9CO_2C_5H_{11}$ | 172.26 | col. lq. | $0.858^{20/15}$ | | 194 | v. sl. s. | ∞ | ∞ |
| (*t*-) | | $C_4H_9CO_2C_5H_{11}$ | 172.26 | col. lq. | $0.861^{14/0}$ | | 173–4 | sl. s. | s. | s. |

*By N. A. Lange, Ph.D., Handbook Publishers, Inc., Sandusky, Ohio. Abridged from table of Physical Constants of Organic Compounds in Lange's "Handbook of Chemistry."

**TABLE 2-2 Physical Properties of Organic Compounds** (*Continued*)

| Name | Synonym | Formula | Formula weight | Form and color | Specific gravity | Melting point, °C | Boiling point, °C | Solubility in 100 parts | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Water | Alcohol | Ether |
| Amylene (*n*-)(α-) | pentene-1 | $C_2H_5CH_2CH{:}CH_2$ | 70.13 | lq. | $0.644^{20}$ | | 30–1 | i. | ∞ | ∞ |
| (*i*-) | 2-methyl-butene-3 | $(CH_3)_2CHCH{:}CH_2$ | 70.13 | col. lq. | $0.632^{15}$ | –135 | $20.5^{771}$ | i. | ∞ | ∞ |
| (α-) | 2-methyl-butene-1 | $(C_2H_5)(CH_3)C{:}CH_2$ | 70.13 | col. lq. | $0.667^{0/0}$ | | $31–2^{758}$ | i. | ∞ | ∞ |
| (-*n*)(β-) | pentene-2 | $C_2H_5CH{:}CHCH_3$ | 70.13 | col. lq. | $0.650^{20/4}$ | –139 | 36.4 | v. sl. s. | ∞ | ∞ |
| (*i*-)(β-) | 2-methyl-butene-2 | $(CH_3)_2C{:}CHCH_3$ | 70.13 | col. lq. | $0.663^{19/4}$ | –124 | 37–8 | i. | s. | ∞ |
| Anethole (*p*-) | *p*-propenyl anisole | $CH_3CH{:}CH{\cdot}C_6H_4OCH_3$ | 148.20 | lf./al. | $0.991^{20/20}$ | 22.5 | 235.3 | v. sl. s. | s. | ∞ |
| Anhydroformald-aniline | methylene aniline | $(CH_2NC_6H_5)_3$ | 315.40 | pr./al. | | 143 | 185 | i. | sl. s. | s. |
| Aniline | amino benzene, phenyl amine, cyanol | $C_6H_5NH_2$ | 93.12 | col. oil | $1.022^{20/4}$ | –6.2 | 184.4 | $3.6^{18}$ | ∞ | ∞ |
| hydrochloride | aniline salt, aniline chloride | $C_6H_5NH_2{\cdot}HCl$ | 129.59 | cr. | $1.222^{4}$ | 198 | 245 | $18^{15}$ | s. | i. |
| nitrate | | $C_6H_5NH_2{\cdot}HNO_3$ | 156.14 | rhb. | $1.356^{4}$ | d. 190 | | s. | s. | sl. s. |
| sulfate | | $(C_6H_5NH_2)_2{\cdot}H_2SO_4$ | 284.32 | lf./al. | $1.377^{4}$ | d. | | $5^{14}$ | sl. s. | i. |
| Anisal-acetone (*p*-) | MeO-benzalacetone | $CH_3OC_6H_4CH{:}CHCOCH_3$ | 176.22 | lf./et. | | 73–4 | | i. | v. s. | v. s. |
| Anisic acid (*p*-) | | $CH_3OC_6H_4CO_2H$ | 152.14 | mn./aq. | $1.385^{4}$ | 184.2 | 275–80 | $0.03^{19}$ | v. s. | v. s. |
| aldehyde (*p*-) | | $CH_3OC_6H_4CHO$ | 136.14 | col. oil | $1.123^{20/4}$ | 2.5 | 247–8 | v. sl. s. | ∞ | ∞ |
| Anisidine (*o*-) | 2-amino-anisole | $CH_3OC_6H_4NH_2$ | 123.15 | col. lq. | $1.098^{15/15}$ | 5.2 | 225 | v. sl. s. | ∞ | ∞ |
| (*m*-) | MeO-aniline(*m*) | $CH_3OC_6H_4NH_2$ | 123.15 | oil | $1.096^{20/4}$ | <–12 | 251 | v. sl. s. | s. | s. |
| (*p*-) | 4-amino anisole | $CH_3OC_6H_4NH_2$ | 123.15 | pl./aq. | $1.089^{55/55}$ | 57.2 | 243 | s. h. | s. | s. |
| Anisole | methyl phenyl ether | $CH_3OC_6H_5$ | 108.13 | col. lq. | $0.990^{22/4}$ | –37.3 | 154–5 | i. | s. | s. |
| Anthracene | paranaphthalene, anthracin green oil | $C_6H_4{:}(CH)_2{:}C_6H_4$ | 178.22 | col. mn. | $1.25^{27/4}$ | 217–8 | 340–2 | i. | $1.5^{20}$ | |
| Anthramine (α) | α-amino-anthracene | $C_6H_4{:}(CH)_2{:}C_6H_3NH_2$ | 193.24 | yel./al. | | 130± | | i. | s. | |
| (β) | β-amino-anthracene | $C_6H_4{:}(CH)_2{:}C_6H_3NH_2$ | 193.24 | yel./al. | | 238 | subl. | i. | sl. s. | sl. s. |
| Anthranil | | $C_6H_4{:}(NH)CO$ | 119.12 | col. oil | $1.187^{15/4}$ | <–18 | d. >215 | sl. s. h. | s. | s. |
| Anthranilic acid (*o*-) | | $H_2NC_6H_4CO_2H$ | 137.13 | col. rhb. | | 144–5 | subl. | $0.35^{14}$ | $11^{10}$ | $16^{7}$ |
| Anthrapurpurin (1-,2-,7-) | | $C_{14}H_5O_2(OH)_3$ | 256.20 | or. nd./al. | | 369 | 462 | sl. s. h. | v. s. h. | sl. s. |
| Anthraquinone | diphenyleneketone, dihydrodiketoanthracene | $C_6H_4{:}(CO)_2{:}C_6H_4$ | 208.20 | yel. rhb. | $1.438^{20/4}$ | 286 | 379–81 | i. | $0.05^{18}$ | v. sl. s. |
| disulfonate $Na_2$ (1-,5-) | ρ-anthraquinone disulfonate | $C_{14}H_6O_2(SO_3Na)_2{\cdot}5H_2O$ | 502.38 | yel. lf. | | | | v. s. | i. | i. |
| (1-,8-) | *x*-anthraquinone disulfonate | $C_{14}H_6O_2(SO_3Na)_2{\cdot}4H_2O$ | 484.37 | yel. pr. | | | | sl. s. | | |
| (2-,6-) | | $C_{14}H_6O_2(SO_3Na)_2{\cdot}7H_2O$ | 538.41 | col. cr. | | | | $3.9^{20}$ | | |
| (2-,7-) | | $C_{14}H_6O_2(SO_3Na)_2{\cdot}4H_2O$ | 484.37 | cr. | | | | $30.5^{20}$ | v. sl. s. | i. |
| sulfonate Na (1-) | | $C_{14}H_7O_2SO_3Na$ | 310.25 | yel. lf. | | | | $0.53^{20}$ | i. | i. |
| (2-) | | $C_{14}H_7O_2SO_3Na$ | 310.25 | silv. lf. | | | | $0.84^{25}$ | i. | i. |
| Anthrarufin (1-,5-) | | $C_{14}H_6O_3(OH)_2$ | 240.20 | yel. lf. | | 280 | subl. | i. | sl. s. | s. |
| Antipyrene | 1-ph-2,3-diMepyrazolone-5 | $C_{11}H_{12}ON_2$ | 188.22 | mn./aq. | $1.088^{113/4}$ | 113(109) | $319^{174}$ | $100^{25}$ | 100 | sl. s. |
| Apiole | 1-allyl-2, 5-diMeO-3,4 methylenedioxybenzene | $C_{12}H_{14}O_2$ | 222.23 | col. nd. | $1.02^{20/4}$ | 30 | 294 | i | s. | s. |
| Arabinose (α)(*d*- or *l*-) | | $CH_2OH(CHOH)_3CHO$ | 150.13 | rhb. pr. | $1.585^{20/4}$ | 159.5 | | $46^{0}$ | $0.5^{9°}$ | i. |
| (*dl*-) | | $CH_2OH(CHOH)_3CHO$ | 150.13 | | | 164.5 | | $16.9^{10}$ | | |
| Arachidic acid | eicosanoic acid | $CH_3(CH_2)_{18}CO_2H$ | 312.52 | col. lf. | | 77 | 328 | i. | s. h. | v. s. |
| Arsanilic acid (*p*-) | | $H_2N{\cdot}C_6H_4{\cdot}AsO_3H_2$ | 217.04 | nd./aq. | | 232 | | v. s. h. | v. s. h. | i. |
| Asparagine (*l*-) | | $HO_2C{\cdot}C_2H_3(NH_2){\cdot}CONH_2$ | 132.12 | rhb. | $1.543^{15/4}$ | 227–35 | d. 235 | $3.1^{28}$ | i. c. | |
| Aspirin (*o*-) | | $CH_3CO_2{\cdot}C_6H_4{\cdot}OH$ | 180.15 | nd./aq. | | 135–6 | | $1^{37}$ | s. | $5^{20}$ |
| Atropic acid | α-phenyl acrylic acid | $C_6H_5C(:CH_2){\cdot}CO_2H$ | 148.15 | nd./aq. | | 106–7 | 267 d. | 0.1 c. | s. | s. |
| Auramine | 4,4′-dimethylaminobenzophenomide | $[(CH_3)_2NC_6H_4]_2C{:}NH$ | 267.36 | col./al. | | 136 | | i. | $7^{20}$ | $2.3^{20}$ |
| Aurine, coralline (4-,4′-) | | $(HOC_6H_4)_2C{:}C_6H_4{:}O$ | 290.30 | red | | 310 d. | | i. | s. | s. |
| Azo-anisole (2-,2′-) | diMeO-azobenzene | $(CH_3O{\cdot}C_6H_4N{:})_2$ | 242.27 | or. pr. | | 153 | | i. | s. | s. |
| benzene | diphenyldiimide | $C_6H_5N{:}N{\cdot}C_6H_5$ | 182.22 | or. mn. | $1.203^{20/4}$ | 68 | 297 | i. | $4.2^{20}$ | |
| Azoxybenzene | | $(C_6H_5)_2N_2O$ | 198.22 | yel. rhb. | $1.248^{20/20}$ | 36 | d. | i. | $11.4^{15}$ | |
| Barbituric acid | malonyl urea | $CO{:}(NHCO)_2{:}CH_2{\cdot}2H_2O$ | 164.12 | col./aq. | | d. 245 | | s. h. | sl. s. | s. |
| Benzal acetone | Me-cinnamyl ketone | $C_6H_5CH{:}CHCOCH_3$ | 146.18 | pl. | $1.035^{20/20}$ | 41–2 | 260–2 | i. | s. | s. |
| Benzaldehyde | artificial almond oil | $C_6H_5CHO$ | 106.12 | col. lq. | $1.046^{20/4}$ | –26 | 179 | 0.3 | ∞ | ∞ |
| Benzamide | | $C_6H_5CONH_2$ | 121.13 | col. pr. | 1.341 | 130 | 290 | $1.35^{25}$ | $17^{25}$ | sl. s. |
| Benzanilide | | $C_6H_5CONHC_6H_5$ | 197.23 | lf./al. | $1.31^{4}$ | 163 | 117–9[10] | i. | $4^{30}$ | sl. s. |
| Benzene | benzol, phenyl hydride, cyclohexatriene | $C_6H_6$ | 78.11 | col. lq. | $0.879^{20/4}$ | 5.5 | 80.1 | $0.07^{22}$ | s. | ∞ |
| sulfinic acid | | $C_6H_5SO_2H$ | 142.17 | pr./aq. | | 83–4 | d. > 100 | v. s. h. | v. s. | v. s. |
| sulfonic acid | | $C_6H_5SO_3H$ | 158.17 | col. nd. | | 65–6 | d. | v. s. | v. s. | i. |
| sulfonic amide | benzene sulfonamide | $C_6H_5SO_2NH_2$ | 157.18 | mn./aq. | | 156 | | $0.43^{16}$ | v. s. | v. s. |
| sulfonic chloride | benzene sulfonyl chloride | $C_6H_5SO_2Cl$ | 176.62 | cr. | $1.384^{15/15}$ | 14.5 | 251.5 | i. | v. s. | s. |
| Benzidine (4-,4′-) | | $NH_2{\cdot}C_6H_4{\cdot}C_6H_4{\cdot}NH_2$ | 184.23 | cr./aq. | | 128–9 | $400^{740}$ | 1 h. | 1 h. | 2 |
| disulfonic acid (2-,2′-) | | $(\cdot C_6H_3(NH_2)SO_3H)_2{\cdot}3H_2O$ | 398.40 | pr./aq. | | d. >175 | | $0.09^{25}$ | i. | i. |
| (3-,3′-) | | $(\cdot C_6H_3(NH_2)SO_3H)_2$ | 344.35 | | | | | v. sl. s. | | |
| Benzil | dibenzoyl | $C_6H_5CO{\cdot}COC_6H_5$ | 210.22 | pr. | $1.23^{15}$ | 95 | 348 d. | i. | v. s. | v. s. |
| Benzoic acid | | $C_6H_5CO_2H$ | 122.12 | mn. pr. | $1.266^{15/4}$ | 121.7 | 249.2 | $0.2^{17}$ | $46^{15}$ | $66^{15}$ |
| anhydride | | $(C_6H_5CO)_2O$ | 226.22 | rhb./et. | $1.199^{15/4}$ | 42 | 360 | i. | s. | s. |
| nitrile | phenyl cyanide | $C_6H_5CN$ | 103.12 | col. lq. | $1.001^{25/6}$ | –12.9 | 190.7 | $1^{100}$ | ∞ | ∞ |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Benzoin (*dl*-) | | $C_6H_5CO{\cdot}CHOHC_6H_5$ | 212.24 | mn. | | 133–7 | $344^{768}$ | v. sl. s. | s. h. | sl. s. |
| Benzophenone | diphenyl ketone | $C_6H_5COC_6H_5$ | 182.21 | col. rhb. | $1.083^{54}$ | 48.5 | 305.4 | i. | $6.5^{15}$ | $15^{13}$ |
| Benzotrichloride | phenyl chloroform | $C_6H_5CCl_3$ | 195.48 | col. lq. | $1.380^{14}$ | –4.75 | 220.7 | i. | s. | s. |
| Benzoyl-benzoic acid (*o*-) | | $C_6H_5COC_6H_4CO_2H{\cdot}H_2O$ | 244.24 | tri./aq. | | 93(128) | | sl. s. | | |
| -chloride | | $C_6H_5COCl$ | 140.57 | col. lq. | $1.212^{20/4}$ | –0.5 | 197.2 | d. | d. h. | ∞ |
| -peroxide | | $(C_6H_5CO)_2O_2$ | 242.22 | rhb./et. | | 108 d. | expl. | i. | s. h. | s. |
| Benzyl acetate | | $CH_3CO_2CH_2C_6H_5$ | 150.17 | col. lq. | $1.057^{17}$ | –51.5 | 213.5 | i. | ∞ | ∞ |
| alcohol | phenyl carbinol | $C_6H_5CH_2OH$ | 108.13 | col. lq. | $1.043^{20/4}$ | –15.3 | 204.7 | $4^{17}$ | ∞ | ∞ |
| amine | ω-amino toluene | $C_6H_5CH_2NH_2$ | 107.15 | lq. | $0.982^{20/4}$ | | 184.5 | ∞ | ∞ | ∞ |
| aniline | phenyl-benzylamine | $C_6H_5CH_2NHC_6H_5$ | 183.24 | mn. pr. | $1.065^{25/25}$ | 37–8 | $306^{750}$ | i. | | s. |
| benzoate | | $C_6H_5CO_2CH_2C_6H_5$ | 212.24 | nd. | $1.12^{20/4}$ | 21 | 323–4 | i. | ∞ | ∞ |
| butyrate | | $C_3H_5CH_2CO_2CH_2C_6H_5$ | 178.22 | col. lq. | $1.016^{16/18}$ | 238–40 | i. | v. s. | v. s. | |
| chloride | ω-chlorotoluene | $C_6H_5CH_2Cl$ | 126.58 | col. lq. | $1.100^{20/20}$ | –39 | 179.4 | i. | ∞ | ∞ |
| ether | dibenzyl ether | $(C_6H_5CH_2)_2O$ | 198.25 | lq. | $1.036^{16}$ | | 295–8 | i. | s. h. | s. |
| formate | | $HCO_2CH_2C_6H_5$ | 136.14 | col. lq. | $1.081^{23}$ | 3.6 | $202–3^{747}$ | i. | s. | ∞ |
| propionate | | $C_2H_5CO_2CH_2C_6H_5$ | 164.20 | lq. | $1.036^{16/17}$ | | 220–2 | i. | | |
| Berberonic acid (2-,4-,5-) | | $C_5H_2N(CO_2H)_3{\cdot}2H_2O$ | 247.16 | tri. | | 243 | | v. sl. s. | sl. s. h. | i. |
| Biuret | allophanamide | $NH(CONH_2)_2$ | 103.08 | nd./al. | | 192–3 d. | | $1.3^{0}$ | s. | |
| Borneol (*dl*-) | | $C_{10}H_{17}OH$ | 154.24 | col. cr. | $1.011^{20/4}$ | 210.5 | subl. | v. sl. s. | | |
| (*d*- or *l*-) | | $C_{10}H_{17}OH$ | 154.24 | col. cr. | $1.011^{20/4}$ | 208–9 | 212–3 | v. sl. s. | v. s. | v. s. |
| (iso-) | | $C_{10}H_{17}OH$ | 154.24 | col. cr. | | 212 | | i. | | |
| Bornyl acetate (*d*-) | | $CH_3CO_2C_{10}H_{17}$ | 196.28 | rhb./pet. | $0.991^{15}$ | 29 | 226–7 | i. | s. | s. |
| Bromo-aniline (*p*-) | | $BrC_6H_4NH_2$ | 172.03 | rhb. | $1.8^{20}$ | 63–4 | | i. c. | v. s. | v. s. |
| -benzene | phenyl bromide | $C_6H_5Br$ | 157.02 | col. lq. | $1.495^{20/4}$ | –30.6 | 156.2 | i. | s. | ∞ |
| -camphor (3-)(*d*-) | α-bromocamphor | $BrC_{10}H_{15}O$ | 231.14 | cr. | $1.449^{20/4}$ | 77–8 | 274 | i. | $20^{26}$ | v. s. |
| -diphenyl (*p*-) | | $BrC_6H_4{\cdot}C_6H_5$ | 233.11 | cr./al. | | 90–1 | 310 | i. | s. | $34^{25}$ |
| -naphthalene (α-) | α-naphthyl bromide | $C_{10}H_7Br$ | 207.07 | col. oil | $1.482^{20/4}$ | 5–6 | 281.1 | i. | s. | ∞ |
| (β-) | β-naphthyl bromide | $C_{10}H_7Br$ | 207.07 | lf./al. | $1.605^{0}$ | 59 | 281–2 | i. | $6^{20}$ | v. s. |
| -phenol (*o*-) | | $BrC_6H_4OH$ | 173.02 | col. lq. | $1.553^{80}$ | 5.6 | 194–5 | s. | s. | ∞ |
| (*m*-) | | $BrC_6H_4OH$ | 173.02 | cr. | | 32–3 | 236–7 | | s. | s. |
| (*p*-) | | $BrC_6H_4OH$ | 173.02 | tet. cr. | $1.588^{80}$ | 63.5 | 238 | $1.4^{15}$ | v. s. | v. s. |
| -styrene (ω)(1) | | $C_6H_5CH{:}CHBr$ | 183.05 | lq. | $1.422^{20/4}$ | 7 | 221 | i. | ∞ | ∞ |
| (2) | | $C_6H_5CH{:}CHBr$ | 183.05 | lq. | $1.427^{20/4}$ | –7.5 | $108^{26}$ | i. | ∞ | ∞ |
| -toluene (*o*-) | *o*-tolyl bromide | $CH_3{\cdot}C_6H_4Br$ | 171.04 | col. lq. | $1.422^{20/4}$ | –28 | 181.8 | i. | s. | $∞^{25}$ |
| (*m*-) | | $CH_3{\cdot}C_6H_4Br$ | 171.04 | col. lq. | $1.410^{20/4}$ | –39.8 | 183.7 | i. | s. | s. |
| (*p*-) | | $CH_3{\cdot}C_6H_4Br$ | 171.04 | cr./al. | $1.390^{20/4}$ | 28.5 | 184–5 | i. | s. | $∞^{25}$ |
| Bromoform | tribromo-methane | $CHBr_3$ | 252.77 | col. lq. | $2.890^{20/4}$ | 8–9 | 150.5 | 0.1 c. | ∞ | ∞ |
| Butadiene (1-,2-) | methyl-allene | $CH_3CH{:}C{:}CH_2$ | 54.09 | lq. | | | 18–9 | i. | ∞ | ∞ |
| (1-,3-) | erythrene | $CH_2{:}CHCH{:}CH_2$ | 54.09 | col. gas | $0.621^{20/4}$ | –108.9 | –4.41 | i. | ∞ | ∞ |
| Butadienyl acetylene | | $CH_2{:}(CH)_2{:}CH{\cdot}C{\vdots}CH$ | 78.11 | col. lq. | $0.773^{20/4}$ | | 83–6 | i. | | |
| Butane | diethyl | $CH_3CH_2CH_2CH_3$ | 58.12 | col. gas | $0.60^{0}$ | –135 | –0.6 | i. | s. | s. |
| (*i*-) | trimethyl-methane | $(CH_3)_3CHCH_3$ | 58.12 | col. gas | $0.60^{0}$ | –145 | –10 | i. | s. | s. |
| Butyl acetate (*n*-) | | $CH_3CO_2(CH_2)_3C_2H_5$ | 116.16 | col. lq. | $0.882^{20}$ | –76.3 | $125^{740}$ | 0.7 | ∞ | ∞ |
| (*s*-) | | $CH_3CO_2CH(CH_3)C_2H_5$ | 116.16 | col. lq. | $0.865^{25/4}$ | | $112^{744}$ | i. | ∞ | ∞ |
| (*i*-) | | $CH_3CO_2CH_2CH(CH_3)_2$ | 116.16 | col. lq. | $0.871^{20/4}$ | –98.9 | 118 | $0.6^{25}$ | ∞ | ∞ |
| (*tert*-) | | $CH_3CO_2C(CH_3)_3$ | 116.16 | col. lq. | $0.866^{20/4}$ | | $95–6^{760}$ | i. | ∞ | ∞ |
| alcohol (*n*-) | butanol-1 | $C_2H_5CH_2CH_2OH$ | 74.12 | col. lq. | $0.810^{20/4}$ | –79.9 | 117 | $9^{15}$ | ∞ | ∞ |
| (*s*-) | butanol-2 | $C_2H_5CH(OH)CH_3$ | 74.12 | col. lq. | $0.808^{20/4}$ | –114.7 | 99.5 | $12.5^{20}$ | ∞ | ∞ |
| (*i*-) | 2-methyl-propanol-1 | $(CH_3)_2CHCH_2OH$ | 74.12 | col. lq. | $0.805^{17.5}$ | –108 | 107–8 | $10^{15}$ | ∞ | ∞ |
| (*tert*-) | 2-methyl-propanol-2 | $(CH_3)_3COH$ | 74.12 | lq. | $0.779^{26}$ | 25.5 | 82.9 | ∞ | ∞ | ∞ |
| amine (*n*-) | | $C_2H_5CH_2CH_2NH_2$ | 73.14 | col. lq. | $0.739^{25/4}$ | –50 | 77.8 | ∞ | ∞ | ∞ |
| (*s*-) | | $C_2H_5CH(NH_2)CH_3$ | 73.14 | col. lq. | $0.724^{20/4}$ | –104 | $66^{772}$ | ∞ | ∞ | ∞ |
| (*i*-) | | $(CH_3)_2CHCH_2NH_2$ | 73.14 | col. lq. | $0.732^{20/20}$ | –85 | 68–9 | ∞ | ∞ | ∞ |
| (*t*-) | | $(CH_3)_3CNH_2$ | 73.14 | col. lq. | $0.698^{18/4}$ | –67.5 | 45.2 | | ∞ | |
| *p*-aminophenol (*N*)(*n*) | | $C_4H_9NH{\cdot}C_6H_4{\cdot}OH$ | 165.23 | | | 71 | | i. | | |
| (*N*)(*i*-) | | $C_4H_9NH{\cdot}C_6H_4{\cdot}OH$ | 165.23 | | | 79 | | i. | | |
| aniline (*n*-) | | $C_4H_9NHC_6H_5$ | 149.23 | lq. | | | $235^{720}$ | i. | v. s. | v. s. |
| (*i*-) | | $C_4H_9NHC_6H_5$ | 149.23 | oil | $0.940^{20/4}$ | | 231–2 | $0.01^{15}$ | v. s. | v. s. |
| arsonic acid (*n*-) | | $C_4H_9AsO(OH)_2$ | 182.04 | col. lf. | | 158–9 | | s. | s. | i. |
| benzoate (*n*-) | | $C_6H_5CO_2C_4H_9$ | 178.22 | col. oil | $1.005^{25/25}$ | –22 | 249–50 | i. | s. | s. |
| (*i*-) | | $C_6H_5CO_2C_4H_9$ | 178.22 | col. oil | $0.997^{25/25}$ | | 241.5 | i. | ∞ | ∞ |
| bromide (*n*-) | 1-bromo-butane | $C_2H_5CH_2CH_2Br$ | 137.03 | lq. | $1.277^{20/4}$ | –112.4 | 101.6 | $0.06^{16}$ | ∞ | ∞ |
| (*s*-) | 2-bromo-butane | $C_2H_5CH(Br)CH_3$ | 137.03 | lq. | $1.251^{25/4}$ | –112 | 91.3 | i. | | |
| (*i*-) | 1-Br-2-Me-propane | $(CH_3)_2CHCH_2Br$ | 137.03 | lq. | $1.258^{25/4}$ | –118.5 | 91.5 | $0.06^{18}$ | ∞ | ∞ |
| (*t*-) | 2-Br-2-Me-propane | $(CH_3)_3CBr$ | 137.03 | lq. | $1.211^{20/4}$ | –16.2 | 73.3 | i. | ∞ | ∞ |
| butyrate (*n*-)(*n*-) | | $C_3H_5CH_2CO_2CH_2CH_2C_2H_5$ | 144.21 | col. lq. | $0.872^{20/20}$ | | $165.7^{736}$ | i. | ∞ | ∞ |
| (*n*-)(*i*-) | | $C_3H_5CH_2CO_2CH_2CH(CH_3)_2$ | 144.21 | col. lq. | $0.863^{18/4}$ | | 156.9 | i. | ∞ | ∞ |
| (*i*-)(*i*-) | | $(CH_3)_2CHCO_2CH_2CH(CH_3)_2$ | 144.21 | col. lq. | $0.875^{0/4}$ | –80.7 | 148–9 | i. | ∞ | ∞ |
| caproate | | $CH_3(CH_2)_4CO_2C_4H_9$ | 172.26 | col. lq. | $0.882^{0/0}$ | | 204.3 | i. | | |
| carbamate (*i*-) | | $NH_2CO_2CH_2CH(CH_3)_2$ | 117.15 | col. lf. | $0.956^{76/4}$ | 65 | 206–7 | i. | s. | s. |
| cellosolve (*n*-) | 2-BuO-ethanol-1 | $C_4H_9OCH_2CH_2OH$ | 118.17 | col. lq. | $0.903^{20/4}$ | | 171.2 | ∞ | ∞ | ∞ |

**TABLE 2-2 Physical Properties of Organic Compounds** (*Continued*)

| Name | Synonym | Formula | Formula weight | Form and color | Specific gravity | Melting point, °C | Boiling point, °C | Solubility in 100 parts | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Water | Alcohol | Ether |
| chloride (*n*-) | 1-chloro-butane | $C_2H_5CH_2CH_2Cl$ | 92.57 | col. lq. | $0.887^{20}$ | –123.1 | $77.9^{763}$ | $0.07^{18}$ | ∞ | ∞ |
| (*s*-) | 2-chloro-butane | $C_2H_5{\cdot}CHCl{\cdot}CH_3$ | 92.57 | col. lq. | $0.871^{20/4}$ | –131 | $67.8^{767}$ | i. | ∞ | ∞ |
| (*i*-) | 1-$Cl_2$-2-Me-propane | $(CH_3)_2CHCH_2Cl$ | 92.57 | col. lq. | $0.884^{15}$ | –131.2 | 68.9 | i. | ∞ | ∞ |
| (*t*-) | 2-$Cl_2$-2-Me-propane | $(CH_3)_3CCl$ | 92.57 | col. lq. | $0.847^{15}$ | –26.5 | 51–2 | i. | ∞ | ∞ |
| dimethylbenzene (*t*-)(1-,3-,5-) | | $(CH_3)_3C{\cdot}C_6H_3{:}(CH_3)_2$ | 162.26 | col. lq. | | | $200–2^{147}$ | i. | | |
| formate (*n*-) | | $HCO_2CH_2CH_2C_2H_5$ | 102.13 | lq. | $0.911^{0}$ | | 106.9 | v. sl. s. | ∞ | ∞ |
| (*s*-) | | $HCO_2CH(CH_3)C_2H_5$ | 102.13 | lq. | $0.882^{20/4}$ | | 97 | sl. s. | ∞ | ∞ |
| (*i*-) | | $HCO_2CH_2CH(CH_3)_2$ | 102.13 | lq. | $0.885^{20/4}$ | –95.3 | 98.2 | $1.1^{22}$ | ∞ | ∞ |
| furoate (*n*-) | | $OC_4H_3CO_2C_4H_9$ | 168.19 | col. lq. | $1.056^{20/4}$ | | $118–20^{25}$ | i. | ∞ | ∞ |
| iodide (*n*-) | 1-iodo-butane | $C_2H_5CH_2CH_2I$ | 184.03 | lq. | $1.617^{20/4}$ | –103.5 | 129.9 | i. | ∞ | ∞ |
| (*s*-) | 2-iodo-butane | $C_2H_5CHICH_3$ | 184.03 | lq. | $1.595^{20}$ | –104 | 118–9 | i. | ∞ | ∞ |
| (*i*-) | 1-iodo-2-Me-propane | $(CH_3)_2CHCH_2I$ | 184.03 | lq. | $1.606^{20/4}$ | –90.7 | 120 | i. | ∞ | ∞ |
| (*t*-) | 2-iodo-2-Me-propane | $(CH_3)_3CI$ | 184.03 | lq. | $1.370^{19/15}$ | –34 | 99 | i. | ∞ | ∞ |
| lactate (*n*-) | | $CH_3CH(OH)CO_2C_4H_3$ | 146.18 | col. lq. | 0.968 | | $75–6^{6}$ | sl. s. | ∞ | ∞ |
| mercaptan (*n*-) | butanthiol-1 | $C_2H_5CH_2CH_2SH$ | 90.18 | col. lq. | $0.837^{25/4}$ | –116 | 97–8 | sl. s. | v. s. | v. s. |
| (*i*-) | 2-Me-propanthiol-1 | $(CH_3)_2CHCH_2SH$ | 90.18 | lq. | $0.836^{20/4}$ | <–79 | 88 | v. sl. s. | s. | s. |
| (*t*-) | | $(CH_3)_3CSH$ | 90.18 | lq. | | | 65–7 | | | |
| methacrylate (*n*-) | | $CH_2{:}C(CH_3)CO_2C_4H_9$ | 142.19 | lq. | $0.889^{15.6}$ | | 155 | i. | | |
| (*i*-) | | $CH_2{:}C(CH_3)CO_2C_4H_9$ | 142.19 | lq. | $0.889^{15.6}$ | | 155 | i. | | |
| phenol (*p*-)(*t*-) | | $(CH_3)_3C{\cdot}C_6H_4{\cdot}OH$ | 150.21 | nd./aq. | $0.908^{112/4}$ | 99 | 236–8 | sl. s. | s. | s. |
| propionate (*n*-) | | $C_2H_5CO_2C_4H_9$ | 130.18 | col. lq. | $0.883^{15}$ | –89.55 | 146 | i. | ∞ | ∞ |
| (*s*-) | | $C_2H_5CO_2C_4H_9$ | 130.18 | col. lq. | $0.866^{20/4}$ | | 132.5 | i. | ∞ | ∞ |
| (*i*-) | | $C_2H_5CO_2C_4H_9$ | 130.18 | col. lq. | $0.888^{0/4}$ | –71.4 | 136.8 | i. | ∞ | ∞ |
| stearate (*n*-) | | $CH_3(CH_2)_{16}CO_2C_4H_9$ | 340.57 | col. lq. | $0.855^{25/25}$ | 27.5 | $220–5^{25}$ | $0.3^{25}$ | s. | s. |
| (*i*-) | | $CH_3(CH_2)_{16}CO_2C_4H_9$ | 340.57 | wax | | 25 | | i. | | |
| iso-thiocyanate (*n*-) | butyl mustard oil | $C_2H_5CH_2CH_2{\cdot}N{:}CS$ | 115.19 | lq. | $0.956^{11}$ | | $165^{724}$ | i. | s. | s. |
| (*i*-) | iso-Bu mustard oil | $(CH_3)_2CHCH_2{\cdot}N{:}CS$ | 115.19 | lq. | $0.964^{14/4}$ | | 162 | i. | s. | s. |
| (*s*-)(*d*-) | | $C_4H_9{\cdot}N{:}CS$ | 115.19 | lq. | $0.943^{20/4}$ | | 159–63 | i. | s. | s. |
| (*t*-) | | $(CH_3)_3C{\cdot}N{:}CS$ | 115.19 | lq. | $0.919^{10}$ | 10.5 | $140^{770}$ | i. | s. | s. |
| valerate (*n*-)(*n*-) | | $CH_3(CH_2)_3CO_2(CH_2)_3CH_3$ | 158.23 | lq. | $0.870^{15/4}$ | –93 | 186 | v. sl. s. | ∞ | ∞ |
| (*i*-)(*n*-) | | $(CH_3)_2CHCH_2CO_2(CH_2)_3CH_3$ | 158.23 | lq. | $0.862^{25/4}$ | | 168.8 | i. | ∞ | ∞ |
| (*i*-)(*s*-) | | $(CH_3)_2CHCH_2CO_2C_4H_9$ | 158.23 | col. lq. | $0.848^{20/4}$ | | $163–4^{752}$ | i. | ∞ | ∞ |
| (*i*-)(*i*-) | | $C_4H_9CO_2C_4H_9$ | 158.23 | col. lq. | $0.874^{0/4}$ | | 168.7 | i. | ∞ | ∞ |
| Butylene (α-) | butene-1 | $C_2H_5CH{:}CH_2$ | 56.10 | col. gas | $0.6^{9}$ | –130 | $–5^{758}$ | i. | v. s. | v. s. |
| (β-) | butene-2 | $CH_3CH{:}CHCH_3$ | 56.10 | col. gas | | –127 | $3^{746}$ | | | |
| Butyraldehyde (*n*-) | | $CH_3CH_2CH_2CHO$ | 72.10 | col. lq. | $0.817^{20/4}$ | –99 | 75.7 | 4 | ∞ | ∞ |
| (*i*-) | 2-Me-propanol | $(CH_3)_2CHCHO$ | 72.10 | col. lq. | $0.794^{20/4}$ | –65.9 | $64^{757}$ | $11^{20}$ | ∞ | ∞ |
| Butyric acid (*n*-) | butanoic acid | $C_2H_5CH_2CO_2H$ | 88.10 | col. lq. | $0.964^{20/4}$ | –4.7 | $163.5^{757}$ | ∞ | ∞ | ∞ |
| (*i*-) | 2-Me-propanoic acid | $(CH_3)_2CHCO_2H$ | 88.10 | col. lq. | $0.949^{20/4}$ | –47 | 154.5 | $20^{20}$ | ∞ | ∞ |
| amide (*n*-) | *n*-butyramide | $C_2H_5CH_2CONH_2$ | 87.12 | rhb. | 1.032 | 115–6 | 216 | $16.3^{15}$ | s. | sl. s. |
| (*i*-) | iso-butyramide | $(CH_3)_2CHCONH_2$ | 87.12 | mn. pl. | 1.013 | 129–30 | 216–20 | v. s. | s. | sl. s. |
| anhydride (*n*-) | | $(C_2H_5CH_2CO)_2O$ | 158.19 | col. lq. | $0.968^{20/20}$ | –75 | 199.5 | d. | d | ∞ |
| (*i*-) | | $[(CH_3)_2CHCO]_2O$ | 158.19 | col. lq. | $0.950^{25/4}$ | –53.5 | $181.5^{734}$ | d. | d | ∞ |
| anilide (*n*-) | *n*-butyranilide | $C_3H_7CONHC_6H_5$ | 163.21 | mn. pr. | 1.134 | 92 | $189^{15}$ | i. | s. | s. |
| Caffeic acid (3-,4-) | | $(HO)_2C_6H_3C_2H_2CO_2H$ | 180.15 | yel./aq. | | 195–213 | d. | s. h. | s. | sl. s. |
| Caffeine | | $C_8H_{10}O_2N_4{\cdot}H_2O$ | 212.21 | nd./al. | $1.23^{19}$ | 237 | subl. | 2 | 2 | 0.3 |
| Camphene (*dl*-) | | $C_{10}H_{16}$ | 136.23 | cr. | $0.822^{78}$ | 50 | 160 | i. | s. | s. |
| (*d*- or *l*-) | | $C_{10}H_{16}$ | 136.23 | cr. | $0.845^{50/4}$ | 42.7 | 159.6 | i. | s. | s. |
| Camphor (*d*-) | | $C_{10}H_{16}O$ | 152.23 | trig. | $0.999^{9/9}$ | 178–9 | $209.1^{759}$ | 0.1 | $120^{12}$ | v. s. |
| Camphoric acid (*d*-) | | $C_8H_{14}(CO_2H)_2$ | 200.23 | mn. | 1.186 | 187 | | $0.6^{12}$ | s. | |
| Cantharidine | | $C_{10}H_{12}O_4$ | 196.20 | cr. | | 212 | | 0.003 | | |
| Capric acid | decanoic acid | $CH_3(CH_2)_8CO_2H$ | 172.26 | col. nd. | $0.889^{87}$ | 31.5 | 268–70 | 0.003 | s. | s. |
| Caproic acid (*n*-) | hexanoic acid | $CH_3(CH_2)_4CO_2H$ | 116.16 | oily lq. | $0.922^{20/4}$ | –1.5 | $202^{761}$ | $1.1^{20}$ | s. | s. |
| (*i*-) | 2-Me-pentanoic-5 acid | $(CH_3)_2CH(CH_2)_2{\cdot}CO_2H$ | 116.16 | col. oil | $0.925^{20/4}$ | –35 | 207.7 | v. sl. s. | s. | s. |
| Caprylic acid (*n*-) | octanoic acid | $CH_3(CH_2)_6CO_2H$ | 144.21 | col. lf. | $0.910^{20/4}$ | 16 | 237.5 | $0.07^{15}$ | s. | s. |
| Carbazole | diphenylenelimine, dibenzopyrrole | $(C_6H_4)_2NH$ | 167.20 | lf. | | 244.8 | 354.8 | i. | $0.92^{14}$ | sl. s. |
| Carbitol | diethylene glycol mono-Et ether | $C_2H_5O(CH_2)_2O(CH_2)_2OH$ | 134.17 | col. lq. | $0.990^{20/20}$ | | 201.9 | ∞ | v. s. | s. |
| Carbon disulfide | | $CS_2$ | 76.13 | col. lq. | $1.263^{20/4}$ | –108.6 | 46.3 | $0.2^{0}$ | ∞ | ∞ |
| monoxide | | CO | 28.01 | col. gas | $0.81^{-195/4}$ | –207 | –192 | $3.5^{0}$ cc. | s. | |
| suboxide | | OC:C:CO | 68.03 | gas | $1.114^{0}$ | –107 | $7^{761}$ | d. | | s. |
| tetrabromide | tetrabromomethane | $CBr_4$ | 331.67 | col. mn. | 3.42 | 90.1(48) | 189.5 | $0.02^{30}$ | s. | s. |
| tetrachloride | tetrachloromethane | $CCl_4$ | 153.84 | col. lq. | $1.595^{20/4}$ | –22.6 | 76.8 | $0.08^{20}$ | ∞ | ∞ |
| tetrafluoride | tetrafluoromethane | $CF_4$ | 88.01 | gas | | | –128 | sl. s. | | |
| Carbonyl sulfide | | COS | 60.07 | col. gas | $1.24^{-87}$ | –138.2 | $–50.2^{760}$ | $80^{14}$ cc. | s. | s. |
| Carminic acid | | $C_{22}H_{20}O_{13}$ | 492.40 | red pd. | | d. 136 | | s. | s. | v. sl. s. |
| Carvacrol (1-,2-,4-) | | $CH_3C_6H_3(OH)CH(CH_3)_2$ | 150.21 | col. lq. | $0.977^{20/4}$ | 0.5 | 238 | v. sl. s. | ∞ | ∞ |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Carvacrylamine (2-,1-,4-) | $H_2NC_6H_3(CH_3)C_3H_7$ | 149.23 | oil | $0.994^{20}$ | –16 | 241 | v. sl. s. | s. | s. |
| Carvone (*d*-) | $C_{10}H_{14}O$ | 150.21 | col. lq. | $0.961^{20/4}$ | | $230^{766}$ | i. | ∞ | ∞ |
| Cellosolve | $C_2H_5O(CH_2)_2OH$ | 90.12 | col. lq. | $0.931^{20/4}$ | –70 | 135.1 | ∞ | ∞ | ∞ |
| acetate | $CH_3CO_2CH_2CH_2OC_2H_5$ | 132.16 | col. lq. | $0.975^{20/4}$ | | 156.3 | 22 | ∞ | ∞ |
| Cellulose | $(C_6H_{10}O_5)x$ | 162.14 | amor. | 1.3–1.4 | | i. | i. | i. | |
| Cetyl acetate | $CH_3CO_2(CH_2)_{15}CH_3$ | 284.47 | nd. | $0.858^{20}$ | 22–3 | $200^{15}$ | i. | v. sl. s. c. | |
| alcohol | $CH_3(CH_2)_{14}CH_2OH$ | 242.43 | lf. | $0.818^{50/4}$ | 49–50 | $189.5^{15}$ | i. | s. | s. |
| Chloral | $CCl_3{\cdot}CHO$ | 147.40 | col. lq. | $1.505^{25/4}$ | –57 | $97.6^{768}$ | v. s. | ∞ | ∞ |
| hydrate | $CCl_3{\cdot}CH(OH)_2$ | 165.42 | mn. pr. | $1.619^{50/4}$ | 51.7 | d. 98 | $474^{17}$ | v. s. | s. |
| Chloranil | $OC{:}(CCl{\cdot}CCl)_2{:}CO$ | 245.89 | yel./bz. | | 290 | subl. | i. | i. c. | i. c. |
| Chloretone | $Cl_3C{\cdot}C(OH)(CH_3)_2$ | 177.47 | col. cr. | | 97 | 167 | 0.8 c. | 111 | s. |
| Chloro-acetanilide (*p*-) | $CH_3CO_2NHC_6H_4Cl$ | 169.61 | rhb. | $1.385^{22}$ | 175–6 | | sl. s. | s. | v. s. |
| -acetic acid | $ClCH_2CO_2H$ | 94.50 | col. cr. | $1.58^{20/20}$ | 61.2 | 189.5 | v. s. | s. | s. |
| -acetone | $CH_3COCH_2Cl$ | 92.53 | col. lq. | $1.162^{16}$ | –44.5 | 121 | ∞ | ∞ | ∞ |
| -acetophenone (ω-) | $C_6H_5COCH_2Cl$ | 154.59 | rhb. | $1.324^{15}$ | 58–9 | 245–7 | 0.11 | v. s. | v. s. |
| -acetyl chloride | $ClCH_2COCl$ | 112.95 | col. lq. | $1.498^{20/20}$ | | 105 | d. | d. | |
| -aniline (*o*-) | $ClC_6H_4NH_2$ | 127.57 | lq. | $1.213^{20/4}$ | 0 | 210.5 | i. | | s. |
| (*m*-) | $ClC_6H_4NH_2$ | 127.57 | lq. | $1.216^{20/4}$ | –10.4 | $230^{767}$ | i. | | s. |
| (*p*-) | $ClC_6H_4NH_2$ | 127.57 | rhb. | $1.427^{19}$ | 70–1 | 230–1 | s. h. | s. | s. |
| -anthraquinone (1-) | $C_6H_4(CO)_2C_6H_3Cl$ | 242.65 | yel. nd. | | 162 | subl. | i. | sl. s. h. | |
| (2-) | $C_6H_4(CO)_2C_6H_3Cl$ | 242.65 | nd./al. | | 208–9 | | i. | | |
| -benzaldehyde (*o*-) | $ClC_6H_4CHO$ | 140.57 | nd. | $1.29^{s}$ | 11 | $208^{748}$ | v. sl. s. | v. s. | v. s. |
| (*m*-) | $ClC_6H_4CHO$ | 140.57 | pr. | $1.250^{15}$ | 17–8 | 213–4 | v. sl. s. | v. s. | v. s. |
| (*p*-) | $ClC_6H_4CHO$ | 140.57 | pr. | $1.196^{61}$ | 47.8 | $213^{748}$ | s. h. | v. s. | v. s. |
| -benzene | $C_6H_5Cl$ | 112.56 | col. lq. | $1.107^{20/4}$ | –45.2 | 132.1 | $0.049^{20}$ | ∞ | ∞ |
| -benzoic acid (*o*-) | $ClC_6H_4CO_2H$ | 156.57 | mn./aq. | $1.544^{25/4}$ | 141–2 | | $0.208^{25}$ | s. | s. |
| (*m*-) | $ClC_6H_4CO_2H$ | 156.57 | pr. | $1.496^{25/4}$ | 158 | | $0.041^{25}$ | s. | s. |
| (*p*-) | $ClC_6H_4CO_2H$ | 156.57 | tri. | $1.541^{24}$ | 242–3 | subl. | $0.008^{25}$ | s. | s. |
| -buta-1,3-diene (2-) | $CH_2{:}CCl{\cdot}CH{:}CH_2$ | 88.54 | col. lq. | $0.958^{20/20}$ | | 59.4 | v. sl. s. | ∞ | ∞ |
| (1-) | $CH_2{:}CH{\cdot}CH{:}CHCl$ | 88.54 | col. lq. | $0.965^{20/20}$ | | 69 | v. sl. s. | ∞ | ∞ |
| -buta-1,2-diene (4-) | $CH_2{:}C{:}CH{\cdot}CH_2Cl$ | 88.54 | col. lq. | $0.991^{20/20}$ | | 88 | d. | | |
| -dimethylhydantoin | $—C(CH_3)_2N(Cl)CON(Cl)CO—$ | 197.03 | | $1.5^{20/20}$ | 130 | | $0.21^{25}$ | | |
| -dinitrobenzene (α)(1-,2-)(4-) | $ClC_6H_3(NO_2)_2$ | 202.56 | cr./et. | | 39(36) | 315 d. | i. | v. s. h. | v. s. |
| (α)(1-,3-)(4-) | $ClC_6H_3(NO_2)_2$ | 202.56 | rhb./et. | $1.697^{22}$ | 53(43) | 315 d. | i. | s. h. | s. |
| -diphenyl (*o*-) | $C_6H_5{\cdot}C_6H_4Cl$ | 188.65 | cr. | | 34 | 267–8 | i. | | |
| (*m*-) | $C_6H_5{\cdot}C_6H_4Cl$ | 188.65 | cr. | | 89 | 284–5 | i. | | |
| (*p*-) | $C_6H_5{\cdot}C_6H_4Cl$ | 188.65 | lf. | | 77.5 | 282 | i. | | |
| -hydroquinone | $ClC_6H_3(OH)_2$ | 144.56 | mn. | | 106 | 263 sl. d. | v. s. | v. s. | v. s. |
| -naphthalene (α-) | $C_{10}H_7Cl$ | 162.61 | col. lq. | $1.194^{20/4}$ | –20 | 259.3 | i. | s. | ∞ |
| (β-) | $C_{10}H_7Cl$ | 162.61 | lf./al. | $1.266^{16}$ | 56–7 | $264^{751}$ | i. | v. s. | v. s. |
| -nitrobenzene (*o*-) | $ClC_6H_4NO_2$ | 157.56 | mn. nd. | $1.305^{80/4}$ | 32.5 | $245.5^{753}$ | i. | s. h. | s. |
| (*m*-) | $ClC_6H_4NO_2$ | 157.56 | yel./al. | $1.343^{50/4}$ | 44.4(24) | 235.6 | i. | v. s. h. | v. s. |
| (*p*-) | $ClC_6H_4NO_2$ | 157.56 | mn. pr. | $1.298^{91}$ | 83–4 | $242^{761}$ | i. | v. s. h. | v. s. |
| -nitrotoluene (2-,4-) | $CH_3C_6H_3(NO_2)(Cl)$ | 171.56 | cr. | $1.256^{80}$ | 38.2 | $240^{718}$ | i. | | |
| (2-,6-) | $CH_3C_6H_3(NO_2)(Cl)$ | 171.56 | cr. | | 37.5 | 238 | i. | | |
| -phenol (*o*-) | $ClC_6H_4OH$ | 128.56 | col. lq. | $1.241^{18/15}$ | 7(0) | 175–6 | $2.85^{20}$ | s. | s. |
| (*m*-) | $ClC_6H_4OH$ | 128.56 | nd. | $1.268^{25}$ | 32–3 | 214 | $2.60^{20}$ | s. | s. |
| (*p*-) | $ClC_6H_4OH$ | 128.56 | nd. | $1.306^{20/4}$ | 41–3 | 217 | $2.71^{20}$ | v. s. | v. s. |
| -propionic acid (α)(dl-) | $CH_3{\cdot}CHCl{\cdot}CO_2H$ | 108.53 | col. lq. | $1.306^{9}$ | <–20 | 186 | ∞ | ∞ | ∞ |
| -toluene (*o*-) | $CH_3{\cdot}C_6H_4Cl$ | 126.58 | col. lq. | $1.082^{20/4}$ | –34 | 159.5 | i. | s. | ∞ |
| (*m*-) | $CH_3{\cdot}C_6H_4Cl$ | 126.58 | col. lq. | $1.072^{20/4}$ | –47.8 | 161.6 | i. | s. | ∞ |
| (*p*-) | $CH_3{\cdot}C_6H_4Cl$ | 126.58 | col. lq. | $1.070^{20/4}$ | 7.5 | 162.2 | i. | s. | ∞ |
| Chloroform | $CHCl_3$ | 119.39 | col. lq. | $1.489^{20}$ | –63.5 | 61.2 | $0.82^{20}$ | ∞ | ∞ |
| Chlorophyll (α-) | $C_{55}H_{72}O_5N_4Mg$ | 893.48 | | | d. | i. | s. | | |
| Chloropicrin | $Cl_3CNO_2$ | 164.39 | lq. | $1.651^{23/4}$ | –64 | $112.3^{766}$ | $0.17^{18}$ | s. | s. |
| Cholesterol | $C_{27}H_{43}OH{\cdot}H_2O$ | 404.65 | rhb./al. | 1.067 | 149–51 | subl. | $0.26^{20}$ | $1.1^{17}$ | 18 |
| Chrysene | $C_{18}H_{12}$ | 228.28 | col. rhb. | | 253–4 | 448 | i. | $0.1^{16}$ | v. sl. s. |
| Chrysoidine (2-,4-) | $C_6H_5{\cdot}N{:}N{\cdot}C_6H_3(NH_2)_2$ | 212.25 | yel. cr. | | 117.5 | | sl. s. h. | s. | s. |
| Chrysophanic acid | $C_{14}H_5(OH)_2(CH_3)O_2$ | 254.23 | yel./al. | | 195 | subl. | i. c. | s. h. | sl. s. |
| Cinchomeronic acid (3-,4-) | $C_5H_3N(CO_2H)_2$ | 167.12 | cr./HCl | | 258–9 d. | subl. d. | v. sl. s. | sl. s. | i. |
| Cineole, eucalyptole | $C_{10}H_{18}O$ | 154.24 | col. oil | $0.927^{20}$ | 1.5 | 176–7 | $1.9^{15}$ | ∞ | ∞ |
| Cinnamic acid (*cis*-) | $C_6H_5CH{:}CHCO_2H$ | 148.15 | mn. pr. | $1.284^{4}$ | 68 | $125^{19}$ | | | |
| (*trans*-) | $C_6H_5CH{:}CHCO_2H$ | 148.15 | mn. pr. | 1.245 | 133 | 300 | $0.04^{18}$ | $24^{20}$ | v. s. |
| aldehyde | $C_6H_5CH{:}CHCHO$ | 132.15 | lq. | $1.110^{20/20}$ | –7.5 | 252 sl. d. | v. sl. s. | s. | ∞ |
| Cinnamyl alcohol | $C_6H_5CH{:}CHCH_2OH$ | 134.17 | nd. | $1.040^{35/35}$ | 33 | 257.5 | sl. s. | v. s. | v. s. |
| cinnamate | $C_8H_7CO_2C_9H_9$ | 264.31 | nd. or pr. | $1.085^{16.5}$ | 44 | | i. | 4 c. | 33 |
| Citraconic acid (*cis*-) | $CH_3C(CO_2H){:}CHCO_2H$ | 130.10 | nd. | 1.617 | 92–3 | | $360^{25}$ | s. | s. |
| Citral (α) | $C_9H_{15}CHO$ | 152.23 | col. oil | $0.890^{17/4}$ | | 229 | i. | ∞ | ∞ |
| Citric acid | $C_3H_4(OH)(CO_2H)_3$ | 192.12 | cr. | $1.542^{20/4}$ | 153 | d. | $207.7^{25}$ | $76^{15}$ | $2^{15}$ |
| Citronellal (*d*-) | $C_9H_{17}{\cdot}CHO$ | 154.24 | col. oil | $0.855^{17.5}$ | | 204–8 | v. sl. s. | ∞ | ∞ |
| Citronellol (*d*-) | $C_{10}H_{20}O$ | 156.26 | col. oil | $0.848^{20/4}$ | | 224–5 | v. sl. s. | ∞ | ∞ |
| Coniine (*d*-)(2-) | $C_3H_7{\cdot}C_5H_{10}N$ | 127.22 | col. lq. | $0.847^{17}$ | –2 | 166–7 | 1.1 | v. s. | v. s. |

**TABLE 2-2 Physical Properties of Organic Compounds** (*Continued*)

| Name | Formula | Formula weight | Form and color | Specific gravity | Melting point, °C | Boiling point, °C | Solubility in 100 parts | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Water | Alcohol | Ether |
| Coumaric acid (*o*-) | $HOC_6H_4CH{:}CHCO_2H$ | 164.15 | nd./aq. | | 207–8 | subl. | sl. s. c. | s. | v. sl. s. |
| (*p*-) | $HOC_6H_4CH{:}CHCO_2H$ | 164.15 | cr./aq. | | 206–7 d. | | s. h. | v. s. h. | v. s. |
| Coumarin | $C_9H_6O_2$ | 146.14 | rhb./et. | $0.935^{20/4}$ | 70 | 290–1 | 0.3 c. | v. s. | s. |
| Coumarone | $C_8H_6O$ | 118.13 | oil | $1.078^{15/15}$ | <–18 | 173–4 | i. | | s. |
| Creatine | $C_4H_9N_3O_2{\cdot}H_2O$ | 149.15 | mn./aq. | | 295 | | $1.4^{18}$ | $0.01^{17}$ | i. |
| Creatinine | $C_4H_7N_3O$ | 113.12 | mn. | | 260 d. | | $8.7^{16}$ | $1^{16}$ | |
| Creosol (3-,1-,4-) | $CH_3O{\cdot}C_6H_3(CH_3)OH$ | 138.16 | pr. | $1.092^{20/20}$ | 5.5 | 221–$2^{765}$ | v. sl. s. | ∞ | ∞ |
| Cresidine (1-,2-,4-) | $CH_3(NH_2)C_6H_3{\cdot}OCH_3$ | 137.18 | nd./pet. | | 93–4 | 235 | v. sl. s. | s. | s. |
| Cresol (*o*-) | $CH_3C_6H_4OH$ | 108.13 | cr. | $1.048^{20/4}$ | 30.8 | 190.8 | 2.5 | $\infty^{30}$ | $\infty^{30}$ |
| (*m*-) | $CH_3C_6H_4OH$ | 108.13 | lq. | $1.034^{20/4}$ | 10.9 | 202.8 | 0.5 | ∞ | ∞ |
| (*p*-) | $CH_3C_6H_4OH$ | 108.13 | pr. | $1.035^{20/4}$ | 35–6 | 202 | 1.8 | $\infty^{36}$ | $\infty^{36}$ |
| Cresyl benzoate (*o*-) | $C_6H_5CO_2C_6H_4CH_3$ | 212.24 | lq. | | | 308 | i. | | |
| (*m*-) | $C_6H_5CO_2C_6H_4CH_3$ | 212.24 | cr. | | 55 | 314 | i. | | |
| (*p*-) | $C_6H_5CO_2C_6H_4CH_3$ | 212.24 | cr. | | 71.5 | 316 | i. | | |
| Crotonic acid (α-) | $CH_3CH{:}CHCO_2H$ | 86.09 | col. mn. | $0.964^{79.7}$ | 72 | 189 | $8.3^{15}$ | | |
| acid (β-)(*cis*-) | $CH_3CH{:}CHCO_2H$ | 86.09 | nd. | $1.031^{15/4}$ | 15.5 | 170–1 d. | $\infty^{25}$ | s. | |
| aldehyde (α) | $CH_3CH{:}CHCHO$ | 70.09 | col. lq. | $0.853^{20/20}$ | –69 | 102.2 | 18 | ∞ | ∞ |
| Cumene | $C_6H_5CH(CH_3)_2$ | 120.19 | col. lq. | $0.862^{20/4}$ | –96.9 | 152.5 | i. | ∞ | ∞ |
| Cumic acid (*p*-) | $(CH_3)_2CH{\cdot}C_6H_4CO_2H$ | 164.20 | tri. | $1.162^{4}$ | 116–7 | subl. | $0.02^{25}$ | s. | s. |
| Cumidine (*p*-) | $(CH_3)_2CH{\cdot}C_6H_4NH_2$ | 135.20 | lq. | 0.953 | <–20 | $225^{761}$ | i. | | |
| Cyanamide | $H_2N{\cdot}CN$ | 42.04 | col. nd. | $1.073^{48/4}$ | 44–5 | $140^{19}$ | v. s. | v. s. | v. s. |
| Cyanic acid | HOCN or HNCO | 43.03 | gas | $1.140^{0}$ | –80 | $-64^{0}$ | sl. s. | | s. |
| Cyanoacetic acid | $CH_2(CN)CO_2H$ | 85.06 | col. lq. | | 65–6 | $108^{0.2}$ | s. | s. | s. |
| Cyanogen | $(CN)_2$ | 52.04 | col. gas | $0.866^{17}$ | –34.4 | –21 | $450^{20}$ cc. | $2300^{20}$ cc. | $500^{20}$ cc. |
| bromide | BrCN | 105.93 | nd. | $2.015^{20/4}$ | 52 | $61.3^{750}$ | s. | s. | s. |
| chloride | ClCN | 61.48 | gas | $1.222^{0}$ | –6.5 | 12.5–13 | $2500^{20}$ cc. | v. s. | $5000^{20}$ cc. |
| Cyanuric acid | $C_3H_3O_3N_3{\cdot}2H_2O$ | 165.11 | mn./aq. | $1.768^{0/4}$ | >360 | d. | $0.27^{17}$ | $0.1^{22}$ | |
| Cyclo-butane | $CH_2<(CH_2)_2>CH_2$ | 56.10 | col. gas | $0.703^{0/4}$ | –50 | 11–$12^{726}$ | i. | v. s. | |
| -heptane | $CH_3<(CH_2CH_2CH_2)_2>$ | 98.18 | oil | $0.810^{20/4}$ | –12 | 118–20 | i. | | |
| -hexane | $CH_2<(CH_2CH_2)_2>CH_2$ | 84.16 | col. lq. | $0.779^{20/4}$ | 6.5 | 80–1 | i. | ∞ | ∞ |
| -hexanol | $CH_2<(CH_2CH_2)_2>CHOH$ | 100.16 | col. nd. | $0.962^{20/4}$ | 23.9 | 160–1 | $3.6^{20}$ | s. | s. |
| -hexanone | $CH_2<(CH_2CH_2)_2>CO$ | 98.14 | col. oil | $0.947^{19/4}$ | –45 | 155–6 | s. | s. | s. |
| -hexene | $(\cdot CH_2{\cdot}CH_2CH{:})_2$ | 82.14 | lq. | $0.810^{20/4}$ | –103.7 | 83.3 | v. sl. s. | v. s. | v. s. |
| -hexyl acetate | $CH_3CO_2C_6H_{11}$ | 142.19 | oil | $0.985^{0/4}$ | | $174^{750}$ | i. | ∞ | ∞ |
| amine | $CH_2<(CH_2CH_2)_2>CHNH_2$ | 99.17 | col. lq. | $0.865^{20/0}$ | | 134 | i. | s. | |
| bromide | $CH_2<(CH_2CH_2)_2>CHBr$ | 163.06 | col. lq. | $1.324^{20/20}$ | | $165^{714}$ | i. | s. | s. |
| chloride | $CH_2<(CH_2CH_2)_2>CHCl$ | 118.61 | col. lq. | $0.977^{18/4}$ | –43.9 | 142 | i. | | ∞ |
| -pentadiene (1-,3-) | $CH_2<(CH{:}CH)_2>$ | 66.10 | col. lq. | $0.805^{19/4}$ | –85 | 41–2 | i. | ∞ | ∞ |
| -pentane | $CH_2<(CH_2CH_2)_2>$ | 70.13 | col. oil | $0.745^{20/4}$ | –93.3 | 49–50 | i. | | |
| -pentanone | $<(CH_2CH_2)_2>CO$ | 84.11 | col. oil | $0.948^{20}$ | –58.2 | 129–30 | v. sl. s. | | |
| -propane | $<CH_2CH_2CH_2>$ | 42.08 | col. gas | $0.720^{-79}$ | –126.6 | $-34^{749}$ | i. | s. | s. |
| Cymene (*o*-) | $CH_3{\cdot}C_6H_3CH(CH_3)_2$ | 134.21 | col. lq. | $0.875^{20/4}$ | | 177 | i. | s. | s. |
| (*m*-) | $CH_3{\cdot}C_6H_4CH(CH_3)_2$ | 134.21 | col. lq. | $0.862^{20}$ | <–25 | 175–6 | i. | s. | s. |
| (*p*-) | $CH_3{\cdot}C_6H_4CH(CH_3)_2$ | 134.21 | col. lq. | $0.857^{20/4}$ | –73.5 | 176–7 | i. | s. | s. |
| Cystine (*l*-) | $[\cdot SCH_2CH(NH_2)CO_2H]_2$ | 240.29 | pl. | | d. 258–61 | | $0.01^{19}$ | i. | |
| Dambose | $C_6H_6(OH)_6$ | 180.16 | mn./aq. | 1.752 | 253 | $319^{15}$ | $2^{12}$ | i. | i. |
| Decahydronaphthalene (*cis*-) | $C_{10}H_{18}$ | 138.24 | lq. | $0.895^{18/4}$ | –51 | 193.3 | i. | s. | s. |
| (*trans*-) | $C_{10}H_{18}$ | 138.24 | lq. | $0.872^{20/4}$ | –32 | 185.3 | i. | s. | s. |
| Decane (*n*-) | $CH_3(CH_2)_8CH_3$ | 142.28 | col. lq. | $0.730^{5}$ | –29.7 | 174.0 | i. | ∞ | ∞ |
| Decyl alcohol | $CH_3(CH_2)_8CH_2OH$ | 158.28 | col. oil | $0.830^{20/4}$ | 7 | 232.9 | i. | s. | |
| Dextrin | $(C_6H_{10}O_5)x$ | 162.14 | amor. | 1.038 | | | s. | i. | i. |
| Diacetone alcohol | $(CH_3)_2C(OH){\cdot}CH_2COCH_3$ | 116.16 | lq. | $0.931^{25}$ | –47 | 167.9 | ∞ | ∞ | ∞ |
| Diamino-benzophenone (4-,4′-) | $H_2NC_6H_4COC_6H_4NH_2$ | 212.24 | yel. nd. | | 237–9 | | sl. s. h. | s. | s. |
| -diphenylamine (4-,4′-) | $H_2NC_6H_4NHC_6H_4NH_2$ | 199.25 | lf./aq. | | 158 | d. | sl. s. | s. | s. |
| -diphenylmethane (4-,4′-) | $H_2NC_6H_4CH_2C_6H_4NH_2$ | 198.26 | nd./aq. | | 93–4 | 249–$53^{15}$ | sl. s. c. | s. | s. |
| -diphenylurea (4-,4′-) | $(H_2NC_6H_4NH)_2CO$ | 242.28 | cr. | | subl. 310 | | v. sl. s. | | |
| Diamyl-amine (*i*-) | $[(CH_3)_2CHCH_2CH_2]_2NH$ | 157.29 | col. lq. | $0.767^{21/4}$ | –44 | 188–90 | sl. s. | s. | ∞ |
| ether (*n*-) | $(C_2H_5CH_2CH_2CH_2)_2O$ | 158.28 | col. lq. | $0.774^{20/4}$ | –69 | 190 | i. | ∞ | ∞ |
| (*i*-) | $[(CH_3)_2CH(CH_2)_2]_2O$ | 158.28 | col. lq. | $0.777^{20/4}$ | | 173.4 | i. | ∞ | ∞ |
| Diamyl ketone (*i*-) | $[(CH_3)_2CHCH_2CH_2]_2CO$ | 170.29 | yel. oil | $0.821^{25/4}$ | 14.6 | 228 | i. | s. | s. |
| phthalate (*n*-) | $C_6H_4(CO_2C_5H_{11})_2$ | 306.39 | col. lq. | | | $204–6^{11}$ | | | |
| (*i*-) | $C_6H_4(CO_2C_5H_{11})_2$ | 306.39 | col. lq. | 1.03 | | $225^{40}$ | i. | s. | s. |
| tartrate (*i*-) | $(HOCH{\cdot}CO_2C_5H_{11})_2$ | 290.35 | lq. | $1.063^{15/4}$ | | $195^{16}$ | i. | | |
| Dianisidine (*o*-)(4-,3-)$_2$ | $[NH_2(OCH_3)C_6H_3{\cdot}]_2$ | 244.28 | col. lf. | | 131.5 | | i. | s. | s. |
| Diazo-aminobenzene | $C_6H_5N{:}N{\cdot}NHC_6H_5$ | 197.23 | yel. lf. | | 96–8 | expl. | i. | s. h. | v. s. |
| -aminotoluene (2-,2′-) | $C_7H_7N{:}N{\cdot}NHC_7H_7$ | 225.28 | or. cr. | | 51 | | 0.05 | | |
| -methane | $CH_2{:}N_2$ | 42.04 | gas | | –145 | –23 | d. | | s. |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Dibenzothiazyl-disulfide (2-,2′-) | $(C_6H_4NSC)_2S_2$ | 232.46 | cr. | 1.50 | 180 | d. | i. | | |
| Dibensoyl methane | $(C_6H_5CO)_2CH_2$ | 224.25 | rhb./al. | | 78 | $219–21^{18}$ | i. | $4.4^{20}$ | s. |
| Dibensyl-amine | $(C_6H_5CH_2)_2NH$ | 197.27 | col. oil | $1.028^{25/25}$ | –26 | $268–71^{250}$ | i. | s. | s. |
| -aniline | $C_6H_5N(CH_2C_6H_5)_2$ | 273.36 | pr./al. | | 70–1 | >300 | i. | v. s. h. | s. |
| ketone | $(C_6H_5CH_2)_2CO$ | 210.26 | cr. | | 34–5 | 330.6 | i. | | |
| phthalate (*o*-) | $C_6H_4(CO_2CH_2C_6H_5)_2$ | 346.36 | pr./al. | | 42–3 | $274^{12}$ | v. sl. s. | s. | s. |
| succinate | $(\cdot CH_2CO_2CH_2C_6H_5)_2$ | 298.32 | lf./al. | | 45–6 | $238^{14}$ | i. | s. | s. |
| Dibromo-benzene (*o*-) | $C_6H_4Br_2$ | 235.92 | col. lq. | $1.956^{20/4}$ | 1.8 | 221–2 | i. | s. | s. |
| (*m*-) | $C_6H_4Br_2$ | 235.92 | col. lq. | $1.952^{20/4}$ | –6.9 | $219^{755}$ | i. | s. | s. |
| (*p*-) | $C_6H_4Br_2$ | 235.92 | pl./al. | $2.261^{18}$ | 87–8 | $218.6^{758}$ | i. | 1.6 | $71^{25}$ |
| -diphenyl (4-,4′-) | $BrC_6H_4\cdot C_6H_4Br$ | 312.02 | mn. pr. | 1.897 | 164–5 | 355–60 | i. | v. sl. s. h. | |
| Dibutyl-adipate (*n*-) | $(\cdot CH_2CH_2CO_2C_4H_9)_2$ | 258.35 | col. lq. | $0.965^{20/4}$ | –38 | $183^{14}$ | i. | ∞ | ∞ |
| (*i*-) | $(\cdot CH_2CH_2CO_2C_4H_9)_2$ | 258.35 | col. lq. | $0.950^{25}$ | –20 | 278–80 | i. | | |
| -amine (*n*-) | $(C_2H_5CH_2CH_2)_2NH$ | 129.24 | col. lq. | $0.768^{20/20}$ | | $159^{761}$ | ∞ | ∞ | ∞ |
| (*i*-) | $[(CH_3)_2CHCH_2]_2NH$ | 129.24 | col. lq. | $0.741^{25/4}$ | –70 | 139–40 | v. sl. s. | s. | s. |
| -*p*-aminophenol (*s*-) | $(C_4H_9)_2N\cdot C_6H_4OH$ | 221.33 | lq. | | | $170^{10}$ | i. | | |
| -aniline (*n*-) | $C_6H_5N(C_4H_9)_2$ | 205.33 | lq. | | | 262.8 | i. | ∞ | ∞ |
| carbonate (*n*-) | $CO(OC_4H_9)_2$ | 174.23 | col. lq. | $0.924^{20/4}$ | | $207^{740}$ | i. | s. | |
| (*i*-) | $CO(OC_4H_9)_2$ | 174.23 | col. lq. | $0.919^{15}$ | | 190 | i. | | |
| (*s*-) | $CO(OC_4H_9)_2$ | 174.23 | col. lq. | | | 178–80 | | | |
| ether (*n*-) | $(C_2H_5CH_2CH_2)_2O$ | 130.22 | lq. | $0.769^{20/20}$ | –98 | 142.4 | <0.05 | ∞ | ∞ |
| (*i*-) | $[(CH_3)_2CHCH_2]_2O$ | 130.22 | lq. | $0.762^{15}$ | | 122.5 | i. | ∞ | ∞ |
| (*s*-) | $[C_2H_5(CH_3)CH]_2O$ | 130.22 | lq. | $0.756^{21}$ | | 121 | i. | ∞ | ∞ |
| ketone (*n*-) | $(C_2H_5CH_2CH_2)_2CO$ | 142.23 | lq. | $0.827^{18/4}$ | –5.9 | 187.7 | i. | s. | v. s. |
| (*i*-) | $[(CH_3)_2CHCH_2]_2CO$ | 142.23 | oil | $0.805^{21/4}$ | | 168.1 | <0.06 | ∞ | ∞ |
| malate (*l*-)(*n*-) | $C_2H_4O(CO_2C_4H_9)_2$ | 246.30 | lq. | $1.038^{20/4}$ | | $170–1^{18}$ | v. sl. s. | | |
| oxalate (*n*-) | $(\cdot CO_2C_4H_9)_2$ | 202.24 | col. lq. | $0.986^{20/4}$ | –29.6 | 245.5 | i. | s. | s. |
| phthalate (*n*-) | $C_6H_4(CO_2C_4H_9)_2$ | 278.34 | col. lq. | $1.045^{21}$ | | 340 | $0.04^{25}$ | ∞ | ∞ |
| tartrate (*d*-)(*n*-) | $(CHOHCO_2C_4H_9)_2$ | 262.30 | pr. | $1.098^{15}$ | 22–2.5 | $200–3^{18}$ | i. | | |
| (*d*-)(*i*-) | $(CHOHCO_2C_4H_9)_2$ | 262.30 | cr. | $1.031^{75/4}$ | 73–4 | 323–5 | v. sl. s. | | |
| Dichloro-acetic acid | $Cl_2CH\cdot CO_2H$ | 128.95 | lq. | $1.560^{25/25}$ | 9.7(–4) | 194.4 | ∞ | ∞ | ∞ |
| -acetone (αα-) | $Cl_2CHCOCH_3$ | 126.98 | lq. | $1.234^{15}$ | | 120 | v. sl. s. | s. | s. |
| -aniline (2-,5-) | $Cl_2C_6H_3NH_2$ | 162.02 | nd. | | 50 | 251 | v. sl. s. | s. | s. |
| -anthraquinone (1-,3-) | $C_6H_4{:}(CO)_2{:}C_6H_2Cl_2$ | 277.10 | yel. nd. | | 208–9 | | i. | i. | |
| (1-,4-) | $C_6H_4{:}(CO)_2{:}C_6H_2Cl_2$ | 277.10 | yel. nd. | | 187.5 | | i. | v. sl. s. | v. sl. s. |
| (1-,5-) | $C_6H_3Cl{:}(CO)_2{:}C_6H_3Cl$ | 277.10 | yel. nd. | | 251 | | i. | sl. s. | |
| (1-,6-) | $C_6H_3Cl{:}(CO)_2{:}C_6H_3Cl$ | 277.10 | yel. nd. | | 203–4 | | i. | | |
| (1-,8-) | $C_6H_3Cl{:}(CO)_2{:}C_6H_3Cl$ | 277.10 | yel. nd. | | 202–3 | | i. | sl. s. | |
| (2-,3-) | $C_6H_4{:}(CO)_2{:}C_6H_2Cl_2$ | 277.10 | yel. nd. | | 268–70 | | i. | sl. s. | |
| (2-,6-) | $C_6H_3Cl{:}(CO)_2{:}C_6H_3Cl$ | 277.10 | yel. nd. | | 282 | | i. | | |
| (2-,7-) | $C_6H_3Cl{:}(CO)_2{:}C_6H_3Cl$ | 277.10 | yel. nd. | | 210–11 | | i. | | |
| -benzene (*o*-) | $C_6H_4Cl_2$ | 147.01 | col. lq. | $1.305^{20/4}$ | –17.6 | 179 | i. | ∞ | ∞ |
| (*m*-) | $C_6H_4Cl_2$ | 147.01 | col. lq. | $1.288^{20/4}$ | –24.8 | $172^{766}$ | i. | s. | s. |
| (*p*-) | $C_6H_4Cl_2$ | 147.01 | col. mn. | $1.458^{21}$ | 53 | $174^{764}$ | i. | v. s. | v. s. |
| -butane (*n*-)(1-,4-) | $ClCH_2(CH_2)_2CH_2Cl$ | 127.02 | lq. | | –38.7 | 161–3 | | | |
| -diphenyl (4-,4′-) | $ClC_6H_4\cdot C_6H_4Cl$ | 223.10 | pr. | $1.442^{0/4}$ | 148 | 315–9 | i. | v. sl. s. | $4^{25}$ |
| -ethane (1-,2-) | $ClCH_2\cdot CH_2Cl$ | 98.97 | col. lq. | $1.256^{20/20}$ | –35.3 | 83.7 | $0.9^{0}$ | ∞ | ∞ |
| -naphthalene (β-)(1-,4-) | $C_{10}H_6Cl_2$ | 197.06 | nd./al. | $1.300^{76/4}$ | 67–8 | $286–7^{740}$ | i. | v. sl. s. | |
| (γ-)(1-,5-) | $C_{10}H_6Cl_2$ | 197.06 | lf./al. | | 107 | subl. | i. | s. | s. |
| -nitrobenzene (2-,5-) | $Cl_2C_6H_3NO_2$ | 192.01 | tri./al. | $1.669^{22}$ | 54.6 | 266 | i. | v. s. h. | |
| -pentane (1-,5-) | $ClCH_2(CH_2)_3CH_2Cl$ | 141.04 | col. lq. | $1.094^{25/4}$ | | 180–1 | i. | s. | s. |
| -phenol (2-,4-) | $Cl_2C_6H_3OH$ | 163.01 | nd. | $1.383^{60/25}$ | 45 | 209–10 | $0.45^{20}$ | v. s. | v. s. |
| Dichloramine T (*p*-) | $CH_3C_6H_4SO_2NCl_2$ | 240.11 | cr. | | 83 | | sl. s. | | |
| Dicyandiamide | $H_2N\cdot C(:NH)\cdot NH\cdot CN$ | 84.08 | mn. pl. | $1.40^{14}$ | 207–8 | d. | $2.3^{18}$ | $1.3^{18}$ | $0.01^{18}$ |
| Diethanolamine | $HN(CH_2CH_2OH)_2$ | 105.14 | pr. | $1.097^{20/4}$ | 28 | $270^{748}$ | ∞ | ∞ | v. sl. s. |
| Diethyl adipate | $(\cdot CH_2CH_2CO_2C_2H_5)_2$ | 202.24 | col. lq. | $1.009^{20/4}$ | –21 | $239–41^{761}$ | $0.43^{80}$ | s. | s. |
| -amine | $(C_2H_5)_2NH$ | 73.14 | col. lq. | $0.712^{15/15}$ | –38.9 | $55.5^{759}$ | v. s. | ∞ | ∞ |
| -aminophenol (*m*-) | $(C_2H_5)_2N\cdot C_6H_4\cdot OH$ | 165.23 | rhb. | | 78 | 276–80 | s. | | |
| -aniline | $(C_2H_5)_2NC_6H_5$ | 149.23 | oil | $0.934^{20/4}$ | –34.4 | 216 | $1.4^{12}$ | s. | s. |
| sulfonic acid (*m*-) | $(C_2H_5)_2NC_6H_4SO_3H$ | 229.29 | cr. | | 270 d. | | s. | | |
| carbonate | $OC(OC_2H_5)_2$ | 118.13 | col. lq. | $0.975^{20/4}$ | –43 | $126^{759}$ | i. | ∞ | ∞ |
| diethyl malonate | $(C_2H_5)_2C(CO_2C_2H_5)_2$ | 216.27 | col. lq. | $0.985^{20/4}$ | | 230 | i. | ∞ | ∞ |
| Diethyl dimethyl malonate | $(CH_3)_2C(CO_2C_2H_5)_2$ | 188.22 | col. lq. | $0.994^{25/25}$ | | 196.7 | i. | ∞ | ∞ |
| glutarate | $CH_2(CH_2CO_2C_2H_5)_2$ | 188.22 | syrup | $1.025^{21}$ | –24 | 237 | $0.88^{20}$ | v. s. | s. |
| ketone | $(C_2H_5)_2CO$ | 86.13 | col. lq. | $0.816^{19/4}$ | –42 | 101.7 | $4.7^{20}$ | ∞ | ∞ |
| malonate | $CH_2(CO_2C_2H_5)_2$ | 160.17 | col. lq. | $1.055^{20/4}$ | –49.8 | 198.9 | $2.08^{20}$ | ∞ | ∞ |
| -malonic acid | $(C_2H_5)_2C(CO_2H)_2$ | 160.17 | pr./aq. | | 125 | d. 170–80 | $65^{16}$ | v. s. | v. s. |
| -naphthylamine (α-) | $C_{10}H_7N(C_2H_5)_2$ | 199.28 | col. oil | 1.005 | | 285–90 | i. | ∞ | ∞ |
| (β-) | $C_{10}H_7N(C_2H_5)_2$ | 199.28 | col. oil | 1.026 | | 318 | i. | ∞ | ∞ |
| oxalate | $(\cdot CO_2C_2H_5)_2$ | 146.14 | col. lq. | $1.079^{20/4}$ | –40.6 | 186 | v. sl. s. | ∞ | ∞ |
| phthalate (*o*-) | $C_6H_4(CO_2C_2H_5)_2$ | 222.23 | col. lq. | $1.121^{25/25}$ | | 298–9 | i. | ∞ | ∞ |
| sulfate | $O_2S(OC_2H_5)_2$ | 154.18 | col. lq. | $1.172^{25/4}$ | –25 | 210 | i. | s. | ∞ |
| sulfide | $(C_2H_5)_2S$ | 90.18 | col. lq. | $0.837^{20/4}$ | –99.5 | $92–3^{754}$ | $0.31^{20}$ | ∞ | ∞ |

**TABLE 2-2 Physical Properties of Organic Compounds** (*Continued*)

| Name | Formula | Formula weight | Form and color | Specific gravity | Melting point, °C | Boiling point, °C | Solubility in 100 parts | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Water | Alcohol | Ether |
| tartrate (*d*-) | $(CHOH{\cdot}CO_2C_2H_5)_2$ | 206.19 | lq. | $1.204^{20/4}$ | 17 | 280 | sl. s. | ∞ | ∞ |
| -toluidine (*o*-) | $CH_3{\cdot}C_6H_4{\cdot}N(C_2H_5)_2$ | 163.25 | lq. | | | 208–9[755] | i. | s. | s. |
| (*m*-) | $CH_3{\cdot}C_6H_4{\cdot}N(C_2H_5)_2$ | 163.25 | lq. | | | 231–2 | i. | s. | s. |
| (*p*-) | $CH_3{\cdot}C_6H_4{\cdot}N(C_2H_5)_2$ | 163.25 | lq. | $0.924^{15.5}$ | | 228–9 | i. | | |
| Diethyleneglycol dinitrate | $O(CH_2CH_2ONO_2)_2$ | 196.12 | lq. | $1.377^{25/4}$ | −11.3 | | i. | | |
| Difluorodichloromethane | $F_2CCl_2$ | 120.92 | gas | $1.486^{-30}$ | −155 | −29.2 | 5.7 cc.[26] | s. | s. |
| Diglycerol | $[(HO)_2C_3H_5]_2O$ | 166.17 | lq. | | | 220–30[10] | s. h. | | i. |
| Dihydroxy-dinaphthyl (α-) | $(HO{\cdot}C_{10}H_6{\cdot})_2$ | 286.31 | pl./al. | | 300 | | i. | s. | v. s. |
| (-2,-2′,-1,-1′) | $(HO{\cdot}C_{10}H_6{\cdot})_2$ | 286.31 | nd./al. | | 218 | subl. | i. | s. | v. s. |
| -diphenyl (4-,4′-) | $(HO{\cdot}C_6H_4{\cdot})_2$ | 186.20 | rhb./al. | 1.25 | 270–2 | subl. | sl. s. | v. s. | v. s. |
| -ethyl formal (β-) | $CH_2(OCH_2CH_2OH)_2$ | 136.15 | lq. | $1.154^{25}$ | −5.3 | 264 | ∞ | | |
| -naphthalene (1-,5-) | $C_{10}H_6(OH)_2$ | 160.16 | pr./aq. | | 258–60 | d. | sl. s. | s. | v. s. |
| (1-,8-) | $C_{10}H_6(OH)_2$ | 160.16 | nd. | | 140 | | sl. s. h. | | v. s. |
| Dimethoxy-benzene (*p*-) | $(CH_3O)_2C_6H_4$ | 138.16 | lf. | $1.053^{55/55}$ | 56 | 212.6 | v. sl. s. | v. s. | v. s. |
| -diphenylamine (4-,4′-) | $HN(C_6H_4OCH_3)_2$ | 229.26 | cr. | | 103 | | i. | | |
| -ethyl adipate | $(CH_2)_4(CO_2C_2H_4OCH_3)_2$ | 262.30 | lq. | $1.075^{15.6}$ | | 145–50[2] | 5 | | |
| Dimethyl adipate | $[(CH_2)_2CO_2CH_3]_2$ | 174.19 | col. lq. | $1.063^{20/4}$ | 10–1 | 115[18] | i. | | |
| -amine | $(CH_3)_2NH$ | 45.08 | col. lq. | $0.680^{0/4}$ | −96 | 7.4 | v. s. | s. | s. |
| -aminoasobenzene (*p*-) | $C_6H_5N{:}N{\cdot}C_6H_4N(CH_3)_2$ | 225.28 | yel./al. | | 116–7 | d. | i. | s. | s. |
| -aminoethanol | $(CH_3)_2NCH_2CH_2OH$ | 89.14 | col. lq. | $0.887^{20/4}$ | | 135[756] | ∞ | | |
| -aminophenol (*m*-) | $(CH_3)_2NC_6H_4OH$ | 137.18 | nd. | | 85 | 265–8 | sl. s. h. | s. | s. |
| -aniline | $(CH_3)_2NC_6H_5$ | 121.18 | yel. lq. | $0.956^{20/4}$ | 2.5 | 193 | i. | s. | s. |
| sulfonic acid (*m*-) | $(CH_3)_2NC_6H_4SO_3H$ | 201.24 | cr. | | d. 266 | | s. | | |
| (*p*-) | $(CH_3)_2NC_6H_4SO_3H{\cdot}H_2O$ | 219.25 | pr. | | 257 | | s. h. | v. sl. s. | v. sl. s. |
| carbonate | $OC(OCH_3)_2$ | 90.08 | col. lq. | $1.070^{20/4}$ | 0.5 | 89–90 | i. | ∞ | ∞ |
| ether | $CH_3OCH_3$ | 46.07 | gas | | −138.5 | −23.7 | 3700 cc.[18] | s. | s. |
| -formamide | $HCON(CH_3)_2$ | 73.09 | lq. | $0.945^{25}$ | −58.3 | 152.8 | ∞ | | |
| fumarate | $(:CHCO_2CH_3)_2$ | 144.12 | col. tri. | | 102 | 192 | i. | sl. s. | sl. s. |
| glutarate | $(CH_2)_3(CO_2CH_3)_2$ | 160.17 | lq. | $1.089^{15.6}$ | −37 | 130[50] | | | |
| glyoxime | $(CH_3{\cdot}C{:}NOH)_2$ | 116.12 | col. cr. | | 240–6 | | $0.06^{20}$ | v. s. | v. s. |
| -naphthalene (1-,4-) | $C_{10}H_6(CH_3)_2$ | 156.22 | lq. | $1.016^{20/4}$ | <−18 | 264–6 | i. | | |
| (2-,3-) | $C_{10}H_6(CH_3)_2$ | 156.22 | lf./al. | | 104 | 265[767] | i. | sl. s. | |
| -naphthylamine (α-) | $C_{10}H_7N(CH_3)_2$ | 171.23 | col. oil | $1.042^{20}$ | | 274.5[711] | i. | s. | s. |
| (β-) | $C_{10}H_7N(CH_3)_2$ | 171.23 | col. cr. | $1.039^{70/70}$ | 46 | 304–5 | i. | s. | s. |
| oxalate | $(\cdot CO_2CH_3)_2$ | 118.09 | col. mn. | $1.148^{54}$ | 54 | 163.3 | 6 | s. | s. |
| phthalate (*o*-) | $C_6H_4(CO_2CH_3)_2$ | 194.18 | col. lq. | $1.189^{25/25}$ | | 280[734] | 0.43 | | |
| sulfate | $(CH_3O)_2SO_2$ | 126.13 | col. oil | $1.352^{20/4}$ | −26.8 | 188.3 | v. sl. s. | ∞ | ∞ |
| sulfide | $(CH_3)_2S$ | 62.13 | oil | $0.846^{21/4}$ | −83.2 | 37.3 | i. | s. | s. |
| tartrate (*d*-) | $(CHOH{\cdot}CO_2CH_3)_2$ | 178.14 | cr. | $1.328^{20/4}$ | 61.5 | 280 | s. | 200[15] | |
| -vinyl-ethenyl carbinol | $(CH_3)_2COH{\cdot}C{:}C{\cdot}CH{:}CH_2$ | 110.15 | lq. | $0.887^{20/4}$ | | 150 | $6^{20}$ | | |
| Dinaphthyl (αα-) | $C_{10}H_7{\cdot}C_{10}H_7$ | 254.31 | lf./al. | | 160 | 240–4[12] | i. | s. h. | s. |
| -methane (αα′-) | $(C_{10}H_7)_2CH_2$ | 268.34 | pr./al. | | 109 | >360 | i. | 0.8 c. | v. s. |
| (β,β′-) | $(C_{10}H_7)_2CH_2$ | 268.34 | nd./al. | | 92 | | i. | s. | |
| Dinitro-anisole (1-)(2-,4-) | $CH_3OC_6H_3(NO_2)_2$ | 198.13 | col. mn. | $1.341^{20}$ | 94–5 | | sl. s. h. | $1.5^{20}$ | |
| -benzene (*o*-) | $C_6H_4(NO_2)_2$ | 168.11 | col. mn. | $1.59^{18}$ | 117–8 | 319[774] | 0.01 c. | $1.9^{21}$ | |
| (*m*-) | $C_6H_4(NO_2)_2$ | 168.11 | col. rhb. | $1.575^{20/4}$ | 89.8 | 300–2 | $0.3^{99}$ | $3^{20}$ | |
| (*p*-) | $C_6H_4(NO_2)_2$ | 168.11 | col. mn. | $1.625^{18}$ | 173–4 | 299[777] | $0.18^{100}$ | $0.18^{21}$ | |
| sulfonic acid (2-,4-)(1-) | $(NO_2)_2C_6H_3SO_3H{\cdot}3H_2O$ | 302.22 | pr. | | 106–8 | | s. | s. | v. sl. s. |
| -benzoic acid (2-,4-) | $(NO_2)_2C_6H_3CO_2H$ | 212.12 | cr./aq. | | 179–80 | | $1.85^{25}$ | s. | |
| (3-,5-) | $(NO_2)_2C_6H_3CO_2H$ | 212.12 | mn. pr. | | 204–5 | subl. | s h. | v. s. | sl. s. |
| -benzophenone (4-,4′-) | $(NO_2C_6H_4)_2CO$ | 272.21 | col. nd. | | 189 | | i. | | |
| -diphenyl (4-,4′-) | $(NO_2C_6H_4)_2$ | 244.20 | nd./al. | 1.445 | 233 | | i. | $1.5^{20}$ | |
| (2-,4′-) | $(NO_2C_6H_4)_2$ | 244.20 | mn. | 1.474 | 93.5 | | i. | v. s. h. | |
| -naphthalene (1-,5-) | $C_{10}H_6(NO_2)_2$ | 218.16 | nd. | | 216 | subl. | i. | | |
| (1-,8-) | $C_{10}H_6(NO_2)_2$ | 218.16 | rhb. | | 170–2 | d. | i. | 0.2 c. | |
| Dinitro-phenol (2-,3-) | $(NO_2)_2C_6H_3OH$ | 184.11 | yel. mn. | $1.681^{20}$ | 144–5 | | sl. s. | v. s. h. | v. s. |
| (2-,4-) | $(NO_2)C_6H_3OH$ | 184.11 | yel. rhb. | $1.683^{24}$ | 114–5 | subl. | 0.5 c. | $4^{20}$ | v. s. h. |
| (2-,6-) | $(NO_2)C_6H_3OH$ | 184.11 | yel. rhb. | | 63–4 | | s. h. | s. h. | s. |
| -salicylic acid (3-,5-) | $(NO_2)_2C_6H_2(OH)CO_2H{\cdot}H_2O$ | 246.13 | pl./aq. | | 173 d. | | s. c. | v. s. | v. s. |
| -stilbene (4-,4′-) | $(NO_2C_6H_4CH{:})_2$ | 270.24 | yel. lf. | | 210–6 | | i. | v. sl. s. | v. sl. s. |
| -toluene (2-,4-) | $(NO_2)_2C_6H_3CH_3$ | 182.13 | nd. | $1.321^{71}$ | 70 | 300 | $0.03^{22}$ | $1.2^{15}$ | $9^{16}$ |
| (3-,4-) | $(NO_2)_2C_6H_3CH_3$ | 182.13 | nd. | $1.259^{111}$ | 60–1 | | i. | | |
| (3-,5-) | $(NO_2)_2C_6H_3CH_3$ | 182.13 | mn. pr. | $1.277^{111}$ | 92–3 | subl. | sl. s. | s. h. | s. |
| Dioxane | $O<(CH_2{\cdot}CH_2)_2>O$ | 88.10 | col. lq. | $1.033^{20/4}$ | 9.5–10.5 | 101.1 | ∞ | s. | s. |
| Dipentene | $C_{13}H_{10}$ | 136.23 | col. lq. | $0.865^{18}$ | | 178 | i. | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Diphenyl | $C_6H_5{\cdot}C_6H_5$ | 154.20 | col. mn. | $0.992^{73/4}$ | 69–70 | 254.9 | i. | $10^{20}$ | $6.6^{20}$ |
| -amine | $C_6H_5NHC_6H_5$ | 169.22 | col. mn. | $1.160^{20/20}$ | 52.9 | 302 | $0.03^{25}$ | $56^{19.5}$ | s. |
| carbonate | $O(COC_6H_5)_2$ | 214.21 | nd./al. | $1.272^{14}$ | 80 | 302–6 | i. | v. s. | s. |
| -chloroarsine | $(C_6H_5)_2AsCl$ | 264.57 | rhb. | $1.583^{40}$ | 43–4 | d. 327 | 0.2 d. | 20 | s. |
| -ethane | $(C_6H_5CH_2{\cdot})_2$ | 182.25 | col. pr. | $0.978^{50/50}$ | 52–3 | 284 | i. | s. | v. s. |
| ether | $C_6H_5OC_6H_5$ | 170.20 | col. rhb. | $1.073^{20}$ | 27 | 259 | v. sl. s. | s. | ∞ |
| guanidine | $(C_6H_5NH)_2C{:}NH$ | 211.26 | mn./al. | | 147–8 | d. > 170 | v. sl. s. | $9^{20}$ | sl. s. |
| -methane | $(C_6H_5)_2CH_2$ | 168.23 | col. pr. | $1.001^{26/4}$ | 26–7 | 265 | i. | v. s. | v. s. |
| phenylenediamine (*p*-) | $(C_6H_5NH)_2C_6H_4$ | 260.32 | cr. | | 152 | | i. | | |
| succinate | $(\cdot CH_2CO_2C_6H_5)_2$ | 270.27 | lf./al. | | 122–3 | 330 | i. | | s. |
| sulfide | $(C_6H_5)_2S$ | 186.26 | col. lq. | $1.119^{15/15}$ | <–40 | 296–7 | i. | s. h. | ∞ |
| sulfone | $(C_6H_5)_2SO_2$ | 218.26 | nd./aq. | $1.248^{25/4}$ | 128–9 | 379 | sl. s. h. | s. h. | |
| urea (uns.) | $(C_6H_5)_2NCONH_2$ | 212.24 | rhb. | 1.276 | 189 | | v. sl. s. | s. | s. |
| Diphenylene oxide | $<(C_6H_4)_2O$ | 168.18 | lf./al. | | 86–7 | 287–8 | i. | s. h. | v. s. |
| Dipropyl adipate (*n*-) | $(\cdot CH_2CH_2CO_2C_3H_7)_2$ | 230.30 | col. lq. | $0.979^{20/4}$ | –20.3 | $143–5^{10}$ | i. | s. | s. |
| -amine (*n*-) | $(C_3H_5CH_2)_2NH$ | 101.19 | col. lq. | $0.739^{20/4}$ | –39.6 | 110–1 | s. | ∞ | ∞ |
| (*i*-) | $[(CH_3)_2CH]_2NH$ | 101.19 | col. lq. | $0.722^{22}$ | –61 | $83.5^{743}$ | s. | s. | |
| aniline (*n*-) | $C_6H_5N(C_3H_7)_2$ | 177.28 | yel. oil | $0.910^{20}$ | | 245.4 | i. | s. | s. |
| carbonate (*n*-) | $O(COCH_2C_2H_5)_2$ | 146.18 | col. lq. | $0.968^{22}$ | | 168.2 | v. sl. s. | | |
| ether (*n*-) | $(C_2H_5CH_2)_2O$ | 102.17 | col. lq. | $0.744^{21/0}$ | –122 | 91 | sl. s. | ∞ | ∞ |
| (*i*-) | $[(CH_3)_2CH]_2O$ | 102.17 | col. lq. | $0.725^{21/0}$ | –60 | 69 | 0.2 | ∞ | ∞ |
| ketone (*n*-) | $(C_2H_5CH_2)_2CO$ | 114.18 | col. lq. | $0.822^{20/4}$ | –32.6 | 144.2 | 0.43 | ∞ | ∞ |
| (*i*-) | $[(CH_3)_2CH]_2CO$ | 114.18 | col. lq. | $0.806^{20/4}$ | | 123.7 | v. sl. s. | ∞ | ∞ |
| oxalate (*n*-) | $(CO_2CH_2C_2H_5)_2$ | 174.19 | col. lq. | $1.038^{0/0}$ | –51.7 | 213.5 | d. h. | | |
| (*i*-) | $[CO_2CH(CH_3)_2]_2$ | 174.19 | col. lq. | | | 190 | | | |
| Disalicylal ethylenediamine | $[HOC_6H_4CH{:}NCH_2{\cdot}]_2$ | 268.30 | cr. | 1.34 | 125–6 | | $0.03^{28}$ | | |
| Ditolyl guanidine (*o*-) | $(C_7H_7NH)_2C{:}NH$ | 239.31 | cr. | $1.10^{20/4}$ | 178–9 | | v. sl. s. | s. h. | s. |
| Divinyl acetylene | $(H_2C{:}CH{\cdot}C{:})_2$ | 78.11 | lq. | $0.776^{20/4}$ | | 85 | i. | | |
| Docosane (*n*-) | $CH_3(CH_2)_{20}CH_3$ | 310.59 | cr. | $0.778^{44/4}$ | 44.5 | $224.5^{15}$ | i. | 4 h. | v. s. |
| Dodecane (*n*-) | $CH_3(CH_2)_{10}CH_3$ | 170.33 | lq. | $0.751^{20/4}$ | –9.6 | 214.5 | i. | v. s. | v. s. |
| Dulcitol | $CH_2OH(CHOH)_4CH_2OH$ | 182.17 | mn. | $1.466^{15}$ | 189 | $290–5^{3}$ | $3.2^{15}$ | v. sl. s. | i. |
| Durene (1-,2-,4-,5-) | $(CH_3)_4C_6H_2$ | 134.21 | mn. | $0.838^{81/4}$ | 79–80 | 193–5 | i. | s. | s. |
| Elaidic acid | $C_8H_{17}CH{:}CH(CH_2)_7CO_2H$ | 282.45 | lf./al. | $0.851^{79/4}$ | 51–2 | $288^{100}$ | i. | v. s. | v. s. |
| Eosine | $C_{20}H_8O_5Br_4$ | 647.93 | col. cr. | | | | i. | s. | |
| Ephedrine (*l*-) | $C_6H_5CHOHCH(CH_3)NHCH_3$ | 165.23 | cr./et. | | 40 | 255 | 5 | 500 | s. |
| Epichlorhydrin (α-) | $C_3H_5O{\cdot}CH_2Cl$ | 92.53 | lq. | $1.183^{25/25}$ | –25.6 | $117^{756}$ | <5 | ∞ | ∞ |
| Epidichlorohydrin (α-) | $CH_2{:}CCl{\cdot}CH_2Cl$ | 110.98 | col. lq. | $1.204^{25}$ | | 94 | i. | ∞ | ∞ |
| Erythritol (*dl*-) | $CH_2OH(CHOH)_2CH_2OH$ | 122.12 | tet. pr. | $1.451^{20/4}$ | 126 | 329–31 | 60 | sl. s. c. | i. |
| tetranitrate | $C_4H_6(ONO_2)_4$ | 302.12 | lf./al. | | 61 | expl. | i. c. | s. | s. |
| Ethane | $CH_3CH_3$ | 30.07 | col. gas | $0.546^{-88}$ | –172 | –88.6 | 4.7 cc.[20] | 150 cc. | |
| Ethanol-amine | $HOCH_2CH_2NH_2$ | 61.08 | col. oil | $1.022^{20}$ | 10.5 | $171^{757}$ | ∞ | ∞ | 1 |
| formamide | $HCONHCH_2CH_2OH$ | 89.09 | lq. | $1.169^{25}$ | <–40 | d. | ∞ | | |
| Ether | $(CH_3CH_2)_2O$ | 74.12 | col. lq. | $0.708^{25/4}$ | –116.3 | 34.6 | $7.5^{20}$ | ∞ | |
| Ethyl abietate | $C_{19}H_{29}CO_2C_2H_5$ | 330.49 | lq. | $1.020^{20/20}$ | | $200^{4}$ | i. | | |
| acetate | $CH_3CO_2C_2H_5$ | 88.10 | col. lq. | $0.901^{20/4}$ | –82.4 | 77.1 | $8.5^{15}$ | ∞ | ∞ |
| acetoacetate | $CH_3COCH_2CO_2C_2H_5$ | 130.14 | col. lq. | $1.025^{20/4}$ | –45 | $180^{755}$ | $13^{17}$ | ∞ | ∞ |
| alcohol | $CH_3CH_2OH$ | 46.07 | col. lq. | $0.789^{20/4}$ | –112 | 78.4 | ∞ | | ∞ |
| -amine | $C_2H_5NH_2$ | 45.08 | col. lq. | $0.689^{15/15}$ | –80.6 | 16.6 | ∞ | ∞ | ∞ |
| hydrochloride | $C_2H_5NH_2{\cdot}HCl$ | 81.55 | mn. | 1.216 | 108–9 | | $240^{17}$ | v. s. | i. |
| aniline | $C_6H_5NHC_2H_5$ | 121.18 | lq. | $0.963^{20/4}$ | –63.5 | 204 | i. | ∞ | ∞ |
| sulfonic acid (*m*-) | $C_2H_5NHC_6H_4SO_3H$ | 201.24 | nd./aq. | | d. 294 | | $2.15^{15}$ | | |
| anisate (*p*-) | $CH_3OC_6H_4CO_2C_2H_5$ | 180.20 | lq. | $1.103^{25/25}$ | 7–8 | 269–70 | i. | s. | s. |
| anthranilate (*o*-) | $NH_2C_6H_4CO_2C_2H_5$ | 165.19 | cr. | $1.117^{20/4}$ | 13 | 266–8 | v. sl. s. | s. | s. |
| benzene | $C_6H_5{\cdot}C_2H_5$ | 106.16 | col. lq. | $0.867^{20/4}$ | –94.4 | 136.2 | $0.01^{15}$ | ∞ | ∞ |
| benzoate | $C_6H_5CO_2C_2H_5$ | 150.17 | col. lq. | $1.052^{15/15}$ | –34.6 | 211–2 | $0.08^{20}$ | ∞ | ∞ |
| -benzyl-aniline | $C_6H_5N(C_2H_5)CH_2C_6H_5$ | 211.29 | yel. oil | $1.034^{18.5}$ | | $285^{10}$ | i. | 18 | ∞ |
| bromide | $C_2H_5Br$ | 108.98 | col. lq. | $1.431^{20/4}$ | –117.8 | 38.4 | $1.06^{0}$ | ∞ | ∞ |
| butyrate (*n*-) | $C_3H_5CH_2CO_2C_2H_5$ | 116.16 | col. lq. | $0.879^{20/4}$ | –93.3 | 120–1 | $0.68^{25}$ | ∞ | ∞ |
| (*i*-) | $(CH_3)_2CHCO_2C_2H_5$ | 116.16 | col. lq. | $0.871^{20/4}$ | –88.2 | 110–1 | sl. s. | ∞ | ∞ |
| caprate (*n*-) | $CH_3(CH_2)_8CO_2C_2H_5$ | 200.31 | lq. | $0.859^{28}$ | –20 | $244.6^{758}$ | $0.002^{20}$ | ∞ | ∞ |
| Ethyl caproate (*n*-) | $CH_3(CH_2)_4CO_2C_2H_5$ | 144.21 | col. lq. | $0.873^{20/20}$ | –67.5 | $165–6^{736}$ | i. | ∞ | ∞ |
| caprylate (*n*-) | $CH_3(CH_2)_6CO_2C_2H_5$ | 172.26 | col. lq. | $0.878^{17}$ | –45 | $207–8^{753}$ | i. | ∞ | ∞ |
| chloride | $CH_3CH_2Cl$ | 64.52 | col. lq. | $0.917^{6/6}$ | –139 | 13 | $0.45^{0}$ | ∞ | ∞ |
| chloroacetate | $ClCH_2CO_2C_2H_5$ | 122.55 | col. lq. | $1.159^{20/4}$ | –26 | 144 | i. | ∞ | ∞ |
| chlorocarbonate | $ClCO_2CH_2CH_3$ | 108.53 | col. lq. | $1.138^{20/4}$ | –80.6 | 94–5 | d. | ∞ | ∞ |
| cinnamate (*trans*-) | $C_6H_5CH{:}CHCO_2H$ | 176.21 | col. lq. | $1.049^{20/4}$ | 12 | 271 | i. | ∞ | ∞ |
| cyanoacetate | $CH_2(CN)CO_2C_2H_5$ | 113.11 | col. lq. | $1.062^{20/4}$ | –22.5 | $208^{753}$ | $2^{25}$ | ∞ | ∞ |
| formate | $HCO_2CH_2CH_3$ | 74.08 | col. lq. | $0.923^{20/4}$ | –79 | $54^{760}$ | $11^{18}$ | ∞ | ∞ |
| furoate (α) | $OC_4H_3CO_2C_2H_5$ | 140.13 | lf. | $1.117^{21/4}$ | 34 | $195^{766}$ | i. | ∞ | ∞ |
| heptoate | $CH_3(CH_2)_5CO_2C_2H_5$ | 158.23 | col. lq. | $0.872^{20/20}$ | –66.1 | 187–8 | $0.029^{20}$ | ∞ | ∞ |
| hypochlorite | $ClOCH_2CH_3$ | 80.52 | yel. lq. | $1.013^{-6/4}$ | expl. | $36^{752}$ | | ∞ | |
| iodide | $CH_3CH_2I$ | 155.98 | col. lq. | $1.933^{20/4}$ | –105 | 72.4 | $0.4^{20}$ | ∞ | ∞ |
| lactate | $CH_3CH(OH)CO_2C_2H_5$ | 118.13 | oil | $1.030^{25/4}$ | | 155 | ∞ | ∞ | ∞ |

**TABLE 2-2 Physical Properties of Organic Compounds** (*Continued*)

| Name | Formula | Formula weight | Form and color | Specific gravity | Melting point, °C | Boiling point, °C | Solubility in 100 parts | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Water | Alcohol | Ether |
| laurate | $CH_3(CH_2)_{10}CO_2C_2H_5$ | 228.36 | oil | $0.868^{13/4}$ | –10.7 | 269 | i. | s. | ∞ |
| mercaptan | $CH_3CH_2SH$ | 62.13 | lq. | $0.839^{20/4}$ | –121 | 36–7 | 1.5 | s. | s. |
| methacrylate | $CH_2{:}C(CH_3)CO_2C_2H_5$ | 114.14 | col. lq. | $0.913^{15.6}$ | | 118 | i. | s. | s. |
| naphthylamine (α-) | $C_{10}H_7NHC_2H_5$ | 171.23 | oil | $1.060^{20/4}$ | | $303^{723}$ | i. | s. | s. |
| naphthyl ether (α-) | $C_{10}H_7OC_2H_5$ | 172.22 | cr. | $1.061^{20/20}$ | 5.5 | 276.4 | i. | s. | s. |
| nitrate | $C_2H_5ONO_2$ | 91.07 | col. lq. | $1.100^{25/4}$ | –102 | 87–8 | $1.3^{55}$ | ∞ | ∞ |
| nitrite | $C_2H_5ONO$ | 75.07 | lq. | $0.900^{15.5}$ | | 17 | v. sl. s. | ∞ | ∞ |
| oleate | $C_{17}H_{33}CO_2C_2H_5$ | 310.50 | oil | $0.867^{25}$ | <–15 | $216–8^{15}$ | i. | ∞ | ∞ |
| palmitate | $CH_3(CH_2)_{14}CO_2C_2H_5$ | 284.47 | col. nd. | $0.858^{25/4}$ | 24–5 | $191^{10}$ | i. | s. | s. |
| pelargonate | $CH_3(CH_2)_7CO_2C_2H_5$ | 186.29 | col. lq. | $0.866^{17.5}$ | –44.5 | $227–8^{757}$ | i. | ∞ | ∞ |
| propionate | $CH_3CH_2CO_2C_2H_5$ | 102.13 | col. lq. | $0.891^{20/4}$ | –72.6 | 99.1 | $2.4^{20}$ | ∞ | ∞ |
| salicylate (*o*-) | $HOC_6H_4CO_2C_2H_5$ | 166.17 | col. lq. | $1.136^{15/4}$ | 1.3 | 233–4 | i. | ∞ | ∞ |
| stearate | $CH_3(CH_2)_{16}CO_2C_2H_5$ | 312.52 | col. cr. | $0.848^{36.3}$ | 33.4(31) | $201^{10}$ | i. | s. | s. |
| toluate (*o*-) | $CH_3{\cdot}C_6H_4CO_2C_2H_5$ | 164.20 | lq. | $1.032^{25/25}$ | <–10 | 227 | i. | ∞ | ∞ |
| (*m*-) | $CH_3{\cdot}C_6H_4CO_2C_2H_5$ | 164.20 | lq. | $1.030^{20/20}$ | | $231^{750}$ | i. | ∞ | ∞ |
| toluene sulfonate (*p*-) | $CH_3{\cdot}C_6H_4SO_3C_2H_5$ | 200.25 | pr./al. | $1.166^{48/4}$ | 33–4 | 221.3 | i. | s. | s. |
| toluidine (*o*-) | $CH_3{\cdot}C_6H_4NHC_2H_5$ | 135.20 | lq. | $0.948^{25/4}$ | <–15 | 215–6 | i. | | |
| (*p*-) | $CH_3{\cdot}C_6H_4NHC_2H_5$ | 135.20 | lq. | $0.942^{25/4}$ | | 217 | i. | | |
| urea | $C_2H_5NH{\cdot}CO{\cdot}NH_2$ | 88.11 | nd. | $1.213^{18}$ | 92 | | v. s. | 80 | i. |
| valerate (*n*-) | $CH_3(CH_2)_3CO_2C_2H_5$ | 130.18 | col. lq. | $0.877^{20}$ | –91.2 | 145.5 | $0.24^{25}$ | ∞ | ∞ |
| (*i*-) | $(CH_3)_2CH(CH_2)_2CO_2C_2H_5$ | 130.18 | col. lq. | $0.867^{20/4}$ | –99.3 | 135 | $0.17^{20}$ | ∞ | ∞ |
| Ethylal | $CH_2(OC_2H_5)_2$ | 104.15 | lq. | $0.824^{25/4}$ | –66.5 | 89 | $9^{18}$ | ∞ | ∞ |
| Ethylene | $H_2C{:}CH_2$ | 28.05 | col. gas | $0.57^{-102/4}$ | –169 | –103.9 | 26 cc.$^{0}$ | 360 cc. | s. |
| bromide | $BrCH_2{\cdot}CH_2Br$ | 187.88 | col. lq. | $2.180^{20/4}$ | 10 | 131.5 | $0.43^{80}$ | ∞ | ∞ |
| bromohydrin | $BrCH_2{\cdot}CH_2OH$ | 124.98 | col. lq. | $1.772^{20/4}$ | | 150.3 | sl. s. | s. | |
| chlorobromide | $ClCH_2{\cdot}CH_2Br$ | 143.43 | lq. | $1.689^{19}$ | –16.6 | 106.7 | $0.69^{80}$ | | |
| chlorohydrin | $ClCH_2{\cdot}CH_2OH$ | 80.52 | col. lq. | $1.213^{20/4}$ | –69 | 128.8 | ∞ | ∞ | ∞ |
| diamine | $H_2NCH_2{\cdot}CH_2NH_2$ | 60.10 | col. lq. | $0.900^{20/20}$ | 8.5 | 117.2 | ∞ | ∞ | 0.3 |
| oxide | $<(CH_2)_2>O$ | 44.05 | lq. | $0.887^{7/4}$ | –111.3 | $13.5^{747}$ | ∞ | ∞ | v. s. |
| Ethylidene diacetate | $CH_3CH(O_2CCH_3)_2$ | 146.14 | col. lq. | $1.061^{12}$ | 18.85 | $168^{740}$ | sl. s. | ∞ | |
| Eugenol (1-,4-,3-) | $C_3H_5{\cdot}C_6H_3(OH)OCH_3$ | 164.20 | oil | $1.070^{15/15}$ | 10.3 | 253.5 | v. sl. s. | ∞ | ∞ |
| (*i*-)(1-,3-,4-) | $C_3H_5{\cdot}C_6H_3(OCH_3)OH$ | 164.20 | oil | $1.091^{15/15}$ | –10 | 267.5 | v. sl. s. | ∞ | ∞ |
| Fenchyl alcohol (*dl*-) | $C_{10}H_{17}OH$ | 154.24 | col. cr. | $0.935^{40}$ | 35 | 201 | sl. s. | | |
| (*d*-)(α-) | $C_{10}H_{17}OH$ | 154.24 | col. pr. | $0.964^{20/4}$ | 45–7 | 201–2 | sl. s. | s. | s. |
| (*i*-)(*l*-) | $C_{10}H_{17}OH$ | 154.24 | col. cr. | 0.961 | 61–2 | 201–2 | i. | | |
| Ferric dimethyl-dithiocarbamate | $Fe[SSCN(CH_3)_2]_3$ | 416.47 | cr. | | d. 100–30 | ign. >150 | v. sl. s. | | |
| Fluorene | $(C_6H_4)_2>CH_2$ | 166.21 | cr./al. | $1.203^{0/4}$ | 115–6 | 293–5 | i. | s. h. | s. |
| Fluorescein | $C_{20}H_{12}O_5$ | 332.30 | yel. red | | d. > 290 | | v. sl. s. h. | s. h. | |
| Fluoro-dichloromethane | $FCHCl_2$ | 102.93 | gas | $1.426^{0}$ | –127 | 14.5 | i. | s. | s. |
| -trichloromethane | $Cl_3CF$ | 137.38 | col. lq. | $1.494^{17.2}$ | | 24.9 | i. | ∞ | ∞ |
| Formaldehyde | HCHO | 30.03 | gas | $0.815^{-20}$ | –92 | –21 | v. s. | v. s. | v. s. |
| (*m*-) | $(CH_2O)_3$ | 90.08 | wh. | $1.17^{65}$ | 64 | $114.5^{759}$ | $21^{25}$ | s. | s. |
| (*p*-) | $(CH_2O)_x{\cdot}xH_2O$ | (30.03) | amor. | | 150–60 | subl. | $20–30^{18}$ | i. | i. |
| Formamide | $HCONH_2$ | 45.04 | lq. | $1.139^{20/4}$ | 2 | 193 | ∞ | ∞ | v. sl. s. |
| Formanilide | $HCONHC_6H_5$ | 121.13 | mn. | $1.147^{15/15}$ | 47 | $216^{120}$ | sl. s. | v. s. | s. |
| Formic acid | $HCO_2H$ | 46.03 | col. lq. | $1.220^{20/4}$ | 8.6 | 100.8 | ∞ | ∞ | |
| Fructose | $CH_2OH(CHOH)_3COCH_2OH$ | 180.16 | nd./aq. | $1.669^{17.5}$ | 95–105 | | v. s. | $8^{18}$ | |
| Fuchsin | $C_{20}H_{19}N_3HCl$ | 337.84 | red | 1.22 | d. >200 | | 0.3 | s. | i. |
| Fulminic acid | C:NOH | 43.03 | | | | | | | |
| Fumaric acid (*trans*-) | $HO_2CCH{:}CHCO_2H$ | 116.07 | col. pr. | $1.635^{20/4}$ | 286–7 | 290 | $0.7^{17}$ | $5.8^{30}$ | $0.7^{25}$ |
| Furfural | $C_4H_3O{\cdot}CHO$ | 96.08 | lq. | $1.159^{20/4}$ | –38.7 | $161.7^{760}$ | $9.1^{13}$ | ∞ | ∞ |
| Furfuran | $C_4H_4O$ | 68.07 | col. lq. | $0.937^{20/4}$ | | $31–2^{756}$ | i. | s. | s. |
| Furfuryl acetate | $CH_3CO_2CH_2C_4H_3O$ | 140.13 | col. oil | $1.118^{20/4}$ | | 175–7 | i. | s. | s. |
| alcohol | $C_4H_3O{\cdot}CH_2OH$ | 98.10 | oil | $1.129^{25/4}$ | | $169.5^{752}$ | ∞ | s. | s. |
| butyrate | $C_3H_7CO_2CH_2{\cdot}C_4H_3O$ | 168.19 | col. lq. | $1.053^{20/4}$ | | 212–3 | v. sl. s. | s. | ∞ |
| propionate | $C_2H_5CO_2CH_2{\cdot}C_4H_3O$ | 154.16 | col. lq. | $1.109^{20/4}$ | | 195–6 | v. sl. s. | s. | ∞ |
| Furoic acid | $C_4H_3O{\cdot}CO_2H$ | 112.08 | mn. pr. | | 133–4 | 230–2 | $3.6^{15}$ | s. | s. |
| G-acid, K salt (2-)(6-,8-) | $HOC_{10}H_5(SO_3K)_2$ | 380.46 | cr. | | | | $8^{25}$ | | |
| Na salt (2-)(6-,8-) | $HOC_{10}H_5(SO_3Na)_2$ | 348.26 | cr. | | | | $34^{20}$ | | |
| Galactose (*d*-)(α-) | $C_5H_{11}O_5{\cdot}CHO$ | 180.16 | pr. | | 165.5 | | $10.3^{0}$ | $0.6^{40}$ | |
| Gallic acid (3-,4-,5-) | $(HO)_3C_6H_2CO_2H{\cdot}H_2O$ | 188.13 | mn./aq. | $1.694^{4/4}$ | d. 220 | | $1^{13}$ | $28^{15}$ | $2.5^{15}$ |
| Gamma acid (2-,8-,6-) | $C_{10}H_5(NH_2)(OH)SO_3H$ | 239.24 | cr. | | | | | | |
| Geraniol | $C_9H_{15}CH_2OH$ | 154.24 | col. lq. | $0.883^{15}$ | <–15 | 230 | i. | ∞ | ∞ |
| Glucose (*d*-)(α-) | $C_5H_{11}O_5{\cdot}CHO$ | 180.16 | rhb. | $1.544^{25}$ | 146 | | $82^{17.5}$ | sl. s. | i. |
| (*d*-)(β-) | $C_6H_{12}O_6{\cdot}H_2O$ | 198.17 | cr. | $1.562^{18/4}$ | 150 | | $154^{15}$ | | |
| Glucuronic acid | $CHO(CHOH)_4CO_2H$ | 194.14 | cr. | | 154 | d. | v. s. | | |
| Glutam(in)ic acid (*dl*-) | $[{\cdot}CHNH_2(CH_2)_2{\cdot}](CO_2H)_2$ | 147.13 | cr./aq. | 1.460 | 199 d. | | $1.5^{20}$ | v. sl. s. | v. sl. s. |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Glutaric acid | $CH_2(CH_2CO_2H)_2$ | 132.11 | col. cr. | $1.429^{15}$ | 97.5 | $200^{20}$ | $63.9^{20}$ | v. s. | v. s. |
| Glycerol | $CH_2OH{\cdot}CHOH{\cdot}CH_2OH$ | 92.09 | col. lq. | $1.260^{50/4}$ | 17.9 | 290 | ∞ | ∞ | i. |
| acetate (mono-) | $C_5H_{10}O_4$ | 134.13 | col. oil | $1.20^{20/4}$ | | $158^{165}$ | v. s. | v. s. | sl. s. |
| (di-) | $(CH_3CO_2)_2C_3H_5OH$ | 176.17 | col. lq. | $1.178^{15/15}$ | 40 | $175–6^{40}$ | s. | s. | sl. s. |
| nitrate (mono-) (α-) | $CH_2OH{\cdot}CHOH{\cdot}CH_2NO_3$ | 137.09 | col. pr. | $1.40^{15}$ | 58–9 | 155–60 | $70^{15}$ | v. s. | v. sl. s. |
| (β-) | $CH_2OH{\cdot}CHNO_3{\cdot}CH_2OH$ | 137.09 | lf. | $1.40^{15}$ | 54 | 155–60 | | v. s. | sl. s. |
| dinitrate (1-,3-) | $CHOH(CH_2ONO_2)_2$ | 182.09 | oil | $1.47^{15}$ | <–30 | $146–8^{15}$ | | v. s. | v. s. |
| Glyceryl triacetate | $(CH_3CO_2)_3C_3H_5$ | 218.20 | col. lq. | $1.161^{17/4}$ | –78 | 258–9 | $7.17^{15}$ | ∞ | ∞ |
| tribenzoate | $(C_6H_5CO_2)_3C_3H_5$ | 404.40 | nd. | $1.228^{12}$ | 75–6 | d. | i. | s. h. | s. |
| tributyrate | $(C_3H_7CH_2CO_2)_3C_3H_5$ | 302.36 | col. lq. | $1.032^{20/4}$ | <–75 | 305–9 | i. | s. | s. |
| tricaprate | $[CH_3(CH_2)_8CO_2]_3C_3H_5$ | 554.83 | col. cr. | $0.921^{40/4}$ | 31(25) | | i. | s. h. | v. s. |
| tricaproate | $[CH_3(CH_2)_4CO_2]_3C_3H_5$ | 386.51 | col. lq. | $0.987^{20/4}$ | –25 | | i. | s. | s. |
| tricaprylate | $[CH_3(CH_2)_6CO_2]_3C_3H_5$ | 470.67 | col. lq. | $0.954^{20/4}$ | 8.3(–21) | | i. | s. | s. |
| trilaurate | $[CH_3(CH_2)_{10}CO_2]_3C_3H_5$ | 638.98 | col. nd. | $0.894^{60/4}$ | 45–6 | | i. | sl. s. c. | v. s. |
| trimyristate | $[CH_3(CH_2)_{12}CO_2]_3C_3H_5$ | 723.14 | lf. | $0.885^{60/6}$ | 56.5 | | i. | s. | |
| trinitrate | $CH_2NO_3{\cdot}CHNO_3{\cdot}CH_2NO_3$ | 227.09 | yel. oil | $1.601^{15}$ | 13.3(2) | $160^{15}$ | $0.18^{20}$ | $50^{20}$ | ∞ |
| trinitrite | $CH_2NO_2{\cdot}CHNO_2{\cdot}CH_2NO_2$ | 179.09 | yel. lq. | $1.291^{10/16}$ | | 150 sl. d. | d. | d. | s. |
| trioleate | $(C_{17}H_{33}CO_2)_3C_3H_5$ | 885.40 | col. oil | $0.915^{15}$ | –4 | $240^{18}$ | i. | sl. s. | v. s. |
| tripalmitate | $[CH_3(CH_2)_{14}CO_2]_3C_3H_5$ | 807.29 | col. nd. | $0.866^{80/4}$ | 65.1 | $310–20^{0.1}$ | i. | $0.004^{21}$ | v. s. |
| tristearate | $[CH_3(CH_2)_{16}CO_2]_3C_3H_5$ | 891.45 | col. pr. | $0.862^{80/4}$ | 70.8(55) | | i. | s. h. | s. h. |
| Glycide | $C_3H_5O{\cdot}CH_2OH$ | 74.08 | col. lq. | $1.114^{16/16}$ | | 166 sl. d. | ∞ | ∞ | ∞ |
| Glycine, Glycocoll | $NH_2CH_2{\cdot}CO_2H$ | 75.07 | mn. | 1.161 | 232–6 d. | | 23 c. | 0.1 c. | i. |
| Glycol | $CH_2OH{\cdot}CH_2OH$ | 62.07 | col. lq. | $1.113^{19/4}$ | –15.6 | 197.4 | ∞ | ∞ | 1.0 |
| diacetate | $(CH_3CO_2CH_2{\cdot})_2$ | 146.14 | col. lq. | $1.109^{14/4}$ | –31 | 190.5 | $14.3^{22}$ | ∞ | ∞ |
| dibenzoate | $(C_6H_5CO_2CH_2{\cdot})_2$ | 270.27 | rhb./et. | | 73–4 | >360 | i. | | s. |
| dibutyrate | $(C_3H_7CO_2CH_2{\cdot})_2$ | 202.24 | col. lq. | $1.024^{0}$ | | 240 | i. | v. s. | v. s. |
| dicaprylate | $(C_7H_{15}CO_2CH_2{\cdot})_2$ | 314.45 | lq. | | 22 | | i. | | |
| diformate | $(HCO_2CH_2{\cdot})_2$ | 118.09 | lq. | | | 174 | v. sl. s. | | |
| dilaurate | $(C_{11}H_{23}CO_2CH_2{\cdot})_2$ | 426.66 | amor. | | 52–4 | $188^{20}$ | i. | v. s. | v. s. |
| dinitrate | $(O_2NO{\cdot}CH_2{\cdot})_2$ | 152.07 | yel. lq. | $1.482^{21/2}$ | –20 | expl. 114 | $0.92^{25}$ | s. | ∞ |
| dinitrite | $(ONO{\cdot}CH_2{\cdot})_2$ | 120.07 | lq. | $1.216^{0}$ | <–15 | 96–8 | i. | s. d. | s. |
| dipalmitate | $(C_{15}H_{31}CO_2CH_2{\cdot})_2$ | 538.87 | nd. | | 71–2 | $260^{0.1}$ | i. | s. | s. |
| dipropionate | $(C_2H_5CO_2CH_2{\cdot})_2$ | 174.19 | lq. | $1.045^{25}$ | | 211–2 | sl. s. | ∞ | ∞ |
| ether | $(HO{\cdot}CH_2CH_2)_2O$ | 106.12 | lq. | $1.118^{20/20}$ | –10.5 | 244.8 | ∞ | ∞ | i. |
| formal | $<O{\cdot}CH_2CH_2OCH_2>$ | 74.08 | lq. | $1.060^{20/4}$ | | 75–6 | ∞ | | |
| formate (mono-) | $HCO_2CH_2CH_2OH$ | 90.08 | lq. | $1.199^{15/4}$ | | 180 | ∞ | | |
| Glycolic acid | $HOCH_2CO_2H$ | 76.05 | nd./aq. | | | 79(63) | d. | ∞ | $90^{25}$ | v. s. |
| Guaiacol (*o*-) | $CH_3O{\cdot}C_6H_4OH$ | 124.13 | pr. | $1.140^{15/15}$ | | 28.3 | 205 | $1.7^{15}$ | v. s. | v. s. |
| Guanidine | $NH{:}C(NH_2)_2$ | 59.07 | col. cr. | | | 50 | | v. s. | s. | |
| H-acid, Na salt (1-,8-,3-,6-) | $C_{10}H_8O_7NS_2Na{\cdot}1a\ H_2O$ | 368.31 | cr. | | | | | $0.17^{20}$ | | |
| Heptacosane (*n*-) | $CH_3(CH_2)_{25}CH_3$ | 380.72 | col. cr. | $0.780^{60/4}$ | | 59.5 | $270^{15}$ | i. | | |
| Heptane (*n*-) | $CH_3(CH_2)_5CH_3$ | 100.20 | col. lq. | $0.684^{20/4}$ | –90.6 | $98.4^{760}$ | $0.005^{15}$ | sl. s. | ∞ |
| (*i*-) | $(CH_3)_2CH(CH_2)_3CH_3$ | 100.20 | col. lq. | $0.679^{20/4}$ | –118.2 | 90.0 | i. | s. | ∞ |
| | $C_3H_7{\cdot}CH(CH_3){\cdot}C_2H_5$ | 100.20 | col. lq. | $0.687^{20/4}$ | –119.4 | 91.8 | i. | s. | ∞ |
| | $(CH_3)_3C{\cdot}CH_2{\cdot}C_2H_5$ | 100.20 | col. lq. | $0.674^{20/4}$ | –125 | 79.1 | i. | s. | ∞ |
| | $[(CH_3)_2CH]_2CH_2$ | 100.20 | col. lq. | $0.675^{20/4}$ | –119.4 | 80.8 | i. | s. | ∞ |
| | $(CH_3)_2C(C_2H_5)_2$ | 100.20 | col. lq. | $0.693^{20/4}$ | –135.0 | 86.0 | i. | s. | ∞ |
| | $(C_2H_5)_3CH$ | 100.20 | col. lq. | $0.698^{20/4}$ | –118.7 | 93.5 | i. | s. | ∞ |
| | $(CH_3)_3C{\cdot}CH(CH_3)_2$ | 100.20 | col. lq. | $0.690^{20/4}$ | –25 | 80.8 | i. | s. | ∞ |
| Heptoic acid | $CH_3(CH_2)_5CO_2H$ | 130.18 | col. lq. | $0.918^{20}$ | –10 | 221–2 | $0.25^{15}$ | s. | s. |
| aldehyde | $CH_3(CH_2)_5CHO$ | 114.18 | col. lq. | $0.850^{20/c}$ | –42 | 155 | $0.02^{20}$ | ∞ | ∞ |
| Heptyl acetate (*n*-) | $CH_3CO_2CH_2(CH_2)_5CH_3$ | 158.24 | col. lq. | $0.874^{16/16}$ | | $191.5^{759}$ | i. | s. | s. |
| alcohol (*n*-) | $CH_3(CH_2)_5CH_2OH$ | 116.20 | col. lq. | $0.824^{20/4}$ | 34.6 | $175^{756}$ | $0.18^{25}$ | ∞ | ∞ |
| | $[(CH_3)_2CH]_2CHOH$ | 116.20 | col. lq. | $0.829^{20/4}$ | | 140 | v. sl. s. | ∞ | ∞ |
| | $(C_2H_5{\cdot}CH_2{\cdot}CH_2)_2CHOH$ | 116.20 | lq. | $0.820^{20/4}$ | –37 | 156 | i. | s. | s. |
| mercaptan | $CH_3CH(SH){\cdot}C_5H_{11}$ | 132.26 | lq. | $0.835^{20}$ | | $174–5^{765}$ | i. | | |
| Hexachloro-benzene | $C_6Cl_6$ | 284.80 | mn. | $2.044^{24}$ | 228–31 | $309^{742}$ | i. | v. sl. s. h. | s. h. |
| -ethane | $CCl_3{\cdot}CCl_3$ | 236.76 | rhb. | $2.091^{20/4}$ | 186–7 | $186^{777}$ | $0.005^{22}$ | v. s. | v. s. |
| Hexacosane (*n*-) | $CH_3(CH_2)_{24}CH_3$ | 366.69 | cr. | $0.779^{57/4}$ | 56.6 | $262^{15}$ | i. | v. sl. s. | |
| Hexadecane (*n*-) | $CH_3(CH_2)_{14}CH_3$ | 226.43 | lf. | $0.774^{20/4}$ | 18.5 | 287.5 | i. | ∞ | ∞ |
| Hexaethylbenzene | $C_6(C_2H_5)_6$ | 246.42 | pr./al. | $0.831^{130/4}$ | 130 | 298.3 | i. | $0.75^{25}$ | $8^{25}$ |
| Hexamethylbenzene | $C_6(CH_3)_6$ | 162.26 | pl./al. | | 166 | 265 | i. | $0.2^{0}$ | v. s. |
| Hexamethylene-diamine | $NH_3(CH_2)_6NH_2$ | 116.20 | lf. | | 42 | 204–5 | v. s. | s. | |
| -diisocyanate | $OCN(CH_2)_6NCO$ | 168.19 | lq. | $1.04^{28}$ | | $143–4^{20}$ | d. | d. | |
| -glycol | $HO(CH_2)_6OH$ | 118.17 | nd./aq. | | 42 | 250 | s. | s. | sl. s. h. |
| tetramine | $(CH_2)_6N_4$ | 140.19 | col. rhb. | | subl. | | $81^{12}$ | 3 | v. sl. s. |
| Hexane (*n*-) | $CH_3(CH_2)_4CH_3$ | 86.17 | col. lq. | $0.659^{20/4}$ | –94 | 69 | $0.014^{15}$ | $50^{33}$ | ∞ |
| (*i*-) | $(CH_3)_2CH(CH_2)_2CH_3$ | 86.17 | lq. | $0.654^{20/4}$ | –153.7 | 60.2 | i. | | s. |
| (neo-) | $(CH_3)_3C{\cdot}C_2H_5$ | 86.17 | lq. | $0.649^{20/20}$ | –98.2 | 49.7 | i. | | s. |
| | $(CH_3)_2CH{\cdot}CH(CH_3)_2$ | 86.17 | lq. | $0.662^{20/4}$ | –129.8 | $58.0^{760}$ | i. | | s. |
| | $(C_2H_5)_2CHCH_3$ | 86.17 | lq. | $0.664^{20/4}$ | –118 | 63.2 | i. | | s. |

**TABLE 2-2 Physical Properties of Organic Compounds** (*Continued*)

| Name | Formula | Formula weight | Form and color | Specific gravity | Melting point, °C | Boiling point, °C | Solubility in 100 parts | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Water | Alcohol | Ether |
| Hexyl acetate (*n*-) | $CH_3CO_2(CH_2)_5CH_3$ | 144.21 | col. lq. | $0.890^{0/0}$ | | 169.2 | i. | v. s. | v. s. |
| alcohol (*n*-) | $CH_3(CH_2)_4CH_2OH$ | 102.17 | col. lq. | $0.820^{20/20}$ | –51.6 | 157.2 | $0.6^{20}$ | ∞ | ∞ |
| | $(CH_3)_2CH{\cdot}C(CH_3)_2OH$ | 102.17 | lq. | $0.821^{20/0}$ | –14 | 120–1 | v. sl. s. | ∞ | ∞ |
| | $(CH_3)_2COH{\cdot}CH_2C_2H_5$ | 102.17 | lq. | $0.809^{20/4}$ | –107 | $123^{762}$ | v. sl. s. | ∞ | ∞ |
| formate (*n*-) | $HCO_2CH_2(CH_2)_4CH_3$ | 130.18 | lq. | $0.898^{0}$ | | 153.6 | | ∞ | ∞ |
| resorcinol (2-,4-) | $CH_3(CH_2)_5C_6H_3(OH)_2$ | 194.26 | col. nd. | | 68–70 | $179^{7}$ | 0.05 | v. s. | s. |
| Hippuric acid | $C_6H_5CONHCH_2CO_2H$ | 179.17 | rhb. | $1.371^{20/4}$ | 187–8 | d. | $0.4^{20}$ | s. h. | $0.25^{18}$ |
| Histidine (*l*-) | $C_6H_9O_2N_3$ | 155.16 | lf./aq. | | d. 287 | | s. | v. sl. s. | i. |
| Homophthalic acid (*o*-) | $HO_2C{\cdot}C_6H_4{\cdot}CH_2CO_2H$ | 180.15 | cr./aq. | | 175–80 | | s. h. | v. s. | sl. s. |
| Hydracrylic acid | $HOCH_2CH_2CO_2H$ | 90.08 | syrup | | | d. | | | |
| Hydro-cyanic acid | HCN | 27.03 | lq. | $0.697^{18}$ | –12 | 25–6 | ∞ | ∞ | ∞ |
| -quinone (*p*-) | $C_6H_4(OH)_2$ | 110.11 | cr. | $1.332^{15}$ | 170.3 | $285^{730}$ | $6^{15}$ | v. s. | v. s. |
| Hydroxy-benzaldehyde (*p*-) | $HO{\cdot}C_6H_4{\cdot}CHO$ | 122.12 | nd./aq. | $1.129^{130}$ | 116–7 | subl. | $1.38^{31}$ | | |
| -benzanilide (*o*-) | $HO{\cdot}C_6H_4{\cdot}CONHC_6H_5$ | 213.23 | pr./al. | | 135 | d. | v. sl. s. h. | s. | s. |
| -quinoline (2-)(α-) | $C_9H_6N{\cdot}OH$ | 145.15 | pr./al. | | 199–200 | subl. | s. h. | v. s. | v. s. |
| (8-)(*o*-) | $C_9H_6N{\cdot}OH$ | 145.15 | pr. | | 75–6 | $266.6^{752}$ | v. sl. s. c. | s. | sl. s. |
| Indigo | $[C_6H_4(CO)(NH)C:]_2$ | 262.26 | cr. | 1.35 | 390–2 | subl. | i. | i. | i. |
| White | $C_{16}H_{12}O_2N_2$ | 264.27 | gray | | | | i. | s. | s. |
| Indole | $C_8H_7N$ | 117.14 | lf./aq. | | 52 | 253–4 | s. h. | s. h. | s. |
| Indoxyl | $C_8H_6NOH$ | 133.14 | yel. pr. | | 85 | 110 | s. | s. | s. |
| Iodo-benzene | $C_6H_5I$ | 204.02 | col. lq. | $1.824^{25/4}$ | –28.5 | 188.6 | $0.034^{20}$ | s. | ∞ |
| -phenol (*p*-) | $IC_6H_4OH$ | 220.02 | nd./aq. | $1.857^{112}$ | 93–4 | d. | sl. s. | v. s. | v. s. |
| Iodoform | $HCI_3$ | 393.78 | yel. hex. | $4.008^{17}$ | 119 | subl. | $0.01^{25}$ | $1.5^{17}$ | $13.6^{25}$ |
| Ionone (α-) | $C_{10}H_{16}{:}CHCOCH_3$ | 192.29 | col. oil | $0.930^{20}$ | | $136.1^{17}$ | sl. s. | ∞ | ∞ |
| (β-) | $C_{10}H_{16}{:}CHCOCH_3$ | 192.29 | col. oil | $0.944^{20}$ | | $140^{18}$ | sl. s. | ∞ | ∞ |
| Irone (β-) | $C_{14}H_{22}O$ | 206.32 | col. oil | $0.939^{20}$ | | $144^{16}$ | v. sl. s. | v. s. | v. s. |
| Isatin | $C_6H_4{<}(CO)(N){>}COH$ | 147.13 | yel. red | | 200–1 | subl. | s. h. | v. s. h. | sl. s. |
| Isoprene | $CH_2{:}CH{\cdot}C(CH_3){:}CH_2$ | 68.11 | col. lq. | $0.681^{20/4}$ | –120 | 34 | i. | ∞ | ∞ |
| Ketene | $H_2C{:}CO$ | 42.04 | col. gas | | –151 | –56 | d. | d. | s. |
| Koch acid (1-)(3-,6-,8-) | $C_{10}H_4(NH_2)S_3O_9HNa_2$ | 427.34 | cr. | | | | $7.2^{20}$ | | |
| Lactic acid (*dl*-) | $CH_3CH(OH)CO_2H$ | 90.08 | hyg. | $1.249^{15/4}$ | 16.8 | $122^{14}$ | ∞ | ∞ | ∞ |
| anhydride | $C_6H_{10}O_5$ | 162.14 | yel. oil | | | d. 250 | v. sl. s. | s. | s. |
| Lactide (*dl*-) | $C_6H_4C_4$ | 144.12 | tri./al. | $0.862^{10/4}$ | 124.5 | $255^{757}$ | v. sl. s. | v. sl. s. c. | |
| Lactose | $C_{12}H_{22}O_{11}{\cdot}H_2O$ | 360.31 | col. rhb. | $1.525^{20}$ | 202 | d. | $17^{10}$ | i. | i. |
| Lauric acid | $CH_3(CH_2)_{10}CO_2H$ | 200.31 | col. nd. | $0.869^{50/4}$ | 48(44) | $225^{100}$ | i. | s. | s. |
| Laurone | $[CH_3(CH_2)_{10}]_2CO$ | 338.60 | pl. | $0.809^{69/4}$ | 69–70 | | i. | i. c. | |
| Lauryl alcohol | $CH_3(CH_2)_{10}CH_2OH$ | 186.33 | lf. | $0.831^{24/4}$ | 24 | 255–9 | i. | s. | s. |
| Lead tetraethyl | $Pb(CH_2CH_3)_4$ | 323.45 | col. lq. | $1.659^{18/4}$ | –136 | $152^{291}$ | i. | sl. s. | ∞ |
| tetramethyl | $Pb(CH_3)_4$ | 267.35 | col. lq. | $1.995^{20/4}$ | –27.5 | $110^{760}$ | i. | ∞ | ∞ |
| Lecithin (protagon) | $C_{42}H_{48}O_9PN$ | 778.08 | wax | | 150–200 d. | | i. | s. h. | s. h. |
| Lepidine (*py*-4) | $C_9H_6N{\cdot}CH_3$ | 143.18 | lq. | $1.086^{20}$ | 9–10 | 261–3 | sl. s. | ∞ | ∞ |
| Leucine (*l*-) | $(CH_3)_2CHCH_2CH(NH_2)CO_2H$ | 131.17 | cr. | $1.293^{18}$ | 295 | subl. | $2.2^{18}$ | | |
| Levulinic acid | $CH_3CO(CH_2)_2CO_2H$ | 116.11 | lf. | $1.140^{20/20}$ | 33.5 | 245–6 | v. s. | v. s. | v. s. |
| Limonene (*d*- or *l*-) | $C_{10}H_{16}$ | 136.23 | lq. | $0.842^{20/4}$ | –96.9 | 177 | i. | ∞ | ∞ |
| Linalool (*d*- or *l*-) | $C_{10}H_{17}OH$ | 154.24 | col. oil | $0.868^{20}$ | | 198–200 | v. sl. s. | s. | ∞ |
| Linalyl acetate | $CH_3CO_2C_{10}H_{17}$ | 196.28 | col. lq. | $0.895^{20}$ | | $220^{762}$ d. | v. sl. s. | ∞ | ∞ |
| Linoleic acid | $C_{17}H_{31}CO_2H$ | 280.44 | yel. oil | $0.903^{18/4}$ | –9.5 | 229–$30^{16}$ | i. | ∞ | ∞ |
| Maleic acid | $HO_2C{\cdot}CH{:}CH{\cdot}CO_2H$ | 116.07 | mn. | 1.609 | 130.5 | 135 d. | $79^{25}$ | $70^{30}$ | $8^{25}$ |
| anhydride | $<(\cdot CHCO)_2>O$ | 98.06 | cr. | 1.5 | 57–60 | 202 | $16.3^{80}$ | | |
| Malic acid (*dl*-) | $HO_2CCH_2CH(OH)CO_2H$ | 134.09 | col. cr. | $1.601^{20/4}$ | 128–9 | 150 d. | $144^{26}$ | v. s. | v. s. |
| (*d*- or *l*-) | $HO_2CCH_2CH(OH)CO_2H$ | 134.09 | col. cr. | $1.595^{20/4}$ | 99–100 | 140 d. | v. s. | v. s. | $8.4^{15}$ |
| Malonic acid | $H_2C(CO_2H)_2$ | 104.06 | col. tri. | $1.631^{15}$ | 130–5 d. | | $138^{16}$ | $42^{25}$ | $8^{15}$ |
| Maltose | $C_{12}H_{22}O_{11}{\cdot}H_2O$ | 360.31 | col. nd. | $1.540^{17}$ | d. | | $108^{25}$ | v. sl. s. c. | i. |
| Mandelic acid (*dl*-) | $C_6H_5CH(OH)CO_2H$ | 152.14 | rhb./aq. | $1.300^{20/4}$ | 118.1 | d. | $16^{20}$ | s. | s. |
| Mannitol (*d*-) | $CH_2OH(CHOH)_4CH_2OH$ | 182.17 | col. rhb. | $1.489^{20/4}$ | 166 | 290–$5^{3}$ | $13^{14}$ | $0.01^{14}$ | i. |
| Mannose (*d*-) | $CH_2OH(CHOH)_4CHO$ | 180.16 | rhb. | $1.539^{20/4}$ | 132 | | $248^{17}$ | v. sl. s. | i. |
| Margaric acid | $CH_3(CH_2)_{15}CO_2H$ | 270.44 | col. pl. | $0.853^{60}$ | 60–1 | $227^{100}$ | i. | $32^{28}$ | v. s. |
| Mellitic acid | $C_6(CO_2H)_6$ | 342.17 | nd./al. | | 286–8 | d. | v. s. | v. s. | |
| Menthol (l-)(α-) | $C_{10}H_{19}OH$ | 156.26 | col. cr. | $0.890^{15/15}$ | 42–3 | 212 | 0.04 c. | v. s. | v. s. |
| Mercapto-benzothiazole (2-) | $<C_6H_4N{:}C(SH)S>$ | 167.24 | nd. | $1.42^{20/4}$ | 179 | d. | i. | s. | sl. s. |
| -thiazoline (2-) | $<CH_2N{:}C(SH)SCH_2>$ | 119.20 | cr. | 1.50 | 106 | | $1.6^{60}$ | | |
| Mercuric cyanide | $Hg(CN)_2$ | 252.65 | cr. | $4.003^{22}$ | d. 320 | | $12.5^{15}$ | | |
| fulminate | $Hg(ONC)_2{\cdot}a\ H_2O$ | 293.65 | cr./aq. | 4.4 | expl. | | $0.07^{12}$ | s. | |
| Mesityl oxide | $(CH_3)_2C{:}CHCOCH_3$ | 98.14 | lq. | $0.858^{20/4}$ | –59 | $130^{750}$ | $3^{20}$ | ∞ | ∞ |
| Mesitylene (1-,3-,5-) | $C_6H_3(CH_3)_3$ | 120.19 | col. lq. | $0.865^{20/4}$ | –45(–52) | 164.8 | i. | s. | ∞ |
| Metanilic acid (*m*-) | $H_2NC_6H_4SO_3H$ | 173.18 | col. nd. | | d. | | $2^{15}$ | v. sl. s. | v. sl. s. |
| Methane | $CH_4$ | 16.04 | gas | $0.415^{-164}$ | –182.6 | –161.4 | $0.4^{20}$ cc. | $47^{20}$ cc. | $104^{10}$ cc. |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Methoxy-methoxyethanol | $CH_3(OCH_2)_2CH_2OH$ | 106.12 | lq. | $1.038^{25}$ | <–70 | 167.5 | ∞ | | |
| Methyl acetate | $CH_3CO_2CH_3$ | 74.08 | col. lq. | $0.924^{20/4}$ | –98.7 | 57.1 | $33^{22}$ | ∞ | ∞ |
| acrylic acid (α-) | $CH_2{:}C(CH_3)CO_2H$ | 86.09 | pr. | $1.015^{20/4}$ | 15–16 | 161–3 | s. h. | ∞ | ∞ |
| alcohol | $CH_3OH$ | 32.04 | col. lq. | $0.792^{20/4}$ | –97–8 | 64.7 | ∞ | ∞ | ∞ |
| -amine | $CH_3NH_2$ | 31.06 | col. gas | $0.699^{-11}$ | –92.5 | $-6.7^{758}$ | v. s. | v. s. | |
| -amine hydrochloride | $CH_3NH_2{\cdot}HCl$ | 67.52 | pl./al. | 1.23 | 226–8 | $230^{15}$ | v. s. | 23 h. | i. |
| aniline | $C_6H_5NHCH_3$ | 107.15 | lq. | $0.989^{20/4}$ | –57 | 195.5 | $0.01^{25}$ | s. | ∞ |
| anthracene (α-) | $C_6H_4{:}(CH)_2{:}C_6H_3CH_3$ | 192.25 | lf./al. | $1.047^{99.4}$ | 86 | | i. | | |
| (β-) | $C_6H_4{:}(CH)_2{:}C_6H_3CH_3$ | 192.25 | col. lf. | $1.181^{0/4}$ | 207 | | i. | v. sl. s. | v. sl. s. |
| anthranilate (*o*-) | $NH_2C_6H_4CO_2CH_3$ | 151.16 | col. lq. | $1.168^{19/4}$ | 24 | $135.5^{15}$ | sl. s. | s. | s. |
| anthraquinone (2-) | $C_6H_4{:}(CO)_2{:}C_6H_3CH_3$ | 222.23 | col. nd. | | 176–7 | subl. | i. | s. | s. |
| benzoate | $C_6H_5CO_2CH_3$ | 136.14 | col. lq. | $1.087^{25/25}$ | –12.5 | 198–9 | $0.02^{30}$ | ∞ | ∞ |
| benzylaniline | $C_6H_5N(CH_3)CH_2C_6H_5$ | 197.27 | lq. | | 9.2 | 305–6 | i. | s. | s. |
| bromide | $CH_3Br$ | 94.95 | gas | $1.732^{0/0}$ | –93 | $4.5^{758}$ | v. sl. s. | s. | s. |
| butyrate (*n*-) | $CH_3(CH_2)_2CO_2CH_3$ | 102.13 | col. lq. | $0.898^{20/4}$ | <–95 | 102.3 | 1.7 | ∞ | ∞ |
| (*i*-) | $(CH_3)_2CHCO_2CH_3$ | 102.13 | col. lq. | $0.891^{20/4}$ | –84.7 | 92.6 | v. sl. s. | ∞ | ∞ |
| caprate | $CH_3(CH_2)_8CO_2CH_3$ | 186.29 | lq. | | –18 | 223–4 | i. | ∞ | ∞ |
| caproate (*n*-) | $CH_3(CH_2)_4CO_2CH_3$ | 130.18 | col. lq. | $0.904^{0/0}$ | | 149.5 | i. | ∞ | ∞ |
| caprylate | $CH_3(CH_2)_6CO_2CH_3$ | 158.23 | col. lq. | $0.887^{18}$ | –40 | 192–4 | i. | ∞ | ∞ |
| cellosolve | $CH_3OCH_2CH_2OH$ | 76.09 | col. lq. | $0.965^{20/4}$ | | 124–5 | ∞ | ∞ | ∞ |
| chloride | $CH_3Cl$ | 50.49 | gas | $0.952^{0}$ | –97.7 | –24 | $280^{16}$ cc. | v. s. | v. s. |
| chloroacetate | $ClCH_2CO_2CH_3$ | 108.53 | col. lq. | $1.236^{20/4}$ | –32.7 | $130^{740}$ | v. sl. s. | ∞ | ∞ |
| chloroformate | $ClCO_2CH_3$ | 94.50 | col. lq. | $1.236^{15}$ | | 71–2 | d. | ∞ | ∞ |
| cinnamate | $C_6H_5CH{:}CHCO_2CH_3$ | 162.18 | cr. | $1.042^{36/0}$ | 33.4 | 263 | i. | v. s. | v. s. |
| cyclohexane | $CH_2 < (CH_2CH_2)_2 > CHCH_3$ | 98.18 | col. lq. | $0.769^{20/4}$ | –126.3 | 101 | i. | s. | s. |
| ethyl carbonate | $CH_3O{\cdot}CO{\cdot}OC_2H_5$ | 104.10 | lq. | $1.002^{27}$ | –14.5 | 109.2 | i. | ∞ | ∞ |
| ethyl ketone | $CH_3.CO{\cdot}C_2H_5$ | 72.10 | col. lq. | $0.805^{20/4}$ | –85.9 | 79.6 | $35^{10}$ | ∞ | ∞ |
| ethyl oxalate | $CH_3OCO{\cdot}CO_2C_2H_5$ | 132.11 | lq. | $1.156^{0/0}$ | | 173.7 | i. | v. s. | v. s. |
| formate | $HCO_2CH_3$ | 60.05 | lq. | $0.974^{20/4}$ | –99.8 | 32 | $30^{20}$ | ∞ | |
| furoate | $C_4H_3O{\cdot}CO_2CH_3$ | 126.11 | col. lq. | $1.179^{21/4}$ | | 181.3 | i. | ∞ | ∞ |
| glucamine | $CH_2OH(CHOH)_4CH_2NHCH_3$ | 195.21 | | | | | | | |
| glycolate | $HOCH_2CO_2CH_3$ | 90.08 | lq. | $1.168^{18}$ | | 151.2 | | | |
| heptoate | $CH_3(CH_2)_5CO_2CH_3$ | 144.21 | lq. | $0.881^{15/4}$ | | 172–3 | i. | | |
| hypochlorite | $ClOCH_3$ | 66.49 | gas | | | $12^{726}$ | | | |
| iodide | $CH_3I$ | 141.95 | col. lq. | $2.279^{20/4}$ | –64.4 | 42.4 | $1.8^{15}$ | ∞ | ∞ |
| lactate | $CH_3CH(OH)CO_2CH_3$ | 104.10 | lq. | $1.090^{19}$ | | 144.8 | ∞ | s. | s. |
| laurate | $CH_3(CH_2)_{10}CO_2CH_3$ | 214.34 | lq. | | 5 | $148^{18}$ | i. | | |
| mercaptan | $CH_3SH$ | 48.10 | gas | $0.896^{0}$ | –121 | $5.8^{752}$ | s. | v. s. | v. s. |
| methacrylate | $CH_2{:}C(CH_3)CO_2CH_3$ | 100.11 | lq. | $0.950^{15.6}$ | –48 | 100.3 | i. | | |
| myristate | $CH_3(CH_2)_{12}CO_2CH_3$ | 242.39 | cr./al. | | 18–9 | $295^{715}$ | i. | | |
| naphthalene (α-) | $C_{10}H_7CH_3$ | 142.19 | oil | $1.025^{14/4}$ | –19 | 244.6 | i. | v. s. | v. s. |
| (β-) | $C_{10}H_7CH_3$ | 142.19 | mn. | $0.994^{40/4}$ | 35–6 | 241–2 | i. | v. s. | v. s. |
| nitrate | $CH_3ONO_2$ | 77.04 | lq. | $1.203^{25}$ | expl. | 65 | sl. s. | s. | s. |
| nitrite | $CH_3ONO$ | 61.04 | gas | $0.991^{15}$ | | –12 | | s. | s. |
| nonyl ketone (*n*-) | $CH_3(CH_2)_8COCH_3$ | 170.29 | col. oil | $0.828^{20/20}$ | 13.5 | 228 | i. | s. | s. |
| oleate | $C_{17}H_{33}CO_2CH_3$ | 296.48 | oil | $0.879^{18}$ | | 190–1[10] | i. | ∞ | ∞ |
| orange | $(CH_3)_2NC_6H_4N_2C_6H_4SO_3Na$ | 327.33 | red pd. | | | | 0.2 c. | | |
| palmitate | $CH_3(CH_2)_{14}CO_2CH_3$ | 270.44 | col. cr. | | 30–1 | $196^{15}$ | i. | s. | s. |
| phosphine | $CH_3PH_2$ | 48.03 | gas | | | $-14^{759}$ | i. | sl. s. | |
| propionate | $CH_3CH_2CO_2CH_3$ | 88.10 | col. lq. | $0.915^{20/4}$ | –87.5 | 79.7 | $0.5^{20}$ | ∞ | ∞ |
| propyl ketone (*n*-) | $CH_3COCH_2CH_2CH_3$ | 86.13 | col. lq. | $0.812^{15/15}$ | –77.8 | 102 | v. sl. s. | ∞ | ∞ |
| salicylate (*o*-) | $HO{\cdot}C_6H_4CO_2CH_3$ | 152.14 | col. lq. | $1.182^{25/25}$ | –8.3 | 222.2 | $0.07^{30}$ | ∞ | ∞ |
| stearate | $CH_3(CH_2)_{16}CO_2CH_3$ | 298.49 | col. cr. | | 38–9 | $215^{15}$ | i. | s. | s. |
| toluate (*o*-) | $CH_3{\cdot}C_6H_4CO_2CH_3$ | 150.17 | col. lq. | $1.073^{15}$ | <–50 | 213 | i. | ∞ | ∞ |
| (*m*-) | $CH_3{\cdot}C_6H_4CO_2CH_3$ | 150.17 | col. lq. | $1.066^{15}$ | | 215 | i. | | |
| (*p*-) | $CH_3{\cdot}C_6H_4CO_2CH_3$ | 150.17 | cr. | | 33–4 | 217 | i. | v. s. | v. s. |
| Methyl toluidine (*o*-) | $CH_3{\cdot}C_6H_4NHCH_3$ | 121.18 | lq. | $0.973^{15}$ | | 206–7 | i. | ∞ | ∞ |
| (*m*-) | $CH_3{\cdot}C_6H_4NHCH_3$ | 121.18 | lq. | | | 206–7 | i. | ∞ | ∞ |
| (*p*-) | $CH_3{\cdot}C_6H_4NHCH_3$ | 121.18 | lq. | $0.935^{55/4}$ | | $211^{761}$ | i. | ∞ | ∞ |
| valerate (*n*-) | $CH_3(CH_2)_3CO_2CH_3$ | 116.16 | lq. | $0.895^{15/4}$ | –91 | 127.3 | v. sl. s. | ∞ | ∞ |
| (*i*-) | $(CH_3)_2CHCH_2CO_2CH_3$ | 116.16 | col. lq. | $0.881^{20/4}$ | | $116.7^{764}$ | v. sl. s. | ∞ | ∞ |
| vinyl ketone | $CH_3COCH{:}CH_2$ | 70.09 | lq. | $0.836^{20/4}$ | | 81 | >85 | | |
| Methylal | $HCH(OCH_3)_2$ | 76.09 | col. lq. | $0.866^{15/4}$ | –104.8 | 42–3 | 33 | ∞ | ∞ |
| Methylene-bis-(phenyl-4-isocyanate) | $(OCN{\cdot}C_6H_4)_2CH_2$ | 250.25 | lq. | $1.222^{30}$ | | 210–2[13] | d. | d. | |
| bromide | $CH_2Br_2$ | 173.86 | col. lq. | $2.495^{20/4}$ | –52.8 | $98.5^{756}$ | $1.17^{0}$ | ∞ | ∞ |
| chloride | $CH_2Cl_2$ | 84.94 | col. lq. | $1.336^{20/4}$ | –96.7 | 40–1 | $2^{20}$ | ∞ | ∞ |
| dianiline | $(C_6H_5NH)_2CH_2$ | 198.26 | cr. | | 65 | 208–9 d. | i. | s. | s. |
| iodide | $CH_2I_2$ | 267.87 | col. lq. | $3.325^{20/4}$ | 5.7 | 180 d. | $1.4^{20}$ | ∞ | ∞ |
| Michler's hydrol (*p*-,*p*′-) | $[(CH_3)_2NC_6H_4]_2CHOH$ | 270.36 | gn. | | 96–7 | | i. | s. h. | s. |
| ketone | $[(CH_3)_2NC_6H_4]_2CO$ | 268.35 | lf./al. | | 174 | >360 d. | i. | sl. s. | v. sl. s. |
| Morphine | $C_{17}H_{19}O_3N{\cdot}H_2O$ | 303.35 | pr./al. | 1.317 | 254 d. | | $0.02^{20}$ | sl. s. | s. |
| Mucic acid | $(\cdot CHOHCHOHCO_2H)_2$ | 210.14 | pd. | | 206–14 | | $0.33^{14}$ | i. | i. |

**TABLE 2-2 Physical Properties of Organic Compounds** (*Continued*)

| Name | Formula | Formula weight | Form and color | Specific gravity | Melting point, °C | Boiling point, °C | Solubility in 100 parts | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Water | Alcohol | Ether |
| Mustard gas | $(ClCH_2{\cdot}CH_2)_2S$ | 159.08 | oil | $1.275^{20/4}$ | 13–4 | 217 | $0.07^{25}$ | s. | s. |
| Myricyl alcohol | $C_{31}H_{63}OH$(?) | 452.82 | cr. | $0.777^{95}$ | 88 | | i. | v. sl. s. | v. s. |
| Myristic acid | $CH_3(CH_2)_{12}CO_2H$ | 228.36 | col. lf. | $0.853^{70/4}$ | 57–8 | $250.5^{100}$ | i. | v. s. | v. s. |
| Myristyl alcohol | $CH_3(CH_2)_{12}CH_2OH$ | 214.38 | cr. | $0.824^{38/4}$ | 38 | $167^{15}$ | <0.02 | sl. s. | s. |
| Naphthalene | $C_{10}H_8$ | 128.16 | pl./al. | $1.145^{20/4}$ | 80.2 | 217.9 | $0.003^{25}$ | $9.5^{20}$ | v. s. |
| disulfonic acid (1-,5-) | $C_{10}H_6(SO_3H)_2$ | 288.28 | lf. | | d. | | $102^{20}$ | s. | i. |
| (1-,6-) | $C_{10}H_6(SO_3H)_2$ | 288.28 | cr. | | d. 125 | | $164^{20}$ | s. | i. |
| sulfonic acid (α-) | $C_{10}H_7SO_3H{\cdot}2H_2O$ | 244.26 | cr. | | 90 | | v. s. | v. s. | sl. s. |
| (β-) | $C_{10}H_7SO_2H{\cdot}H_2O$ | 226.24 | cr. | | 125 | | $77^{30}$ | | |
| Naphthasultam (1-,8-) | $C_{10}H_7O_2NS$ | 205.22 | nd. | | 177–8 | | s. h. | sl. s. | s. |
| disulfonate Na (1-,8-) | $C_{10}H_5O_8NS_2Na_2{\cdot}2H_2O$ | 445.35 | cr. | | | | v. s. | | |
| (2-,4-) | $C_{10}H_4O_8NS_2Na_3{\cdot}8a\ H_2O$ | 584.45 | lf. | | | | v. s. | sl. s. | |
| Naphthoic acid (α-) | $C_{10}H_7CO_2H$ | 172.17 | nd. | | 160–1 | 300 | v. sl. s. h. | s. h. | s. |
| (β-) | $C_{10}H_7CO_2H$ | 172.17 | mn. | $1.077^{100/4}$ | 184 | >300 | $0.007^{25}$ | s. | s. |
| Naphthol (α-) | $C_{10}H_7OH$ | 144.16 | mn. | $1.224^{4}$ | 96 | 278–80 | sl. s. h. | v. s. | v. s. |
| (β-) | $C_{10}H_7OH$ | 144.16 | mn. | $1.217^{4}$ | 122–3 | 285–6 | $0.074^{25}$ | v. s. | v. s. |
| sulfonic acid (α-)(1-,2-) | $HO{\cdot}C_{10}H_6SO_3H$ | 224.22 | pl./aq. | | >250 | | v. s. h. | | i. |
| (β-)(2-,6-) | $HO{\cdot}C_{10}H_6SO_3H$ | 224.22 | lf. | | 125 | | v. s. | v. s. | |
| Naphthyl acetate (α-) | $CH_3CO_2C_{10}H_7$ | 186.20 | nd./al. | | 46–9 | | sl. s. h. | s. | s. |
| (β-) | $CH_3CO_2C_{10}H_7$ | 186.20 | nd./al. | | 69–70 | | i. | s. | s. |
| amine (α-) | $C_{10}H_7NH_2$ | 143.18 | rhb. | $1.123^{25/25}$ | 50 | 300.8 | 0.17 c. | v. s. | v. s. |
| (β-) | $C_{10}H_7NH_2$ | 143.18 | lf./aq. | $1.061^{98/4}$ | 111–2 | 306.1 | v. s. h. | s. | s. |
| amine hydrochloride (α-) | $C_{10}H_7NH_2{\cdot}HCl$ | 179.65 | nd. | | | subl. | $3.8^{20}$ | s. | s. |
| (β-) | $C_{10}H_7NH_2{\cdot}HCl$ | 179.65 | lf. | | | | v. s. | v. s. | |
| amine sulfonic acid (1-,4-) | $NH_2{\cdot}C_{10}H_6{\cdot}SO_3H$ | 223.24 | nd. | | d. | | $0.2^{100}$ | i. | i. |
| (1-,5-) | $NH_2{\cdot}C_{10}H_6{\cdot}SO_3H{\cdot}H_2O$ | 241.26 | cr. | | | | sl. s. | | |
| (1-,7-) | $NH_2{\cdot}C_{10}H_6{\cdot}SO_3H{\cdot}H_2O$ | 241.26 | cr. | | | | $0.46^{25}$ | | |
| (1-,8-) | $NH_2{\cdot}C_{10}H_6{\cdot}SO_3H{\cdot}H_2O$ | 241.26 | cr. | | | | $0.42^{100}$ | | |
| (2-,5-) | $NH_2{\cdot}C_{10}H_6{\cdot}SO_3H$ | 223.24 | cr. | | | | 0.08 | | |
| (2-,6-) | $NH_2{\cdot}C_{10}H_6{\cdot}.SO_3H{\cdot}H_2O$ | 241.26 | cr. | | | | $0.38^{100}$ | | |
| (2-,7-) | $NH_2{\cdot}C_{10}H_6{\cdot}SO_3H{\cdot}H_2O$ | 241.26 | cr. | | | | $0.28^{100}$ | | |
| isocyanate (α-) | $C_{10}H_7N{:}CO$ | 169.17 | col. lq. | 1.18 | | 269–70 | d. | s. | s. |
| Nicotine | $C_{10}H_{14}N_2$ | 162.23 | oil | $1.009^{20/4}$ | <–80 | $246^{730}$ | s. | ∞ | ∞ |
| Nicotinic acid (3-) | $C_5H_4NCO_2H$ | 123.11 | nd./al. | | 235.2 | subl. | s. h. | s. h. | v. sl. s. |
| (*i*-)(4-) | $C_5H_4NCO_2H$ | 123.11 | nd./aq. | | 317 | d. | s. h. | sl. s. h. | v. sl. s. |
| Nitro-acetanilide (*p*-) | $CH_3CONHC_6H_4NO_2$ | 180.16 | rhb. | | 215–6 | | s. h. | s. | s. |
| -acetophenone (*m*-) | $CH_3COC_6H_4NO_2$ | 165.14 | nd. | | 80–1 | 202 | i. | s. | |
| -aminoanisole (4-,1-,2-) | $NO_2{\cdot}C_6H_3(OCH_3)NH_2$ | 168.15 | red nd. | $1.207^{156}$ | 118 | | i. | s. | |
| (5-,1-,2-) | $NO_2{\cdot}C_6H_3(OCH_3)NH_2$ | 168.15 | yel. nd. | $1.211^{156}$ | 139–40 | | | | |
| (3-,1-,4-) | $NO_2{\cdot}C_6H_3(OCH_3)NH_2$ | 168.15 | red | | 123 | | sl. s. | s. | s. |
| -aminophenol (4-,2-,1-) | $NO_2{\cdot}C_6H_3(NH_2)OH$ | 154.12 | or. pr. | | 142–3 | | sl. s. c. | v. s. | v. s. |
| -aniline (*o*-) | $NO_2{\cdot}C_6H_4NH_2$ | 138.12 | yel. rhb. | $1.442^{15}$ | 71.5 | 284.1 | s. h. | v. s. | v. s. |
| (*m*-) | $NO_2{\cdot}C_6H_4NH_2$ | 138.12 | yel. rhb. | 1.43 | 114 | 306.4 | $0.11^{20}$ | $7.1^{20}$ | $7.9^{20}$ |
| (*p*-) | $NO_2{\cdot}C_6H_4NH_2$ | 138.12 | yel. mn. | $1.437^{14}$ | 146–7 | 331.7 | $0.08^{19}$ | $5.8^{20}$ | $6.1^{20}$ |
| -anisole (*o*-) | $CH_3OC_6H_4NO_2$ | 153.13 | col. cr. | $1.254^{20/4}$ | 9.4 | 272–3 | $0.17^{30}$ | ∞ | ∞ |
| (*p*-) | $CH_3OC_6H_4NO_2$ | 153.13 | pr./al. | $1.233^{20}$ | 54 | 274 | $0.06^{30}$ | v. s. | v. s. |
| -anthraquinone (α-) | $C_6H_4{:}(CO)_2{:}C_6H_3NO_2$ | 253.20 | nd. | | 230 | $270^{7}$ | i. | sl. s. | v. sl. s. |
| -anthraquinone sulfonic acid (1-,5-) | $NO_2{\cdot}C_{14}H_6O_2{\cdot}SO_3H$ | 333.26 | yel. cr. | | | | s. | i. | i. |
| -benzal chloride (*m*-) | $NO_2{\cdot}C_6H_4{\cdot}CHCl_2$ | 206.03 | mn. | | 65 | | i. | v. s. h. | v. s. |
| -benzaldehyde (*m*-) | $NO_2{\cdot}C_6H_4CHO$ | 151.12 | nd./aq. | | 58 | $164^{23}$ | $1.95^{112}$ | v. s. h. | v. s. |
| Nitro-benzene | $C_6H_5NO_2$ | 123.11 | yel. lq. | $1.205^{18/4}$ | 5.7 | 210.9 | $0.19^{20}$ | v. s. | ∞ |
| -benzidine (2-) | $NH_2C_6H_4C_6H_3(NH_2)NO_2$ | 229.23 | red nd. | | 143 | | sl. s. h. | | |
| -benzoic acid (*o*-) | $NO_2{\cdot}C_6H_4{\cdot}CO_2H$ | 167.12 | tri./aq. | $1.575^{4/4}$ | 147.5 | | $0.65^{20}$ | $28^{11}$ | $22^{11}$ |
| (*m*-) | $NO_2{\cdot}C_6H_4{\cdot}CO_2H$ | 167.12 | mn. | $1.494^{4/4}$ | 140–1 | | $0.24^{165}$ | $31^{12}$ | $25^{10}$ |
| (*p*-) | $NO_2{\cdot}C_6H_4{\cdot}CO_2H$ | 167.12 | yel. mn. | $1.550^{22/4}$ | 240–2 | subl. | $0.02^{15}$ | $0.9^{10}$ | $2.2^{18}$ |
| -benzyl alcohol (*m*-) | $NO_2{\cdot}C_6H_4{\cdot}CH_2OH$ | 153.13 | cr. | | 27 | $175–80^{3}$ | | | |
| -benzyl bromide (*p*-) | $NO_2{\cdot}C_6H_4CH_2Br$ | 216.04 | nd./al. | | 99–100 | | i. | $2^{19}$ | v. s. |
| -chlorotoluene (1-,2-,6-) | $CH_3{\cdot}C_6H_3(NO_2)Cl$ | 171.58 | cr. | | 37.5 | 238 | i. | | |
| -cresol (1-,3-,4-) | $CH_3{\cdot}C_6H_3(NO_2)OH$ | 153.13 | yel. | $1.240^{89/4}$ | 32 | $125^{22}$ | v. sl. s. | v. s. | v. s. |
| -cymene (1-,2-,4-) | $CH_3{\cdot}C_6H_3(NO_2)CH(CH_3)_2$ | 179.21 | oil | $1.067^{20/4}$ | | $152^{15}$ | i. | | |
| -dimethylaniline (*o*-) | $NO_2{\cdot}C_6N_4NHCH_3$ | 166.18 | yel. oil | $1.179^{20/4}$ | | $151–3^{80}$ | v. sl. s. | v. s. | v. s. |
| (*m*-) | $NO_2{\cdot}C_6H_4NHCH_3$ | 166.18 | red mn. | $1.313^{17}$ | 60–1 | 280–5 | i. | s. | s. |
| (*p*-) | $NO_2{\cdot}C_6H_4NHCH_3$ | 166.18 | yel. nd. | | 163–4 | | i. | s. h. | |
| -diphenyl (*o*-) | $C_6H_5{\cdot}C_6H_4NO_2$ | 199.20 | rhb. | 1.44 | 37 | 320 | i. | s. | v. s. |
| (*p*-) | $C_6H_5{\cdot}C_6H_4NO_2$ | 199.20 | nd./al. | | 113–4 | 340 | i. | sl. s. c. | v. s. |
| -diphenylamine (*o*-) | $C_6H_5{\cdot}NH{\cdot}C_6H_4NO_2$ | 214.22 | or. cr. | | 75–6 | | | | |
| -guanidine | $H_2NC(NH)NHNO_2$ | 104.07 | nd./aq. | | 246–7 | | $9^{100}$ | sl. s. | v. sl. s. |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| -naphthalene (α-) | $C_{10}H_7NO_2$ | 173.16 | yel./al. | $1.223^{62}$ | 59–60 | 304 | i. | s. | s. |
| (β-) | $C_{10}H_7NO_2$ | 173.16 | col./al. | | 79 | $165^{15}$ | i. | v. s. | v. s. |
| -phenol (*o*-) | $NO_2{\cdot}C_6H_4{\cdot}OH$ | 139.11 | yel. mn. | $1.295^{45}$ | 44–5 | 214.5 | $1.08^{100}$ | v. s. | v. s. |
| (*m*-) | $NO_2{\cdot}C_6H_4{\cdot}OH$ | 139.11 | col. mn. | $1.485^{20}$ | 96–7 | $194^{70}$ | $1.35^{20}$ | v. s. | s. |
| (*p*-) | $NO_2{\cdot}C_6H_4{\cdot}OH$ | 139.11 | yel. pr. | $1.479^{20}$ | 113–4 | subl. | $1.6^{25}$ | v. s. | v. s. |
| -phenol sulfonic acid (1-,4-,2-) | $HO{\cdot}C_6H_3(NO_2)SO_3H{\cdot}3H_2O$ | 273.22 | nd. | | d. 110 | | v. s. | v. s. | sl. s. |
| (1-,2-,4-) | $HO{\cdot}C_6H_3(NO_2)SO_3H{\cdot}3H_2O$ | 273.22 | nd./aq. | | 51.5 | | v. s. | v. s. | |
| -phthalic acid (3-) | $NO_2{\cdot}C_6H_3(CO_2H)_2$ | 211.13 | yel./aq. | | 222 | | $2.05^{25}$ | v. s. h. | sl. s. |
| (4-) | $NO_2{\cdot}C_6H_3(CO_2H)_2$ | 211.13 | yel. cr. | | 164–5 | | v. s. | v. s. | s. |
| -toluene (*o*-) | $CH_3{\cdot}C_6H_4NO_2$ | 137.13 | yel. lq. | $1.163^{20/4}$ | –4.1 | 222.3 | $0.07^{80}$ | ∞ | ∞ |
| (*m*-) | $CH_3{\cdot}C_6H_4NO_2$ | 137.13 | lq. | $1.160^{18/4}$ | 15–16 | 230–1 | $0.05^{80}$ | ∞ | ∞ |
| (*p*-) | $CH_3{\cdot}C_6H_4NO_2$ | 137.13 | rhb. | $1.139^{55/55}$ | 51.9 | 237.7 | $0.04^{90}$ | $8.6^{15}$ | $80.8^{15}$ |
| -toluene sulfonic acid (1-,4-,2-) | $CH_3{\cdot}C_6H_3(NO_2)SO_3H{\cdot}2H_2O$ | 253.23 | pl./aq. | | 130 | | $47.7^{28}$ | v. s. | v. s. |
| -toluidine (4-,1-,2-) | $NO_2{\cdot}C_6H_3(CH_3)NH_2$ | 152.15 | yel. mn. | $1.365^{15}$ | 105–7 | | v. sl. s. | s. | s. |
| (3-,1-,4-) | $NO_2{\cdot}C_6H_3(CH_3)NH_2$ | 152.15 | red mn. | $1.312^{17}$ | 116–7 | | sl. s. h. | s. | |
| Nitron | $C_{20}H_{16}N_4$ | 312.36 | yel. lf. | | 189–90 d. | | i. | s. h. | v. sl. s. |
| Nitroso-dimethylaniline (*p*-) | $ON{\cdot}C_6H_4N(CH_3)_2$ | 150.18 | gn. tri. | | 86–7 | | i. | s. | s. |
| -naphthol (β-)(1-) | $ON{\cdot}C_{10}H_6OH$ | 173.16 | brn. pr. | | 109.5 | | $0.1^{20}$ | $2.4^{18}$ | |
| Nonadecane (*n*-) | $CH_3(CH_2)_{17}CH_3$ | 268.51 | cr. | $0.777^{32/4}$ | 32 | 330 | i. | sl. s. | s. |
| Nonane (*n*-) | $CH_3(CH_2)_7CH_3$ | 128.25 | col. lq. | $0.718^{20/4}$ | –53.7 | $150.5^{759}$ | i. | sl. s. | s. |
| Octadecane (*n*-) | $CH_3(CH_2)_{16}CH_3$ | 254.48 | cr. | $0.775^{28/4}$ | 28 | 317 | i. | sl. s. | s. |
| Octane (*n*-) | $CH_3(CH_2)_6CH_3$ | 114.22 | col. lq. | $0.703^{20/4}$ | –56.5 | 125.7 | $0.002^{16}$ | sl. s. | s. |
| (iso-) | $(CH_3)_3CCH_2CH(CH_3)_2$ | 114.22 | col. lq. | $0.692^{20/4}$ | –107.4 | $99.3^{760}$ | i. | sl. s. | s. |
| Octyl acetate (*n*-) | $CH_3CO_2CH_2(CH_2)_6CH_3$ | 172.26 | col. lq. | $0.885^{0/4}$ | –38.5 | 210 | i. | s. | s. |
| (*sec*-) | $CH_3CO_2CH(CH_3)C_6H_{13}$ | 172.26 | col. lq. | $0.863^{14/4}$ | | 195 | i. | s. | s. |
| alcohol (*n*-) | $CH_3(CH_2)_6CH_2OH$ | 130.22 | col. lq. | $0.827^{20/4}$ | –16 | 194–5 | $0.054^{25}$ | ∞ | ∞ |
| (*sec*-) | $CH_3(CH_2)_5CH(OH)CH_3$ | 130.22 | col. lq. | $0.822^{20/4}$ | –38.6 | 179–80 | $0.096^{25}$ | ∞ | ∞ |
| Octylene (*n*-) | $CH_3(CH_2)_5CH{:}CH_2$ | 112.21 | lq. | $0.721^{18/4}$ | | 126 | i. | ∞ | ∞ |
| Oleic acid | $C_8H_{17}CH{:}CH(CH_2)_7CO_2H$ | 282.45 | col. nd. | $0.854^{78/4}$ | 14 | $285–6^{100}$ | i. | ∞ | ∞ |
| Orcinol (1-,3-,5-) | $(HO)_2C_6H_3{\cdot}CH_3$ | 124.13 | pr./bz. | $1.290^{4}$ | 107–8 | 287–90 | v. s. | v. s. | v. s. |
| Oxalic acid | $HO_2C{\cdot}CO_2H{\cdot}2H_2O$ | 126.07 | col. mn. | $1.653^{19/4}$ | 101.5 | subl. | s. | s. | 1.3 |
| Palmitic acid | $CH_3(CH_2)_{14}CO_2H$ | 256.42 | col. pl. | $0.849^{70/4}$ | 63–4 | $271.5^{100}$ | i. | $9^{20}$ | s. |
| Pelargonic acid | $CH_3(CH_2)_7CO_2H$ | 158.23 | col. oil | $0.906^{20/4}$ | 12.5 | 253–4 | v. sl. s. | s. | s. |
| Penta-chloroethane | $CHCl_2{\cdot}CCl_3$ | 202.31 | col. lq. | $1.671^{25/4}$ | –22 | 162 | $0.05^{20}$ | ∞ | ∞ |
| -decane (*n*-) | $CH_3(CH_2)_{13}CH_3$ | 212.41 | col. lq. | $0.770^{20/4}$ | 10 | 270.5 | i. | v. s. | v. s. |
| -erythritol | $C(CH_2OH)_4$ | 136.15 | cr. | | 262 | $276^{30}$ | $5.6^{15}$ | v. sl. s. | i. |
| Pentandiol | $HOCH_2(CH_2)_3CH_2OH$ | 104.15 | lq. | $0.994^{20/4}$ | | 239.4 | ∞ | | |
| Pentane (*n*-) | $CH_3(CH_2)_3CH_3$ | 72.15 | col. lq. | $0.630^{18/4}$ | –129.7 | 36.3 | $0.036^{16}$ | ∞ | ∞ |
| (*i*-) | $(CH_3)_2CHCH_2CH_3$ | 72.15 | col. lq. | $0.621^{19}$ | –160.0 | 27.95 | i. | ∞ | ∞ |
| (neo-) | $(CH_3)_2C(CH_3)_2$ | 72.15 | col. lq. | $0.613^{20/4}$ | –20 | 9.5 | i. | s. | s. |
| Phenacetin | $C_2H_5OC_6H_4NHCOCH_3$ | 179.21 | col. mn. | | 134–5 | d. | $0.7^{20}$ | 40 h. | $1.6^{25}$ |
| Phenanthrene | $<(C_6H_4CH)_2>$ | 178.22 | pl./al. | $1.179^{25}$ | 99–100 | 340 | i. | 10 h. | v. s. |
| Phenetidine (*o*-) | $C_2H_5O{\cdot}C_6H_4{\cdot}NH_2$ | 137.18 | oil | | <–21 | 228–9 | i. | s. | s. |
| (*p*-) | $C_2H_5O{\cdot}C_6H_4{\cdot}NH_2$ | 137.18 | lq. | $1.061^{15}$ | 3–4 | 254–5 | i. | s. | s. |
| Phenetole | $C_2H_5O{\cdot}C_6H_5$ | 122.16 | col. lq. | $0.967^{20/4}$ | –30.2 | 172 | i. | ∞ | ∞ |
| Phenol | $C_6H_5OH$ | 94.11 | col. nd. | $1.071^{25/4}$ | 42–3 | 181.4 | $8.2^{15}$ | ∞ | ∞ |
| -phthalein | $C_{20}H_{14}O_4$ | 318.31 | col. rhb. | $1.299^{25/4}$ | 261–2 | | $0.2^{20}$ | $10^{25}$ | 5.9 c. |
| -sulfonic acid (*o*-) | $HO{\cdot}C_6H_4SO_3H{\cdot}e\ H_2O$ | 187.68 | cr. | | 50 d. | | v. s. | v. s. | |
| Phenyl acetaldehyde | $C_6H_5CH_2CHO$ | 120.14 | lq. | $1.025^{20}$ | | 193–4 | v. sl. s. | ∞ | ∞ |
| acetic acid | $C_6H_5CH_2CO_2H$ | 136.14 | lf. | $1.081^{80/4}$ | 76–7 | 265.5 | $1.66^{20}$ | v. s. | v. s. |
| -acetylene | $C_6H_5C{:}CH$ | 102.13 | col. lq. | $0.930^{20/4}$ | –43 | 142–3 | i. | ∞ | ∞ |
| aniline (*o*-) | $C_6H_5{\cdot}C_6H_4{\cdot}NH_2$ | 169.22 | cr. | | 45–6 | $299^{760}$ | v. sl. s. | s. | s. |
| (*p*-) | $C_6H_5{\cdot}C_6H_4{\cdot}NH_2$ | 169.22 | lf. | | 50–2 | 302 | s. h. | s. | s. |
| Phenyl-ethyl alcohol | $C_6H_5CH_2CH_2OH$ | 122.16 | col. oil | $1.023^{18/4}$ | | $219–21^{750}$ | $1.6^{20}$ | s. | ∞ |
| -glycine | $C_6H_5NHCH_2CO_2H$ | 151.16 | cr. | | 127 | | s. | s. | sl. s. |
| -hydrazine | $C_6H_5NH{\cdot}NH_2$ | 108.14 | yel. oil | $1.097^{23/4}$ | 19.6 | 243.5 | sl. s. h. | ∞ | ∞ |
| -hydrazine sulfonic acid (*p*-) | $H_2NNHC_6H_4SO_3H$ | 188.20 | cr./al. | | 286 | | $0.6^{12}$ | sl. s. | |
| isocyanate | $C_6H_5N{:}CO$ | 119.12 | lq. | $1.096^{20/4}$ | | $166^{769}$ | d. | d. | v. s. |
| -methylpyrazolone (3-)(*N*-) | $C_4H_5ON_2{\cdot}C_6H_5$ | 174.20 | pr./aq. | | 128 | $191^{17}$ | $1^{20}$ | v. s. h. | v. sl. s. |
| -mustard oil | $C_6H_5N{:}CS$ | 135.18 | col. lq. | $1.138^{15/15}$ | –21 | 219–20 | i. | s. | s. |
| naphthalene (α-) | $C_{10}H_7{\cdot}C_6H_5$ | 204.26 | waxy | | 45 | 336–7 | i. | v. s. | v. s. |
| (β-) | $C_{10}H_7{\cdot}C_6H_5$ | 204.26 | lf./al. | | 102.5 | 345–6 | i. | sl. s. | sl. s. |
| naphthylamine (α-) | $C_{10}H_7NHC_6H_5$ | 219.27 | pr./al. | 1.17 | 62 | $335^{258}$ | $0.08^{60}$ | s. | s. |
| (β-) | $C_{10}H_7NHC_6H_5$ | 219.27 | rhb. | 1.18 | 107–8 | 399.5 | $0.4^{60}$ | v. s. h. | v. s. h. |
| phenol (*o*-) | $C_6H_5{\cdot}C_6H_4OH$ | 170.20 | nd. | | 56–7 | 275 | i. | s. | s. |
| (*p*-) | $C_6H_5{\cdot}C_6H_4OH$ | 170.20 | nd. | | 164–5 | 305–8 | i. | s. | s. |
| propyl alcohol (γ-) | $C_6H_5(CH_2)_3OH$ | 136.19 | oil | $1.008^{20/4}$ | <–18 | 235–7 | sl. s. | ∞ | ∞ |
| quinoline (2-)(α-) | $C_6H_5{\cdot}C_9H_6N$ | 205.25 | nd. | | 86 | 363 | sl. s. | s. h. | s. |
| (8-)(0-) | $C_6H_5{\cdot}C_9H_6N$ | 205.25 | lq. | | | $283^{187}$ | sl. s. | s. | s. |
| salicylate, salol | $HO{\cdot}C_6H_4CO_2C_6H_5$ | 214.21 | rhb./al. | $1.250^{20/4}$ | 42–3 | $172–3^{12}$ | $0.015^{25}$ | v. s. | s. |
| stearate | $CH_3(CH_2)_{16}CO_2C_6H_5$ | 360.56 | cr. | | 52 | $267^{15}$ | i. | | |
| urethane | $C_6H_5NHCO_2C_2H_5$ | 165.19 | pl./al. | $1.106^{30/4}$ | 52–3 | 237–8 | i. c. | s. | s. |

**TABLE 2-2 Physical Properties of Organic Compounds** (*Continued*)

| Name | Formula | Formula weight | Form and color | Specific gravity | Melting point, °C | Boiling point, °C | Solubility in 100 parts | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Water | Alcohol | Ether |
| Phenylene-diamine (*o*-) | $C_6H_4(NH_2)_2$ | 108.14 | lf./aq. | | 103–4 | 256–8 | $733^{81}$ | v. s. | v. s. |
| (*m*-) | $C_6H_4(NH_2)_2$ | 108.14 | rhb. | $1.139^{15/15}$ | 62.8 | 284–7 | $35.1^{25}$ | v. s. | s. |
| (*p*-) | $C_6H_4(NH_2)_2$ | 108.14 | mn. | | 140 | 267 | $669^{107}$ | s. | s. |
| Phloroglucinol (1-,3-,5-) | $C_6H_3(OH)_3{\cdot}2H_2O$ | 162.14 | rhb. | | 117 | subl. | $1.13^{25}$ | v. s. | v. s. |
| Phorone | $[(CH_3)_2C{:}CH]_2CO$ | 138.20 | yel. pr. | $0.885^{20/4}$ | 28 | $197.2^{743}$ | $0.1^{50}$ | s. | s. |
| Phosgene | $OCCl_2$ | 98.92 | gas | $1.392^{19/4}$ | –104 | $8.2^{756}$ | v. sl. s. | | |
| Phthalic acid (*o*-) | $C_6H_4(CO_2H)_2$ | 166.13 | mn./aq. | $1.593^{20/4}$ | 208 | d. | $0.70^{25}$ | $12^{18}$ | $0.68^{15}$ |
| (*m*-)(iso-) | $C_6H_4(CO_2H)_2$ | 166.13 | nd./aq. | | 330 | subl. | $0.2^{100}$ | s. | |
| anhydride (*o*-) | $C_6H_4{<}(CO)_2{>}O$ | 148.11 | rhb. | $1.527^{4}$ | 130.8 | 284.5 | v. sl. s. | s. | sl. s. |
| nitrile (*o*-) | $C_6H_4(CN)_2$ | 128.13 | cr. | | 141 | | sl. s. c. | | |
| Phthalide | $C_6H_4(CH_2)(CO){>}O$ | 134.13 | nd./aq. | $1.164^{99/4}$ | 73(65) | 290 | v. sl. s. | s. | |
| Phthalimide (*o*-) | $C_6H_4{<}(CO)_2{>}NH$ | 147.13 | cr./et. | | 238 | subl. | $0.04^{25}$ | 5 | s. h. |
| Picoline (α-) | $C_5H_4N{\cdot}CH_3$ | 93.12 | col. lq. | $0.950^{15/4}$ | –70 | 128.8 | v. s. | ∞ | ∞ |
| (β-) | $C_5H_4N{\cdot}CH_3$ | 93.12 | col. lq. | $0.961^{15/4}$ | | 143.5 | ∞ | ∞ | ∞ |
| (γ-) | $C_5H_4N{\cdot}CH_3$ | 93.12 | lq. | $0.957^{15/4}$ | | 143.1 | ∞ | ∞ | ∞ |
| Picramic acid (1-,2-,4-,6-) | $HO{\cdot}C_6H_2(NH_2)(NO_2)_2$ | 199.12 | red nd. | | 169 | | $0.14^{22}$ | s. | sl. s. |
| Picric acid (2-,4-,6-) | $HO{\cdot}C_6H_2(NO_2)_3$ | 229.11 | yel. rhb. | $1.763^{20/4}$ | 121.8 | expl. | $1.23^{20}$ | $6^{20}$ | $1^{13}$ |
| Picryl chloride (2-,4-,6-) | $ClC_6H_2(NO_2)_3$ | 247.56 | yel. mn. | $1.797^{20}$ | 83 | d. | $0.018^{15}$ | $4.8^{17}$ | $7^{17}$ |
| Pinacol | $[(CH_3)_2C{\cdot}OH]_2$ | 118.17 | col. nd. | $0.967^{15}$ | 43(38) | $171–2^{789}$ | sl. s. c. | v. s. | v. s. |
| Pinacoline | $CH_3COC(CH_3)_3$ | 100.16 | col. lq. | $0.800^{16}$ | –52.5 | 106.2 | $2.5^{15}$ | s. | s. |
| Pinene (α-)(*dl*-) | $C_{10}H_{16}$ | 136.23 | col. lq. | $0.878^{20/4}$ | –55 | 154–6 | v. sl. s. | s. | ∞ |
| hydrochloride | $C_{10}H_{17}Cl$ | 172.69 | lf. | | 131–2 | 207–8 | i. | 33 | s. |
| Pinol (*dl*-) | $C_{10}H_{16}O$ | 152.23 | lq. | $0.953^{20/20}$ | | 183–4 | | s. | s. |
| Piperidine | $CH_2{<}(CH_2CH_2)_2{>}NH$ | 85.15 | lq. | $0.860^{20/4}$ | –9 | 106 | ∞ | ∞ | |
| carboxylic acid (α-)(*dl*-) | $HO_2C{\cdot}CH{<}(CH_2CH_2)_2{>}NH$ | 129.16 | cr. | | 264 | | s. | | |
| Piperidinium pentamethylene dithiocarbamate | $(CH_2)_5CS_2H{\cdot}HN(CH_2)_5$ | 232.41 | cr. | 1.13 | 175 | | $6^{28}$ | | |
| Propane | $CH_3CH_2CH_3$ | 44.09 | gas | $0.585^{-45/4}$ | –187.1 | –42.2 | $6.5^{18}$ cc. | s. | v. s. |
| Propionic acid | $CH_3CH_2CO_2H$ | 74.08 | col. lq. | $0.992^{20/4}$ | –22 | 141.1 | ∞ | ∞ | ∞ |
| aldehyde | $CH_3CH_2CHO$ | 58.08 | col. lq. | $0.807^{20/4}$ | –81 | $49.5^{740}$ | $20^{20}$ | ∞ | ∞ |
| anhydride | $(CH_3CH_2CO)_2O$ | 130.14 | col. lq. | $1.012^{20/4}$ | –45 | $168.8^{780}$ | d. | d. | |
| Propyl acetate (*n*-) | $CH_3CO_2CH_2CH_2CH_3$ | 102.13 | col. lq. | $0.886^{20/4}$ | –92.5 | 101.6 | $1.6^{16}$ | ∞ | ∞ |
| (*i*-) | $CH_3CO_2CH(CH_3)_2$ | 102.13 | col. lq. | $0.874^{20/20}$ | –73.4 | 88.4 | $3^{20}$ | ∞ | ∞ |
| alcohol (*n*-) | $CH_3CH_2CH_2OH$ | 60.09 | col. lq. | $0.804^{20/4}$ | –127 | 97.8 | ∞ | ∞ | ∞ |
| (*i*-) | $(CH_3)_2CHOH$ | 60.09 | col. lq. | $0.789^{20/4}$ | –85.8 | 82.5 | ∞ | ∞ | ∞ |
| amine (*n*-) | $CH_3CH_2CH_2NH_2$ | 59.11 | col. lq. | $0.718^{20/20}$ | –83 | $49–50^{761}$ | ∞ | ∞ | ∞ |
| (*i*-) | $(CH_3)_2CHNH_2$ | 59.11 | col. lq. | $0.694^{15/4}$ | –101 | 33–4 | ∞ | ∞ | ∞ |
| aniline (*n*-) | $C_6H_5NHCH_2CH_2CH_3$ | 135.20 | lq. | $0.949^{18}$ | | 222 | i. | v. s. | v. s. |
| benzoate (*n*-) | $C_6H_5CO_2CH_2CH_2CH_3$ | 164.20 | col. lq. | $1.021^{25/25}$ | –51.6 | 231 | i. | s. | s. |
| (*i*-) | $C_6H_5CO_2CH(CH_3)_2$ | 164.20 | col. lq. | $1.010^{25/25}$ | | 218.5 | i. | s. | s. |
| bromide (*n*-) | $CH_3CH_2CH_2Br$ | 123.00 | col. lq. | $1.353^{20/4}$ | –109.9 | 70.8 | $0.25^{20}$ | ∞ | ∞ |
| (*i*-) | $(CH_3)_2CHBr$ | 123.00 | col. lq. | $1.310^{20/4}$ | –89 | 60 | $0.32^{20}$ | ∞ | ∞ |
| *n*-butyrate (*n*-) | $C_3H_5CH_2CO_2CH_2C_2H_5$ | 130.18 | col. lq. | $0.879^{15}$ | –95.2 | 142.7 | $0.17^{17}$ | ∞ | ∞ |
| *i*-butyrate (*n*-) | $(CH_3)_2CHCO_2CH_2C_2H_5$ | 130.18 | col. lq. | $0.884^{0/4}$ | | 134–5 | v. sl. s. | | |
| *n*-butyrate (*i*-) | $C_3H_5CH_2CO_2CH(CH_3)_2$ | 130.18 | col. lq. | $0.865^{18}$ | | 128 | v. sl. s. | | |
| *i*-butyrate (*i*-) | $(CH_3)_2CHCO_2CH(CH_3)_2$ | 130.18 | col. lq. | $0.869^{0/4}$ | | 120.8 | v. sl. s. | | |
| chloride (*n*-) | $CH_3CH_2CH_2Cl$ | 78.54 | col. lq. | $0.890^{20/4}$ | –122.8 | 46.4 | $0.27^{20}$ | ∞ | ∞ |
| (*i*-) | $(CH_3)_2CHCl$ | 78.54 | col. lq. | $0.859^{20}$ | –117 | 36.5 | $0.31^{20}$ | ∞ | ∞ |
| Propyl formate (*n*-) | $HCO_2CH_2CH_2CH_3$ | 88.10 | col. lq. | $0.901^{20/4}$ | –92.9 | 81.3 | $12.2^{22}$ | ∞ | ∞ |
| (*i*-) | $HCO_2CH(CH_3)_2$ | 88.10 | col. lq. | $0.873^{20/4}$ | | $68–71^{751}$ | $2.1^{22}$ | ∞ | ∞ |
| furoate (*n*-) | $C_4H_3O{\cdot}CO_2C_3H_7$ | 154.16 | col. lq. | $1.075^{26/4}$ | | 211 | v. sl. s. | s. | ∞ |
| lactate (*n*-) | $CH_3CH(OH)CO_2CH_2C_2H_5$ | 132.16 | col. lq. | | | $122–3^{150}$ | s. | s. | s. |
| (*i*-) | $CH_3CH(OH)CO_2CH(CH_3)_2$ | 132.16 | col. lq. | | | 167.5 | s. | s. | s. |
| mercaptan (*n*-) | $CH_3CH_2CH_2SH$ | 76.15 | lq. | $0.836^{25/4}$ | –112 | 67–8 | v. sl. s. | s. | s. |
| (*i*-) | $(CH_3)_2CHSH$ | 76.15 | lq. | $0.809^{25/4}$ | –130.7 | 58-60 | v. sl. s. | ∞ | ∞ |
| propionate (*n*-) | $C_2H_5CO_2CH_2C_2H_5$ | 116.16 | col. lq. | $0.883^{20/4}$ | –76 | 122-3 | $0.56^{25}$ | ∞ | ∞ |
| (*i*-) | $C_2H_5CO_2CH(CH_3)_2$ | 116.16 | col. lq. | $0.893^{0}$ | | $109–11^{750}$ | $0.6^{25}$ | ∞ | ∞ |
| thiocyanate (*i*-) | $(CH_3)_2CH{\cdot}CNS$ | 101.16 | lq. | $0.963^{20}$ | | $152–3^{754}$ | i. | ∞ | ∞ |
| n-valerate (*n*-) | $CH_3(CH_2)_3CO_2CH_2C_2H_5$ | 144.21 | lq. | $0.874^{15}$ | –70.7 | 67.5 | i. | ∞ | ∞ |
| i-valerate (*n*-) | $(CH_3)_2CHCH_2CO_2C_3H_7$ | 144.21 | col. lq. | $0.863^{20/4}$ | | 155.9 | i. | ∞ | ∞ |
| i-valerate (*i*-) | $(CH_3)_2CHCH_2CO_2C_3H_7$ | 144.21 | col. lq. | $0.854^{17}$ | | $142^{756}$ | | | |
| Propylene | $CH_3CH{:}CH_2$ | 42.08 | gas | $0.609^{-47/4}$ | –185 | $-48^{749}$ | 44.6 cc. | 1200 cc. | |
| bromide | $CH_3CHBrCH_2Br$ | 201.91 | col. lq. | $1.933^{20/4}$ | –55.5 | 141.6 | $0.25^{20}$ | s. | v. s. |
| chlorohydrin | $CH_3CHClCH_2OH$ | 94.54 | col. lq. | $1.103^{20}$ | | 133-4 | s. | s. | s. |
| chloride | $CH_3CHClCH_2Cl$ | 112.99 | col. lq. | $1.159^{20/20}$ | <–70 | 96.8 | $0.27^{20}$ | v. s. | v. s. |
| glycol | $CH_3CH(OH)CH_2OH$ | 6.09 | col. oil | $1.040^{19.4}$ | | 188-9 | ∞ | ∞ | 8 |
| oxide | $CH_3(CHCH_2)O$ | 58.08 | col. lq. | $0.831^{20/20}$ | | 35 | $33^{20}$ | ∞ | ∞ |
| Protocatechuic acid (3-,4-) | $(HO)_2C_6H_3CO_2H{\cdot}H_2O$ | 172.13 | nd./aq. | $1.542^{4/4}$ | 199 d. | | $1.82^{14}$ | v. s. | s. |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Pulegol (iso-)(*d*-) | $C_{10}H_{17}OH$ | 154.24 | col. lq. | $0.911^{20/4}$ | | $86\text{-}9^{10}$ | v. sl. s. | | |
| Pulegone | $C_{10}H_{16}O$ | 152.23 | col. lq. | $0.932^{20/20}$ | | $224^{754}$ | i. | ∞ | ∞ |
| Pyrazole | ——NH·N:CH·CH:CH—— | 68.08 | nd./et. | | 70 | 186-8 | s. | s. | s. |
| Pyrazoline | ——NH·N:CH·$CH_2CH_2$—— | 70.09 | lq. | | | 144 | ∞ | ∞ | sl. s. |
| Pyrazolone | ——NH·CO·$CH_2$CH:N—— | 84.08 | nd. | | 165 | subl. d. | s. | v. s. | v. sl. s. |
| Pyrene | $C_{16}H_{10}$ | 202.24 | yel. pr. | $1.277^{0/4}$ | 149-50 | >360 | i. | 3 h. | v. s. |
| Pyridazine | $N_2$ < $(CHCH)_2$ > | 80.09 | lq. | $1.107^{20/4}$ | –8 | 208 | ∞ | s. | s. |
| Pyridine | CH < $(CHCH)_2$ > N | 79.10 | col. lq. | $0.982^{20/4}$ | –42 | 115-6 | ∞ | ∞ | s. |
| Pyrocatechol (*o*-) | $C_6H_4(OH)_2$ | 110.11 | nd./aq. | $1.344^{4}$ | 104-5 | 240-5 | $45.1^{20}$ | v. s. | v. s. |
| Pyrogallol (1-,2-,3-) | $C_6H_3(OH)_3$ | 126.11 | nd. | $1.453^{4}$ | 133-4 | 309 | $40^{13}$ | s. | s. |
| Pyrone | CO < $(CHCH)_2$ > O | 96.08 | cr. | $1.190^{40.3}$ | 32.5 | 215-7 | v. sl. s. | s. | v. s. |
| Pyrrole | < $(CH:CH)_2$ > NH | 67.09 | lq. | $0.948^{20/4}$ | | 131 | i. | s. | s. |
| Pyrrolidine | < $(CH_2{\cdot}CH_2)_2$ > NH | 71.12 | lq. | $0.852^{22.5}$ | | 87-8 | ∞ | ∞ | ∞ |
| Pyrroline | < $(CH{\cdot}CH_2)_2$ > NH | 69.10 | lq. | $0.910^{20/4}$ | | 90-1 | v. s. | ∞ | ∞ |
| Pyruvic acid | $CH_3COCO_2H$ | 88.06 | col. lq. | $1.267^{20/4}$ | 13.6 | 165 | ∞ | ∞ | ∞ |
| Quercitrin | $C_{21}H_{20}O_{11}{\cdot}2H_2O$ | 484.40 | yel. nd. | | 182-5 | | $0.04^{20}$ | s. | sl. s. |
| Quinaldine (p*y*-2) | $CH_3{\cdot}C_9H_6N$ | 143.18 | lq. | $1.059^{20/4}$ | –1 | $244\text{-}5^{750}$ | v. sl. s. | | s. |
| Quinoline | $C_9H_7N$ | 129.15 | lq. | $1.095^{20}$ | –15 | $237.1^{747}$ | 6 | ∞ | ∞ |
| (iso-) | $C_9H_7N$ | 129.15 | pl. | $1.099^{21/4}$ | 24.6 | $240.5^{763}$ | sl. s. | | s. |
| -diol (1-,3-) | ——$C_6H_4CH$:C(OH)N:C(OH)—— | 161.15 | cr. | | 237 | | v. sl. s. | | |
| Quinone (*p*-) | CO < $(CHCH)_2$ > CO | 108.09 | yel. mn. | $1.318^{20/4}$ | 115.7 | subl. | sl. s. h. | s. | s. |
| R-acid Ca salt (2-)(3-,6-) | $HOC_{10}H_5(SO_3)_2Ca$ | 342.35 | cr. | | | | $30.6^{25}$ | | |
| K salt | $HOC_{10}H_5(SO_3K)_2$ | 380.46 | cr. | | | | $29.5^{25}$ | | |
| Na salt | $HOC_{10}H_5(SO_3Na)_2$ | 348.26 | cr. | | | | $25.2^{25}$ | | |
| Raffinose | $C_{18}H_{32}O_{16}{\cdot}5H_2O$ | 594.52 | cr./aq. | $1.465^{0}$ | 119 | d. 130 | $14.3^{20}$ | $0.1^{20}$ | |
| Resorcinol (*m*-) | $C_6H_4(OH)_2$ | 110.11 | col. rhb. | $1.272^{15}$ | 110.7 | 276.5 | $147^{12}$ | v. s. | v. s. |
| Retene | $C_{18}H_{18}$ | 234.32 | lf./al. | $1.13^{16}$ | 98-9 | 390-4 | i. | 69 h. | v. s. h. |
| Rhamnose (β-) | $CH_3(CHOH)_4CHO{\cdot}H_2O$ | 182.17 | col. mn. | $1.471^{20/4}$ | 126 | | $60.8^{21}$ | | i. |
| Ricinoleic acid | $C_{17}H_{32}(OH)CO_2H$ | 298.45 | lq. | $0.954^{16}$ | 4-5 | $226\text{-}8^{10}$ | i. | ∞ | ∞ |
| Rosaniline | $C_{20}H_{21}ON_3$ | 319.39 | col. nd. | | 186 d. | | v. sl. s. | sl. s. | i. |
| Rosolic acid | $C_{20}H_{16}O_3$ | 304.33 | red lf. | | 308-10 d. | | $0.12^{25}$ | v. s. h. | sl. s. |
| Saccharin | $C_6H_4(CO)(SO_2)$ > NH | 183.18 | mn. | | 225-8 | subl. | $0.4^{25}$ | 3.1 c. | 1.05 c. |
| Safrole (1-,3-,4-) | $CH_2$:CHC$H_2{\cdot}C_6H_3{:}O_2CH_2$ | 162.18 | col. mn. | $1.100^{20/4}$ | 11.2 | 233-4 | i. | s. | ∞ |
| (iso-)(1-,3-,4-) | $CH_3{\cdot}$CH:CH$\cdot C_6H_3{:}O_2CH_2$ | 162.18 | col. lq. | $1.122^{20/4}$ | 6-7 | 252-3 | i. | ∞ | ∞ |
| Salicylic acid (*o*-) | HO$\cdot C_6H_4{\cdot}CO_2H$ | 138.12 | mn. | $1.443^{20/4}$ | 159 | $211^{20}$ | $0.2^{23}$ | $49^{15}$ | $51^{15}$ |
| aldehyde (*o*-) | HO$\cdot C_6H_4{\cdot}$CHO | 122.12 | col. oil | $1.153^{25/4}$ | -7 | 196.5 | $1.7^{86}$ | ∞ | ∞ |
| Saligenin | HO$\cdot C_6H_4{\cdot}CH_2$OH | 124.13 | rhb./aq. | $1.161^{25}$ | 86-7 | subl. | $6.6^{15}$ | v. s. | v. s. |
| Schaeffer's salt, Ca | $(HOC_{10}H_6SO_3)_2Ca{\cdot}5H_2O$ | 576.59 | cr. | | | | $4.76^{20}$ | | |
| K | $HOC_{10}H_6SO_3K$ | 262.31 | cr. | | | | $3.46^{25}$ | | |
| Na | $HOC_{10}H_6SO_3Na$ | 246.21 | cr. | | | | $6.29^{25}$ | | |
| Semicarbazide | $NH_2{\cdot}CO{\cdot}NH{\cdot}NH_2$ | 75.07 | pr./al. | | 96 | | v. s. | v. s. | i. |
| hydrochloride | $NH_2{\cdot}CO{\cdot}NH{\cdot}NH_3Cl$ | 111.54 | pr. | | 173 d. | | v. s. | sl. s. | i. |
| Skatole (3-) | $CH_3{\cdot}C_8H_6N$ | 131.17 | lf. | | 95 | $265\text{-}6^{755}$ | 0.05 c. | s. | s. |
| Sodium methylate | $CH_3ONa$ | 54.03 | pd. | | d. 300 | | d. | | |
| Sorbitol | $[CH_2OH(CHOH)_2]_2$ | 182.17 | cr. | | 110-2 | | v. s. | v. s. h. | |
| Sorbose (*d*- or *l*-) | $C_6H_{12}O_6$ | 180.16 | rhb. | $1.654^{15}$ | 165 | | $55^{17}$ | sl. s. | |
| Starch | $(C_6H_{10}O_5)x$ | 162.14 | amor. | $1.50^{21}$ | d. | | i. | i. | i. |
| Stearic acid | $CH_3(CH_2)_{16}CO_2H$ | 284.47 | mn. | $0.847^{69.3}$ | 70-1 | $291^{110}$ | $0.03^{25}$ | $2^{20}$ | $6^{g}$ |
| amide | $CH_3(CH_2)_{16}CONH_2$ | 283.48 | col. cr. | | 108-9 | $251^{12}$ | i. | s. h. | s. h: |
| Styrene | $C_6H_5CH{:}CH_2$ | 104.14 | col. lq. | $0.903^{20/4}$ | –31 | 145-6 | v. sl. s. | ∞ | ∞ |
| Suberic acid | $HO_2C(CH_2)_6CO_2H$ | 174.19 | nd./aq. | $1.266^{25/4}$ | 140-4 | $279^{100}$ | $0.14^{16}$ | s. | $0.8^{15}$ |
| Succinic acid | $HO_2C(CH_2)_2CO_2H$ | 118.09 | col. mn. | $1.572^{25/4}$ | 189-90 | 235 d. | $6.8^{20}$ | $9.9^{15}$ | $1.2^{15}$ |
| Sucrose | $C_{12}H_{22}O_{11}$ | 342.30 | col. mn. | $1.588^{15}$ | 170-86 d. | | $179^{0}$ | 0.9 | i. |
| Sulfanilic acid (*p*-) | $H_2N{\cdot}C_6H_4{\cdot}SO_3H$ | 173.18 | col. cr. | | d. > 280 | | $0.8^{10}$ | v. sl. s. | v. sl. s. |
| Sylvestrene (*d*-) | $C_{10}H_{16}$ | 136.23 | lq. | $0.863^{20/4}$ | | 176-7 | | | |
| Tartaric acid (meso-) | $(CHOHCO_2H)_2$ | 150.09 | cr. | 1.737 | 159-60 | | $120^{15}$ | | |
| (racemic) | $(CHOHCO_2H)_2{\cdot}H_2O$ | 168.10 | tri. | $1.697^{20/4}$ | 205-6 | | $20.6^{20}$ | $2^{0}$ | 0.09 |
| (*d*- or *l*-) | $(CHOHCO_2H)_2$ | 150.09 | mn. | $1.760^{20/4}$ | 168-70 | d. | $139^{20}$ | $25^{15}$ | $0.4^{15}$ |
| Tartronic acid | $CH(OH)(CO_2H)_2{\cdot}$a $H_2O$ | 129.07 | pr./aq. | | d. 155-8 | subl. | v. s. | v. s. | i. |
| Terephthalic acid (*p*-) | $C_6H_4(CO_2H)_2$ | 166.13 | cr. | 1.510 | subl. | | 0.001 c. | sl. s. h. | i. |
| Terpin hydrate (*cis*-) | $C_{10}H_{20}O_2{\cdot}H_2O$ | 190.28 | rhb. | | 117 | d. | $0.4^{15}$ | $10^{15}$ | $1^{15}$ |
| Terpineol (α-)(*d*- or *l*-) | $C_{10}H_{18}O$ | 154.24 | col. cr. | $0.935^{15}$ | 38-40 | 219-21 | i. | v. s. | v. s. |
| (*dl*-) | $C_{10}H_{18}O$ | 154.24 | col. cr. | $0.935^{20/20}$ | 35 | $218\text{-}9^{752}$ | i. | v. s. | v. s. |
| Terpinyl acetate (α-)(*dl*-) | $CH_3CO_2{\cdot}C_{10}H_{17}$ | 196.28 | lq. | $0.966^{20/4}$ | < –50 | 220 d. | i. | 20 | |
| Tetrabromo-ethane (sym) | $Br_2CH{\cdot}CHBr_2$ | 345.70 | col. lq. | $2.964^{20/4}$ | –1.0 | $151^{54}$ | i. | ∞ | ∞ |
| (uns) | $Br_3C{\cdot}CH_2Br$ | 345.70 | col. lq. | $2.875^{20/4}$ | 0 | $104^{13}$ | | s. | |
| Tetrachloro-ethane (sym) | $Cl_2CH{\cdot}CHCl_2$ | 167.86 | col. lq. | $1.600^{20/4}$ | –36 | 146.3 | $0.29^{20}$ | ∞ | ∞ |
| (uns) | $Cl_3C{\cdot}CH_2Cl$ | 167.86 | lq. | $1.588^{20/4}$ | | 129-30 | i. | ∞ | ∞ |
| -ethylene | $Cl_2C{:}CCl_2$ | 165.85 | col. lq. | $1.624^{15/4}$ | –19 | 120.8 | $0.02^{20}$ | ∞ | ∞ |
| Tetracosane (*n*-) | $CH_3(CH_2)_{22}CH_3$ | 338.64 | cr. | $0.779^{51/4}$ | 51.1 | 324 | | | s. |
| Tetradecane (*n*-) | $CH_3(CH_2)_{12}CH_3$ | 198.38 | col. lq. | $0.765^{20/4}$ | 5.5 | 252.5 | i. | v. s. | v. s. |
| Tetraethyl-thiuram disulfide | $[(C_2H_5)_2NCS]_2S_2$ | 296.52 | cr. | 1.17 | 70 | | i. | | |

**TABLE 2-2 Physical Properties of Organic Compounds** (*Concluded*)

| Name | Formula | Formula weight | Form and color | Specific gravity | Melting point, °C | Boiling point, °C | Solubility in 100 parts | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Water | Alcohol | Ether |
| Tetrafluoro-ethylene | $F_2C{:}CF_2$ | 100.02 | gas | $1.58^{-78}$ | −142.5 | −76.3 | $0.01^{30}$ | | |
| Tetrahydro-furan | $—CH_2(CH_2)_2CH_2{\cdot}O—$ | 72.10 | col. lq. | $0.888^{21/4}$ | −65 | 65-6 | s. | s. | s. |
| -furfuryl alcohol | $C_4H_7O{\cdot}CH_2OH$ | 102.13 | col. lq. | $1.050^{20/4}$ | | 177-$8^{743}$ | ∞ | ∞ | ∞ |
| -pyran | $—CH_2(CH_2)_3CH_2{\cdot}O—$ | 86.13 | lq. | $0.881^{20/4}$ | | 88 | s. | | |
| Tetralin | $—C_6H_4CH_2(CH_2)_2CH_2—$ | 132.20 | col. lq. | $0.973^{18/4}$ | −31 | $206^{764}$ | i. | s. | s. |
| Tetramethyl-thiuram disulfide | $[(CH_3)_2NCS]_2S_2$ | 240.41 | cr. | 1.29 | 155-6 | | i. | | |
| Tetryl (2-,4-,6-) | $(NO_2)_3C_6H_2{\cdot}N(CH_3)NO_2$ | 287.15 | yel. mn. | $1.57^{19}$ | 130.5 | expl. | i. | s. h. | s. |
| Theobromine | $C_7H_8O_2N_4$ | 180.17 | rhb. | | 330 | | $0.06^{15}$ | 0.06 c. | 0.03 h. |
| Thio-acetic acid | $CH_3{\cdot}CO{\cdot}SH$ | 76.11 | yel. lq. | $1.074^{10}$ | < −17 | 93 | s. | ∞ | ∞ |
| -aniline (4-, 4′-) | $(NH_2{\cdot}C_6H_4)_2S$ | 216.29 | nd./aq. | | 108 | | sl. s. h. | s. | s. |
| -carbanilide | $(C_6H_5{\cdot}NH)_2CS$ | 228.30 | rhb./al. | $1.3^{24}$ | 154 | d. | i. | v. s. | v. s. |
| -naphthol (β-) | $C_{10}H_7{\cdot}SH$ | 160.22 | cr./al. | | 81 | 286-8 | v. sl. s. | v. s. | v. s. |
| -phenol | $C_6H_5{\cdot}SH$ | 110.17 | col. lq. | $1.074^{23/4}$ | | 168-9 | v. sl. s. | v. s. | ∞ |
| -salicylic acid (*o*-) | $HS{\cdot}C_6H_4{\cdot}CO_2H$ | 154.18 | yel. nd. | | 164 | subl. | sl. s. h. | s. | |
| -urea | $NH_2{\cdot}CS{\cdot}NH_2$ | 76.12 | rhb./al. | $1.405^{20/4}$ | 180-2 | d. | $9.2^{13}$ | s. | sl. s. |
| Thiophene | $<(CH{:}CH)_2>S$ | 84.13 | col. lq. | $1.070^{15/4}$ | −30 | 84 | i. | s. | |
| Thymol (5-,2-,1-) | $(CH_3)(C_3H_7)C_6H_3OH$ | 150.21 | cr. | $0.972^{25/25}$ | 51.5 | $232^{752}$ | $0.09^{19}$ | v. s. | v. s. |
| Tolidine (0-)(3-,3′-,4-,4′-) | $[CH_3(NH_2)C_6H_3]_2$ | 212.28 | lf. | | 128-9 | | v. sl. s. | s. | s. |
| Toluene | $C_6H_5{\cdot}CH_3$ | 92.13 | col. lq. | $0.866^{20/4}$ | −95 | 110.8 | $0.05^{16}$ | s. | ∞ |
| sulfonic acid (*o*-) | $CH_3{\cdot}C_6H_4SO_3H{\cdot}2H_2O$ | 208.23 | cr. | | d. | $128.8^{0}$ | v. s. | s. | |
| (*p*-) | $CH_3{\cdot}C_6H_4SO_3H{\cdot}H_2O$ | 190.21 | mn. | | 104-5 | 146-$7^{0}$ | v. s. | s. | |
| sulfonic amide (*p*-) | $CH_3{\cdot}C_6H_4SO_2NH_2$ | 171.21 | mn. | | 137 | | $0.2^{9}$ | $7.4^{5}$ | |
| sulfonic chloride (*p*-) | $CH_3{\cdot}C_6H_4{\cdot}SO_2Cl$ | 190.64 | tri. | | 69 | $134.5^{10}$ | i. | s. | s. |
| Toluic acid (*o*-) | $CH_3{\cdot}C_6H_4{\cdot}CO_2H$ | 136.14 | cr./aq. | $1.062^{115/4}$ | 104-5 | $259^{751}$ | $2.17^{100}$ | v. s. | |
| (*m*-) | $CH_3{\cdot}C_6H_4{\cdot}CO_2H$ | 136.14 | pr./aq. | $1.054^{112/4}$ | 110-1 | 263 | $1.6^{100}$ | v. s. | v. s. |
| (*p*-) | $CH_3{\cdot}C_6H_4{\cdot}CO_2H$ | 136.14 | cr./aq. | | 179-80 | 274-5 | $1.3^{100}$ | v. s. | v. s. |
| Toluidine (*o*-) | $CH_3{\cdot}C_6H_4{\cdot}NH_2$ | 107.15 | col. lq. | $0.999^{20/4}$ | −16.3 | 199.7 | $1.5^{25}$ | ∞ | ∞ |
| (*m*-) | $CH_3{\cdot}C_6H_4{\cdot}NH_2$ | 107.15 | col. lq. | $0.989^{20/4}$ | −31.5 | 203.3 | sl. s. | ∞ | ∞ |
| (*p*-) | $CH_3{\cdot}C_6H_4{\cdot}NH_2$ | 107.15 | cr. | $1.046^{20/4}$ | 44-5 | 200.3 | $0.74^{21}$ | v. s. | v. s. |
| hydrochloride (*o*-) | $CH_3{\cdot}C_6H_4{\cdot}NH_2Cl$ | 143.62 | mn. pr. | | 218-20 | 242 | s. | sl. s. | |
| sulfonic acid (1-,2-,3-) | $CH_3(NH_2)C_6H_3SO_3H$ | 187.21 | cr. | | | | $0.97^{11}$ | | |
| Toluylenediamine (1-,2-,4-) | $CH_3{\cdot}C_6H_3(NH_2)_2$ | 122.17 | rhb. | | 99 | 283-5 | s. h. | s. | s. |
| Tolylene diisocyanate (1-,2-,4-) | $CH_3{\cdot}C_6H_3(NCO)_2$ | 174.15 | lq. | $1.23^{28}$ | | $134.5^{20}$ | d. | d. | |
| Trehalose | $C_{12}H_{22}O_{11}{\cdot}2H_2O$ | 378.33 | rhb./al. | | 97 | | s. h. | sl. s. h. | i. |
| Triamylamine (*n*-) | $[CH_3(CH_2)_3CH_2]_3N$ | 227.42 | lq. | | | 240-5 | i. | | |
| (*i*-) | $[(CH_3)_2CH(CH_2)_2]_3N$ | 227.42 | col. lq. | $0.786^{20/4}$ | | 235 | i. | | |
| Tributyl-amine (*n*-) | $[CH_3(CH_2)_2CH_2]_3N$ | 185.34 | col. lq. | $0.778^{20/20}$ | | $216.5^{761}$ | i. | s. | ∞ |
| phosphite | $[CH_3(CH_2)_3O]_3P$ | 250.32 | lq. | $0.925^{20/4}$ | | $122\text{-}3^{12}$ | i. | | |
| Trichloro-acetic acid | $Cl_3C{\cdot}CO_2H$ | 163.40 | cr. | $1.617^{46/15}$ | 58 | $195.5^{754}$ | $120^{25}$ | s. | s. |
| -benzene (*s*-)(1-,3-,5-) | $C_6H_3Cl_3$ | 181.46 | nd. | | 63.5 | $208.5^{764}$ | i. | sl. s. | |
| -ethane (1-,1-,1-) | $Cl_3C{\cdot}CH_3$ | 133.42 | lq. | $1.325^{26/4}$ | | 74.1 | i. | ∞ | ∞ |
| -ethylene | $Cl_2C{:}CHCl$ | 131.40 | col. lq. | $1.466^{20/20}$ | −73 | 87.2 | $0.1^{25}$ | ∞ | ∞ |
| -phenol | $Cl_3C_6H_2OH$ | 197.46 | nd. | $1.490^{75/4}$ | 68-9 | 246 | $0.09^{25}$ | v. s. | v. s. |
| Tricosane (*n*-) | $CH_3(CH_2)_{21}CH_3$ | 324.61 | lf. | $0.779^{48/4}$ | 47.7 | $234^{15}$ | i. | | |
| Tricresyl phosphate (*o*-) | $OP(OC_6H_4CH_3)_3$ | 368.36 | lq. | | | | i. | | |
| Tridecane (*n*-) | $CH_3(CH_2)_{11}CH_3$ | 184.35 | col. lq. | $0.757^{20/4}$ | −6.2 | 234 | i. | v. s. | v. s. |
| Triethanol amine | $(HOCH_2CH_2)_3N$ | 149.19 | col. lq. | $1.126^{20/20}$ | 20-1 | $277\text{-}9^{150}$ | ∞ | ∞ | sl. s. |
| Triethyl-amine | $(CH_3CH_2)_3N$ | 101.19 | col. oil | $0.729^{20/20}$ | −114.8 | 89.4 | $\infty > 19^{0}$ | ∞ | ∞ |
| -benzene (1-,3-,5-) | $(C_2H_5)_3C_6H_3$ | 162.26 | lq. | $0.861^{20/4}$ | | 215 | i. | s. | s. |
| (1-,2-,4-) | $(C_2H_5)_3C_6H_3$ | 162.26 | lq. | $0.882^{17/4}$ | | $217\text{-}8^{755}$ | i. | s. | s. |
| borate | $B(OCH_2CH_3)_3$ | 146.00 | lq. | $0.864^{20/20}$ | | 120 | d. | | |
| citrate | $HOC_3H_4(CO_2C_2H_5)_3$ | 276.28 | oil | $1.137^{20/4}$ | | 294 | i. | ∞ | ∞ |
| Triethylene glycol | $(\cdot CH_2OCH_2CH_2OH)_2$ | 150.17 | col. lq. | $1.125^{20/20}$ | −5 | 290 | ∞ | ∞ | v. sl. s. |
| Trifluoro-chloromethane | $CF_3Cl$ | 104.47 | gas | $1.726^{-130}$ | −182 | −80 | | | |
| chloroethylene | $F_2C{:}CFCl$ | 116.48 | gas | | −157.5 | −27.9 | d. | | |
| -trichloroethane | $Cl_2CF{\cdot}CClF_2$ | 187.39 | lq. | $1.576^{20/4}$ | −35 | 47.6 | i. | ∞ | ∞ |
| Trimethoxybutane (1-,3-,3-) | $CH_2(OCH_3)CH_2C(OCH_3)_2CH_3$ | 148.20 | lq. | 0.932 | | $63\text{-}5^{25}$ | d. | | |
| Trimethylamine | $(CH_3)_3N$ | 59.11 | gas | $0.662^{-5}$ | −124 | 3.5 | $41^{19}$ | s. | s. |
| Trimethylene bromide | $BrCH_2CH_2CH_2Br$ | 201.91 | lq. | $1.987^{15/4}$ | −34.4 | 167.5 | $0.17^{30}$ | s. | s. |
| chloride | $ClCH_2CH_2CH_2Cl$ | 112.99 | lq. | $1.201^{15}$ | | 123-5 | $0.27^{25}$ | s. | s. |
| glycol | $HOCH_2CH_2CH_2OH$ | 76.09 | oil | $1.060^{20/4}$ | | 214 | ∞ | ∞ | |
| Trinitro-benzene (1-,3-,5-) | $C_6H_3(NO_2)_3$ | 213.11 | col. rhb. | $1.688^{20/4}$ | 121 | d. | $0.03^{15}$ | $1.9^{18}$ | $1.5^{18}$ |
| -benzoic acid (2-,4-,6-) | $(NO_2)_3C_6H_2CO_2H$ | 257.12 | rhb./aq. | | 210-20 d. | | $2.05^{24}$ | | |
| -tert-butylxylene | $(NO_2)_3C_6(CH_3)_2C_4H_9$ | 297.26 | nd./al. | | 110 | | i. | sl. s. | s. |
| -naphthalene (α-)(1-,3-,5-) | $C_{10}H_5(NO_2)_3$ | 263.16 | rhb. | | 122-3 | | i. | s. | |
| (β-)(1-,3-,8-) | $C_{10}H_5(NO_2)_3$ | 263.16 | cr./al. | | 218-9 | | $0.02^{100}$ | $0.05^{23}$ | $0.13^{15}$ |
| (γ-)(1-,4-,5-) | $C_{10}H_5(NO_2)_3$ | 263.16 | yel. cr. | | 148-9 | | i. | $0.11^{19}$ | $0.4^{19}$ |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| -phenol (2-,3-,6-) | $(NO_2)_3C_6H_2OH$ | 229.11 | nd. | | 117-8 | | s. h. | v. s. | v. s. |
| -toluene (β-)(2-,3-,4-) | $CH_3C_6H_2(NO_2)_3$ | 227.13 | cr. | $1.620^{20/4}$ | 112 | expl. | i. | sl. s. c. | s. |
| (γ-)(2-,4-,5-) | $CH_3C_6H_2(NO_2)_3$ | 227.13 | yel. pl. | $1.620^{20/4}$ | 104 | expl. | i. | s. h. | v. s. |
| (α-)(2-,4-,6-) | $CH_3C_6H_2(NO_2)_3$ | 227.13 | cr./al. | 1.654 | 80.8 | expl. | $0.01^{20}$ | $1.5^{22}$ | $5^{33}$ |
| Trional | $C_2H_5(CH_3)C(SO_2C_2H_5)_2$ | 242.34 | pl./al. | $1.199^{85/4}$ | 76 | d. | $0.3^{15}$ | $5^{0}$ | $6.6^{15}$ |
| Triphenyl-arsine | $(C_6H_5)_3As$ | 306.21 | pl. | 1.306 | 59-60 | >360 | i. | s. | v. s. |
| carbinol | $(C_6H_5)_3COH$ | 260.32 | cr. | $1.188^{20/4}$ | 162.5 | >360 | i. | v. s. | v. s. |
| guanidine (α-) | $C_6H_5N{:}C(NHC_6H_5)_2$ | 287.35 | rhb./al. | 1.13 | 144-5 | d. | i. | $4^{0}$ | |
| methane | $(C_6H_5)_3CH$ | 244.32 | cr. | $1.014^{99/4}$ | 93.4 | $359^{754}$ | i. | v. s. h. | v. s. |
| methyl | $(C_6H_5)_3C\ldots$ | 243.31 | col. cr. | | 145-7 | d. | i. | sl. s. h. | |
| phosphate | $OP(OC_6H_5)_3$ | 326.28 | pr./al. | $1.206^{58/4}$ | 49-50 | $245^{11}$ | i. | $155^{25}$ | v. s. |
| Tripropylamine (*n*-) | $(CH_3CH_2CH_2)_3N$ | 143.27 | col. lq. | $0.757^{20/4}$ | –93.5 | 156.5 | v. sl. s. | ∞ | ∞ |
| Undecane (*n*-) | $CH_3(CH_2)_3CH_3$ | 156.30 | col. lq. | $0.741^{20/4}$ | –25.6 | 194.5 | i. | ∞ | ∞ |
| Urea | $H_2N{\cdot}CO{\cdot}NH_2$ | 60.06 | col. pr. | $1.335^{20/4}$ | 132.7 | d. | $100^{17}$ | $20^{20}$ | sl. s. |
| nitrate | $CO(NH_2)_2{\cdot}HNO_3$ | 123.07 | col. mn. | | 152 d. | | v. s. h. | s. | |
| Uric acid | $C_5H_4O_3N_4$ | 168.11 | cr. | $1.893^{20}$ | d. | | 0.06 h. | i. | i. |
| Valeric acid (*n*-) | $C_3H_5CH_2CH_2CO_2H$ | 102.13 | col. lq. | $0.939^{20/4}$ | –34.5 | 187 | $3.3^{16}$ | ∞ | ∞ |
| (*i*-) | $(CH_3)_2CHCH_2CO_2H$ | 102.13 | col. lq. | $0.931^{20/20}$ | –37.6 | 176 | $4.2^{20}$ | ∞ | ∞ |
| aldehyde (*n*-) | $C_2H_5CH_2CH_2CHO$ | 86.13 | lq. | $0.819^{11}$ | –92 | 103.4 | v. sl. s. | s. | s. |
| (*i*-) | $(CH_3)_2CHCH_2CHO$ | 86.13 | col. lq. | $0.803^{17}$ | –51 | 92.5 | sl. s. | s. | s. |
| amide (*n*-) | $C_3H_5CH_2CH_2CONH_2$ | 101.15 | mn. pl. | 1.023 | 106 | | v. s. | v. s. | v. s. |
| (*i*-) | $(CH_3)_2CHCH_2CONH_2$ | 101.15 | mn. | $0.965^{20/4}$ | 135-7 | 232 | s. | s. | s. |
| Vanillic acid (3-,4-,1-) | $CH_3O(OH)C_6H_3CO_2H$ | 168.14 | nd./aq. | | 207 | subl. | $0.12^{14}$ | v. s. | v. s. |
| alcohol (3-,4-,1-) | $CH_3O(OH)C_6H_3CH_2OH$ | 154.16 | mn./aq. | | 115 | d. | v. s. h. | v. s. | v. s. |
| hyl-thiuram disulfide | $[(C_2H_5)_2NCS]_2S_2$ | 296.52 | cr. | 1.17 | 70 | | i. | | |
| Vanillin (3-,4-,1-) | $CH_3O(OH)C_6H_3CHO$ | 152.14 | mn. | 1.056 | 81-2 | 285 | $1^{14}$ | v. s. | v. s. |
| Veratrole (*o*-) | $C_6H_4(OCH_3)_2$ | 138.16 | cr. | $1.091^{15/15}$ | 22.5 | 207.1 | v. sl. s. | s. | s. |
| Vinyl acetate | $CH_3CO_2CH{:}CH_2$ | 86.09 | col. lq. | $0.932^{20/4}$ | < –60 | 72-3 | $2^{20}$ | ∞ | ∞ |
| (poly-) | $(CH_3CO_2CH{:}CH_2)x$ | (86.09) | | $1.19^{20}$ | 100-25 | | i. | | |
| acetic acid | $CH_2{:}CH{\cdot}CH_2CO_2H$ | 86.09 | col. lq. | $1.013^{15/15}$ | –39 | 163 | s. | ∞ | ∞ |
| acetylene | $CH_2{:}CH{\cdot}C{:}CH$ | 52.07 | gas | $0.705^{1.5}$ | | 5.5 | $0.67^{0.6}$ | | |
| alcohol | $CH_2{:}CHOH$ | 44.06 | | | | | | | |
| (poly-) | $(CH_2{:}CHOH)x$ | (44.06) | | $1.3^{20}$ | d. >200 | | s. | | |
| chloride | $CH_2{:}CHCl$ | 62.50 | gas | $0.908^{25/25}$ | –160 | –12 | sl. s. | s. | v. s. |
| propionate | $C_2H_5CO_2CH{:}CH_2$ | 100.11 | lq. | | | 93-5 | v. sl. s. | | |
| Xylene (*o*-) | $C_6H_4(CH_3)_2$ | 106.16 | col. lq. | $0.881^{20/4}$ | –25 | 144 | i. | s. | ∞ |
| (*m*-) | $C_6H_4(CH_3)_2$ | 106.16 | col. lq. | $0.867^{17/4}$ | –47.4 | 139.3 | i. | s. | ∞ |
| (*p*-) | $C_6H_4(CH_3)_2$ | 106.16 | col. lq. | $0.861^{20/4}$ | 13.2 | 138.5 | i. | s. | v. s. |
| sulfonic acid (1-,4-,2-) | $(CH_3)_2C_6H_3SO_3H{\cdot}2H_2O$ | 222.25 | col. lf. | | 86 | $149^{0.1}$ | s. | | |
| Xylidine (1:2)(3-) | $(CH_3)_2C_6H_3NH_2$ | 121.18 | lq. | $0.991^{15}$ | < –15 | 223 | v. sl. s. | s. | s. |
| (1:2)(4-) | $(CH_3)_2C_6H_3NH_2$ | 121.18 | pr. | $1.076^{17.5}$ | 49-50 | 224-6 | v. sl. s. | | |
| (1:3)(2-) | $(CH_3)_2C_6H_3NH_2$ | 121.18 | lq. | $0.980^{15}$ | | 216-7 | v. sl. s. | | |
| (1:3)(4-) | $(CH_3)_2C_6H_3NH_2$ | 121.18 | lq. | $0.978^{20/4}$ | | 213-4 | v. sl. s. | | |
| (1:3)(5-) | $(CH_3)_2C_6H_3NH_2$ | 121.18 | oil | $0.972^{20/4}$ | | 221-2 | v. sl. s. | | |
| (1:4)(2-) | $(CH_3)_2C_6H_3NH_2$ | 121.18 | oil | $0.979^{21/4}$ | 15.5 | $215^{789}$ | v. sl. s. | | |
| Xylose (*l*-)(+) | $CH_2OH(CHOH)_3CHO$ | 150.13 | nd. | $1.535^{0}$ | 153-4 | | $117^{20}$ | v. sl. s. | i. |
| Xylylene dichloride (*p*-) | $C_6H_4(CH_2Cl)_2$ | 175.06 | mn. | $1.417^{0}$ | 100.5 | 240-5 d. | i. | s. | v. sl. s. |
| Zinc diethyl | $Zn(CH_2CH_3)_2$ | 123.50 | col. lq. | $1.182^{18}$ | –28 | 118 | d. | d. | |
| dimethyl | $Zn(CH_3)_2$ | 95.45 | col. lq. | $1.386^{11}$ | –40 | 46 | d. | d. | |
| dimethyl-dithiocarbamate | $Zn[S_2CN(CH_3)_2]_2$ | 305.79 | | $2.00^{40/4}$ | 248-50 | | i. | | |

NOTE: °F = ⅘ °C + 32.

# VAPOR PRESSURES OF PURE SUBSTANCES

## UNITS CONVERSIONS

For this subsection, the following units conversions are applicable:

$$°F = \tfrac{9}{5}\,°C + 32.$$

To convert millimeters of mercury to pounds-force per square inch, multiply by 0.01934.

## ADDITIONAL REFERENCES

Additional compilations of vapor-pressure data include Boublik, Fried, and Hala, *The Vapor Pressures of Pure Substances*, Elsevier, Amsterdam, 1984. See also Hirata, Ohe, and Nagahama, *Computer Aided Data Book of Vapor-Liquid Equilibria,* Kodansha/Elsevier, Tokyo, 1975; Weishaupt, *Landolt-Börnstein New Series Group IV,* vol. 3; *Thermodynamic Equilibria of Boiling Mixtures,* Springer-Verlag, Berlin, 1975; Wichterle, Linek, and Hala, *Vapor-Liquid Equilibrium Data Bibliography,* Elsevier, Amsterdam, 1973; suppl. 1, 1976; suppl. 2, 1982.

**TABLE 2-3 Vapor Pressure of Water Ice from –15 to 0°C***

mmHg

| *t*, °C | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 |
|---|---|---|---|---|---|---|---|---|---|---|
| –14 | 1.361 | 1.348 | 1.336 | 1.324 | 1.312 | 1.300 | 1.288 | 1.276 | 1.264 | 1.253 |
| –13 | 1.490 | 1.477 | 1.464 | 1.450 | 1.437 | 1.424 | 1.411 | 1.399 | 1.386 | 1.373 |
| –12 | 1.632 | 1.617 | 1.602 | 1.588 | 1.574 | 1.559 | 1.546 | 1.532 | 1.518 | 1.504 |
| –11 | 1.785 | 1.769 | 1.753 | 1.737 | 1.722 | 1.707 | 1.691 | 1.676 | 1.661 | 1.646 |
| –10 | 1.950 | 1.934 | 1.916 | 1.899 | 1.883 | 1.866 | 1.849 | 1.833 | 1.817 | 1.800 |
| –9 | 2.131 | 2.112 | 2.093 | 2.075 | 2.057 | 2.039 | 2.021 | 2.003 | 1.985 | 1.968 |
| –8 | 2.326 | 2.306 | 2.285 | 2.266 | 2.246 | 2.226 | 2.207 | 2.187 | 2.168 | 2.149 |
| –7 | 2.537 | 2.515 | 2.493 | 2.472 | 2.450 | 2.429 | 2.408 | 2.387 | 2.367 | 2.346 |
| –6 | 2.765 | 2.742 | 2.718 | 2.695 | 2.672 | 2.649 | 2.626 | 2.603 | 2.581 | 2.559 |
| –5 | 3.013 | 2.987 | 2.962 | 2.937 | 2.912 | 2.887 | 2.862 | 2.838 | 2.813 | 2.790 |
| –4 | 3.280 | 3.252 | 3.225 | 3.198 | 3.171 | 3.144 | 3.117 | 3.091 | 3.065 | 3.039 |
| –3 | 3.568 | 3.539 | 3.509 | 3.480 | 3.451 | 3.422 | 3.393 | 3.364 | 3.336 | 3.308 |
| –2 | 3.880 | 3.848 | 3.816 | 3.785 | 3.753 | 3.722 | 3.691 | 3.660 | 3.630 | 3.599 |
| –1 | 4.217 | 4.182 | 4.147 | 4.113 | 4.079 | 4.045 | 4.012 | 3.979 | 3.946 | 3.913 |
| –0 | 4.579 | 4.542 | 4.504 | 4.467 | 4.431 | 4.395 | 4.359 | 4.323 | 4.287 | 4.252 |

*For data at 0(0.2)–30(2)–98°C see p. 2324, *Handbook of Chemistry and Physics,* 40th ed., Chemical Rubber Publishing Co.

**TABLE 2-4 Vapor Pressure of Liquid Water from –16 to 0°C***

mmHg

| *t*, °C | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 |
|---|---|---|---|---|---|---|---|---|---|---|
| –15 | 1.436 | 1.425 | 1.414 | 1.402 | 1.390 | 1.379 | 1.368 | 1.356 | 1.345 | 1.334 |
| –14 | 1.560 | 1.547 | 1.534 | 1.522 | 1.511 | 1.497 | 1.485 | 1.472 | 1.460 | 1.449 |
| –13 | 1.691 | 1.678 | 1.665 | 1.651 | 1.637 | 1.624 | 1.611 | 1.599 | 1.585 | 1.572 |
| –12 | 1.834 | 1.819 | 1.804 | 1.790 | 1.776 | 1.761 | 1.748 | 1.734 | 1.720 | 1.705 |
| –11 | 1.987 | 1.971 | 1.955 | 1.939 | 1.924 | 1.909 | 1.893 | 1.878 | 1.863 | 1.848 |
| –10 | 2.149 | 2.134 | 2.116 | 2.099 | 2.084 | 2.067 | 2.050 | 2.034 | 2.018 | 2.001 |
| –9 | 2.326 | 2.307 | 2.289 | 2.271 | 2.254 | 2.236 | 2.219 | 2.201 | 2.184 | 2.167 |
| –8 | 2.514 | 2.495 | 2.475 | 2.456 | 2.437 | 2.418 | 2.399 | 2.380 | 2.362 | 2.343 |
| –7 | 2.715 | 2.695 | 2.674 | 2.654 | 2.633 | 2.613 | 2.593 | 2.572 | 2.553 | 2.533 |
| –6 | 2.931 | 2.909 | 2.887 | 2.866 | 2.843 | 2.822 | 2.800 | 2.778 | 2.757 | 2.736 |
| –5 | 3.163 | 3.139 | 3.115 | 3.092 | 3.069 | 3.046 | 3.022 | 3.000 | 2.976 | 2.955 |
| –4 | 3.410 | 3.384 | 3.359 | 3.334 | 3.309 | 3.284 | 3.259 | 3.235 | 3.211 | 3.187 |
| –3 | 3.673 | 3.647 | 3.620 | 3.593 | 3.567 | 3.540 | 3.514 | 3.487 | 3.461 | 3.436 |
| –2 | 3.956 | 3.927 | 3.898 | 3.871 | 3.841 | 3.813 | 3.785 | 3.757 | 3.730 | 3.702 |
| –1 | 4.258 | 4.227 | 4.196 | 4.165 | 4.135 | 4.105 | 4.075 | 4.045 | 4.016 | 3.986 |
| –0 | 4.579 | 4.546 | 4.513 | 4.480 | 4.448 | 4.416 | 4.385 | 4.353 | 4.320 | 4.289 |

*Computed from the above table with the aid of the thermodynamic equation

$$\log_{10}\frac{p_w}{p_i} = \frac{-1.1489t}{273.1+t} - 1.330\times10^{-5}t^2 + 9.084\times10^{-8}t^3$$

**TABLE 2-5 Vapor Pressure of Liquid Water from 0 to 100°C***

mmHg

| *t*, °C | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 4.579 | 4.613 | 4.647 | 4.681 | 4.715 | 4.750 | 4.785 | 4.820 | 4.855 | 4.890 |
| 1 | 4.926 | 4.962 | 4.998 | 5.034 | 5.070 | 5.107 | 5.144 | 5.181 | 5.219 | 5.256 |
| 2 | 5.294 | 5.332 | 5.370 | 5.408 | 5.447 | 5.486 | 5.525 | 5.565 | 5.605 | 5.645 |
| 3 | 5.685 | 5.725 | 5.766 | 5.807 | 5.848 | 5.889 | 5.931 | 5.973 | 6.015 | 6.058 |
| 4 | 6.101 | 6.144 | 6.187 | 6.230 | 6.274 | 6.318 | 6.363 | 6.408 | 6.453 | 6.498 |
| 5 | 6.543 | 6.589 | 6.635 | 6.681 | 6.728 | 6.775 | 6.822 | 6.869 | 6.917 | 6.965 |
| 6 | 7.013 | 7.062 | 7.111 | 7.160 | 7.209 | 7.259 | 7.309 | 7.360 | 7.411 | 7.462 |
| 7 | 7.513 | 7.565 | 7.617 | 7.669 | 7.722 | 7.775 | 7.828 | 7.882 | 7.936 | 7.990 |
| 8 | 8.045 | 8.100 | 8.155 | 8.211 | 8.267 | 8.323 | 8.380 | 8.437 | 8.494 | 8.551 |
| 9 | 8.609 | 8.668 | 8.727 | 8.786 | 8.845 | 8.905 | 8.965 | 9.025 | 9.086 | 9.147 |
| 10 | 9.209 | 9.271 | 9.333 | 9.395 | 9.458 | 9.521 | 9.585 | 9.649 | 9.714 | 9.779 |
| 11 | 9.844 | 9.910 | 9.976 | 10.042 | 10.109 | 10.176 | 10.244 | 10.312 | 10.380 | 10.449 |
| 12 | 10.518 | 10.588 | 10.658 | 10.728 | 10.799 | 10.870 | 10.941 | 11.013 | 11.085 | 11.158 |
| 13 | 11.231 | 11.305 | 11.379 | 11.453 | 11.528 | 11.604 | 11.680 | 11.756 | 11.833 | 11.910 |
| 14 | 11.987 | 12.065 | 12.144 | 12.223 | 12.302 | 12.382 | 12.462 | 12.543 | 12.624 | 12.706 |
| 15 | 12.788 | 12.870 | 12.953 | 13.037 | 13.121 | 13.205 | 13.290 | 13.375 | 13.461 | 13.547 |
| 16 | 13.634 | 13.721 | 13.809 | 13.898 | 13.987 | 14.076 | 14.166 | 14.256 | 14.347 | 14.438 |
| 17 | 14.530 | 14.622 | 14.715 | 14.809 | 14.903 | 14.997 | 15.092 | 15.188 | 15.284 | 15.380 |
| 18 | 15.477 | 15.575 | 15.673 | 15.772 | 15.871 | 15.971 | 16.071 | 16.171 | 16.272 | 16.374 |
| 19 | 16.477 | 16.581 | 16.685 | 16.789 | 16.894 | 16.999 | 17.105 | 17.212 | 17.319 | 17.427 |
| 20 | 17.535 | 17.644 | 17.753 | 17.863 | 17.974 | 18.085 | 18.197 | 18.309 | 18.422 | 18.536 |
| 21 | 18.650 | 18.765 | 18.880 | 18.996 | 19.113 | 19.231 | 19.349 | 19.468 | 19.587 | 19.707 |
| 22 | 19.827 | 19.948 | 20.070 | 20.193 | 20.316 | 20.440 | 20.565 | 20.690 | 20.815 | 20.941 |
| 23 | 21.068 | 21.196 | 21.324 | 21.453 | 21.583 | 21.714 | 21.845 | 21.977 | 22.110 | 22.243 |
| 24 | 22.377 | 22.512 | 22.648 | 22.785 | 22.922 | 23.060 | 23.198 | 23.337 | 23.476 | 23.616 |
| 25 | 23.756 | 23.897 | 24.039 | 24.182 | 24.326 | 24.471 | 24.617 | 24.764 | 24.912 | 25.060 |
| 26 | 25.209 | 25.359 | 25.509 | 25.660 | 25.812 | 25.964 | 26.117 | 26.271 | 26.426 | 26.582 |
| 27 | 26.739 | 26.897 | 27.055 | 27.214 | 27.374 | 27.535 | 27.696 | 27.858 | 28.021 | 28.185 |
| 28 | 28.349 | 28.514 | 28.680 | 28.847 | 29.015 | 29.184 | 29.354 | 29.525 | 29.697 | 29.870 |
| 29 | 30.043 | 30.217 | 30.392 | 30.568 | 30.745 | 30.923 | 31.102 | 31.281 | 31.461 | 31.642 |
| 30 | 31.824 | 32.007 | 32.191 | 32.376 | 32.561 | 32.747 | 32.934 | 33.122 | 33.312 | 33.503 |
| 31 | 33.695 | 33.888 | 34.082 | 34.276 | 34.471 | 34.667 | 34.864 | 35.062 | 35.261 | 35.462 |
| 32 | 35.663 | 35.865 | 36.068 | 36.272 | 36.477 | 36.683 | 36.891 | 37.099 | 37.308 | 37.518 |
| 33 | 37.729 | 37.942 | 38.155 | 38.369 | 33.584 | 38.801 | 39.018 | 39.237 | 39.457 | 39.677 |
| 34 | 39.898 | 40.121 | 40.344 | 40.569 | 40.796 | 41.023 | 41.251 | 41.480 | 41.710 | 41.942 |
| 35 | 42.175 | 42.409 | 42.644 | 42.880 | 43.117 | 43.355 | 43.595 | 43.836 | 44.078 | 44.320 |
| 36 | 44.563 | 44.808 | 45.054 | 45.301 | 45.549 | 45.799 | 46.050 | 46.302 | 46.556 | 46.811 |
| 37 | 47.067 | 47.324 | 47.582 | 47.841 | 48.102 | 48.364 | 48.627 | 48.891 | 49.157 | 49.424 |
| 38 | 49.692 | 49.961 | 50.231 | 50.502 | 50.774 | 51.048 | 51.323 | 51.600 | 51.879 | 52.160 |
| 39 | 52.442 | 52.725 | 53.009 | 53.294 | 53.580 | 53.867 | 54.156 | 54.446 | 54.737 | 55.030 |
| 40 | 55.324 | 55.61 | 55.91 | 56.21 | 56.51 | 56.81 | 57.11 | 57.41 | 57.72 | 58.03 |
| 41 | 58.34 | 58.65 | 58.96 | 59.27 | 59.58 | 59.90 | 60.22 | 60.54 | 60.86 | 61.18 |
| 42 | 61.50 | 61.82 | 62.14 | 62.47 | 62.80 | 63.13 | 63.46 | 63.79 | 64.12 | 64.46 |
| 43 | 64.80 | 65.14 | 65.48 | 65.82 | 66.16 | 66.51 | 66.86 | 67.21 | 67.56 | 67.91 |
| 44 | 68.26 | 68.61 | 68.97 | 69.33 | 69.69 | 70.05 | 70.41 | 70.77 | 71.14 | 71.51 |
| 45 | 71.88 | 72.25 | 72.62 | 72.99 | 73.36 | 73.74 | 74.12 | 74.50 | 74.88 | 75.26 |
| 46 | 75.65 | 76.04 | 76.43 | 76.82 | 77.21 | 77.60 | 78.00 | 78.40 | 78.80 | 79.20 |
| 47 | 79.60 | 80.00 | 80.41 | 80.82 | 81.23 | 81.64 | 82.05 | 82.46 | 82.87 | 83.29 |
| 48 | 83.71 | 84.13 | 84.56 | 84.99 | 85.42 | 85.85 | 86.28 | 86.71 | 87.14 | 87.58 |
| 49 | 88.02 | 88.46 | 88.90 | 89.34 | 89.79 | 90.24 | 90.69 | 91.14 | 91.59 | 92.05 |

| *t*, °C | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 50 | 92.51 | 97.20 | 102.09 | 107.20 | 112.51 | 118.04 | 123.80 | 129.82 | 136.08 | 142.60 |
| 60 | 149.38 | 156.43 | 163.77 | 171.38 | 179.31 | 187.54 | 196.09 | 204.96 | 214.17 | 223.73 |
| 70 | 233.7 | 243.9 | 254.6 | 265.7 | 277.2 | 289.1 | 301.4 | 314.1 | 327.3 | 341.0 |
| 80 | 355.1 | 369.7 | 384.9 | 400.6 | 416.8 | 433.6 | 450.9 | 468.7 | 487.1 | 506.1 |
| 90 | 525.76 | 527.76 | 529.77 | 531.78 | 533.80 | 535.82 | 537.86 | 539.90 | 541.95 | 544.00 |
| 91 | 546.05 | 548.11 | 550.18 | 552.26 | 554.35 | 556.44 | 558.53 | 560.64 | 562.75 | 564.87 |
| 92 | 566.99 | 569.12 | 571.26 | 573.40 | 575.55 | 577.71 | 579.87 | 582.04 | 584.22 | 586.41 |
| 93 | 588.60 | 590.80 | 593.00 | 595.21 | 597.43 | 599.66 | 601.89 | 604.13 | 606.38 | 608.64 |
| 94 | 610.90 | 613.17 | 615.44 | 617.72 | 620.01 | 622.31 | 624.61 | 626.92 | 629.24 | 631.57 |
| 95 | 633.90 | 636.24 | 638.59 | 640.94 | 643.30 | 645.67 | 648.05 | 650.43 | 652.82 | 655.22 |
| 96 | 657.62 | 660.03 | 662.45 | 664.88 | 667.31 | 669.75 | 672.20 | 674.66 | 677.12 | 679.69 |
| 97 | 682.07 | 684.55 | 687.04 | 689.54 | 692.05 | 694.57 | 697.10 | 699.63 | 702.17 | 704.71 |
| 98 | 707.27 | 709.83 | 712.40 | 714.98 | 717.56 | 720.15 | 722.75 | 725.36 | 727.98 | 730.61 |
| 99 | 733.24 | 735.88 | 738.53 | 741.18 | 743.85 | 746.52 | 749.20 | 751.89 | 754.58 | 757.29 |
| 100 | 760.00 | 762.72 | 765.45 | 768.19 | 770.93 | 773.68 | 776.44 | 779.22 | 782.00 | 784.78 |
| 101 | 787.57 | 790.37 | 793.18 | 796.00 | 796.82 | 801.66 | 804.50 | 807.35 | 810.21 | 813.06 |

*From the Physikalisch-technische Reichsanstalt, Holborn, Scheel, and Henning, *Wärmetabellen,* Friedrich Vieweg & Sohn, Brunswick, 1909. By permission. For data at 50(0.2)101.8°C, see *Handbook of Chemistry and Physics,* 40th ed., p. 2326, Chemical Rubber Publishing Co. For a tabulation of temperature for pressures 700(1)779 mm Hg, see Atack, *Handbook of Chemical Data,* p. 117, Reinhold, New York, 1957. For a tabulation of pressure for 105(5)200(10)370°C, see Atack, p. 134, and for 100(1)374°C, see *Handbook of Chemistry and Physics,* 40th ed., pp. 2328–2330, Chemical Rubber Publishing Co.

**TABLE 2-6 Vapor Pressure of Inorganic and Organic Liquids**

| Cmpd. no. | Name | Formula | CAS no. | C1 | C2 | C3 | C4 | C5 | $T_{min}$, K | $P_s$ at $T_{min}$ | $T_{max}$, K | $P_s$ at $T_{max}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Methane | $CH_4$ | 74828 | 39.205 | –1324.4 | –3.4366 | 3.1019E–05 | 2 | 90.69 | 1.1687E+04 | 190.56 | 4.5897E+06 |
| 2 | Ethane | $C_2H_6$ | 74840 | 51.857 | –2598.7 | –5.1283 | 1.4913E–05 | 2 | 90.35 | 1.1273E+00 | 305.32 | 4.8522E+06 |
| 3 | Propane | $C_3H_8$ | 74986 | 59.078 | –3492.6 | –6.0669 | 1.0919E–05 | 2 | 85.47 | 1.6788E–04 | 369.83 | 4.2135E+06 |
| 4 | *n*-Butane | $C_4H_{10}$ | 106978 | 66.343 | –4363.2 | –7.046 | 9.4509E–06 | 2 | 134.86 | 6.7441E–01 | 425.12 | 3.7699E+06 |
| 5 | *n*-Pentane | $C_5H_{12}$ | 109660 | 78.741 | –5420.3 | –8.8253 | 9.6171E–06 | 2 | 143.42 | 6.8642E–02 | 469.7 | 3.3642E+06 |
| 6 | *n*-Hexane | $C_6H_{14}$ | 110543 | 104.65 | –6995.5 | –12.702 | 1.2381E–05 | 2 | 177.83 | 9.0169E–01 | 507.6 | 3.0449E+06 |
| 7 | *n*-Heptane | $C_7H_{16}$ | 142825 | 87.829 | –6996.4 | –9.8802 | 7.2099E–06 | 2 | 182.57 | 1.8269E–01 | 540.2 | 2.7192E+06 |
| 8 | *n*-Octane | $C_8H_{18}$ | 111659 | 96.084 | –7900.2 | –11.003 | 7.1802E–06 | 2 | 216.38 | 2.1083E+00 | 568.7 | 2.4673E+06 |
| 9 | *n*-Nonane | $C_9H_{20}$ | 111842 | 109.35 | –9030.4 | –12.882 | 7.8544E–06 | 2 | 219.66 | 4.3058E–01 | 594.6 | 2.3054E+06 |
| 10 | *n*-Decane | $C_{10}H_{22}$ | 124185 | 112.73 | –9749.6 | –13.245 | 7.1266E–06 | 2 | 243.51 | 1.3930E+00 | 617.7 | 2.0908E+06 |
| 11 | *n*-Undecane | $C_{11}H_{24}$ | 1120214 | 131 | –11143 | –15.855 | 8.1871E–06 | 2 | 247.57 | 4.0836E–01 | 639 | 1.9493E+06 |
| 12 | *n*-Dodecane | $C_{12}H_{26}$ | 112403 | 137.47 | –11976 | –16.698 | 8.0906E–06 | 2 | 263.57 | 6.1534E–01 | 658 | 1.8223E+06 |
| 13 | *n*-Tridecane | $C_{13}H_{28}$ | 629505 | 137.45 | –12549 | –16.543 | 7.1275E–06 | 2 | 267.76 | 2.5096E–01 | 675 | 1.6786E+06 |
| 14 | *n*-Tetradecane | $C_{14}H_{30}$ | 629594 | 140.47 | –13231 | –16.859 | 6.5877E–06 | 2 | 279.01 | 2.5268E–01 | 693 | 1.5693E+06 |
| 15 | *n*-Pentadecane | $C_{15}H_{32}$ | 629629 | 135.57 | –13478 | –16.022 | 5.6136E–06 | 2 | 283.07 | 1.2884E–01 | 708 | 1.4743E+06 |
| 16 | *n*-Hexadecane | $C_{16}H_{34}$ | 544763 | 156.06 | –15015 | –18.941 | 6.8172E–06 | 2 | 291.31 | 9.2265E–02 | 723 | 1.4106E+06 |
| 17 | *n*-Heptadecane | $C_{17}H_{36}$ | 629787 | 156.95 | –15557 | –18.966 | 6.4559E–06 | 2 | 295.13 | 4.6534E–02 | 736 | 1.3438E+06 |
| 18 | *n*-Octadecane | $C_{18}H_{38}$ | 593453 | 157.68 | –16093 | –18.954 | 5.9272E–06 | 2 | 301.31 | 3.3909E–02 | 747 | 1.2555E+06 |
| 19 | *n*-Nonadecane | $C_{19}H_{40}$ | 629925 | 182.54 | –17897 | –22.498 | 7.4008E–06 | 2 | 305.04 | 1.5909E–02 | 758 | 1.2078E+06 |
| 20 | *n*-Eicosane | $C_{20}H_{42}$ | 112958 | 203.66 | –19441 | –25.525 | 8.8382E–06 | 2 | 309.58 | 9.2574E–03 | 768 | 1.1746E+06 |
| 21 | 2-Methylpropane | $C_4H_{10}$ | 75285 | 100.18 | –4841.9 | –13.541 | 2.0063E–02 | 1 | 113.54 | 1.4051E–02 | 408.14 | 3.6199E+06 |
| 22 | 2-Methylbutane | $C_5H_{12}$ | 78784 | 72.35 | –5010.9 | –7.883 | 8.9795E–06 | 2 | 113.25 | 1.1569E–04 | 460.43 | 3.3709E+06 |
| 23 | 2,3-Dimethylbutane | $C_6H_{14}$ | 79298 | 77.235 | –5695.9 | –8.5109 | 8.0163E–06 | 2 | 145.19 | 1.5081E–02 | 499.98 | 3.1255E+06 |
| 24 | 2-Methylpentane | $C_6H_{14}$ | 107835 | 77.36 | –5791.7 | –8.4912 | 7.7939E–06 | 2 | 119.55 | 9.2204E–06 | 497.5 | 3.0192E+06 |
| 25 | 2,3-Dimethylpentane | $C_7H_{16}$ | 565593 | 78.282 | –6347 | –8.502 | 6.4169E–06 | 2 | 160 | 1.2631E–02 | 537.35 | 2.8823E+06 |
| 26 | 2,3,3-Trimethylpentane | $C_8H_{18}$ | 560214 | 83.105 | –6903.7 | –9.1858 | 6.4703E–06 | 2 | 172.22 | 1.6820E–02 | 573.5 | 2.8116E+06 |
| 27 | 2,2,4-Trimethylpentane | $C_8H_{18}$ | 540841 | 87.868 | –6831.7 | –9.9783 | 7.7729E–06 | 2 | 165.78 | 1.6187E–02 | 543.96 | 2.5630E+06 |
| 28 | Ethylene | $C_2H_4$ | 74851 | 74.242 | –2707.2 | –9.8462 | 2.2457E–02 | 1 | 104 | 1.2361E+02 | 282.34 | 5.0296E+06 |
| 29 | Propylene | $C_3H_6$ | 115071 | 57.263 | –3382.4 | –5.7707 | 1.0431E–05 | 2 | 87.89 | 9.3867E–04 | 365.57 | 4.6346E+06 |
| 30 | 1-Butene | $C_4H_8$ | 106989 | 68.49 | –4350.2 | –7.4124 | 1.0503E–05 | 2 | 87.8 | 7.1809E–07 | 419.95 | 4.0391E+06 |
| 31 | *cis*-2-Butene | $C_4H_8$ | 590181 | 102.62 | –5260.3 | –13.764 | 1.9183E–02 | 1 | 134.26 | 2.4051E–01 | 435.58 | 4.2388E+06 |
| 32 | *trans*-2-Butene | $C_4H_8$ | 624646 | 70.589 | –4530.4 | –7.7229 | 1.0928E–05 | 2 | 167.62 | 7.4729E+01 | 428.63 | 4.0811E+06 |
| 33 | 1-Pentene | $C_5H_{10}$ | 109671 | 120.15 | –6192.4 | –16.597 | 2.1922E–02 | 1 | 107.93 | 3.5210E–06 | 464.78 | 3.5557E+06 |
| 34 | 1-Hexene | $C_6H_{12}$ | 592416 | 85.3 | –6171.7 | –9.702 | 8.9604E–06 | 2 | 133.39 | 2.5272E–04 | 504.03 | 3.1397E+06 |
| 35 | 1-Heptene | $C_7H_{14}$ | 592767 | 92.68 | –7055.2 | –10.679 | 8.4459E–06 | 2 | 154.27 | 1.2810E–03 | 537.29 | 2.8225E+06 |
| 36 | 1-Octene | $C_8H_{16}$ | 111660 | 97.57 | –7836 | –11.272 | 7.7267E–06 | 2 | 171.45 | 2.7570E–03 | 566.65 | 2.5735E+06 |
| 37 | 1-Nonene | $C_9H_{18}$ | 124118 | 144.45 | –9676.2 | –19.446 | 1.8031E–02 | 1 | 191.78 | 8.5514E–03 | 593.25 | 2.3308E+06 |
| 38 | 1-Decene | $C_{10}H_{20}$ | 872059 | 78.808 | –8367.9 | –7.9553 | 8.7442E–18 | 6 | 206.89 | 1.7308E–02 | 616.4 | 2.2092E+06 |
| 39 | 2-Methylpropene | $C_4H_8$ | 115117 | 102.5 | –5021.8 | –13.88 | 2.0296E–02 | 1 | 132.81 | 6.2213E–01 | 417.9 | 3.9760E+06 |
| 40 | 2-Methyl-1-butene | $C_5H_{10}$ | 563462 | 97.33 | –5631.8 | –12.589 | 1.5395E–02 | 1 | 135.58 | 1.9687E–02 | 465 | 3.4544E+06 |
| 41 | 2-Methyl-2-butene | $C_5H_{10}$ | 513359 | 82.605 | –5606.6 | –9.4236 | 1.0512E–05 | 2 | 139.39 | 1.9447E–02 | 471 | 3.3769E+06 |
| 42 | 1,2-Butadiene | $C_4H_6$ | 590192 | 39.714 | –3769.9 | –2.6407 | 6.9379E–18 | 6 | 136.95 | 4.4720E–01 | 452 | 4.3613E+06 |
| 43 | 1,3-Butadiene | $C_4H_6$ | 106990 | 73.522 | –4564.3 | –8.1958 | 1.1580E–05 | 2 | 164.25 | 6.9110E+01 | 425.17 | 4.3041E+06 |
| 44 | 2-Methyl-1,3-butadiene | $C_5H_8$ | 78795 | 79.656 | –5239.6 | –9.4314 | 9.5850E–03 | 1 | 127.27 | 2.4768E–03 | 484 | 3.8509E+06 |
| 45 | Acetylene | $C_2H_2$ | 74862 | 172.06 | –5318.5 | –27.223 | 5.4619E–02 | 1 | 192.4 | 1.2603E+05 | 308.32 | 6.1467E+06 |
| 46 | Methylacetylene | $C_3H_4$ | 74997 | 119.42 | –5364.5 | –16.81 | 2.5523E–02 | 1 | 170.45 | 3.7264E+02 | 402.39 | 5.6206E+06 |
| 47 | Dimethylacetylene | $C_4H_6$ | 503173 | 66.592 | –4999.8 | –6.8387 | 6.6793E–06 | 2 | 240.91 | 6.1212E+03 | 473.2 | 4.8699E+06 |
| 48 | 3-Methyl-1-butyne | $C_5H_8$ | 598232 | 69.459 | –5250 | –7.1125 | 7.9289E–17 | 6 | 183.45 | 4.3551E+01 | 463.2 | 4.1986E+06 |
| 49 | 1-Pentyne | $C_5H_8$ | 627190 | 82.805 | –5683.8 | –9.4301 | 1.0767E–05 | 2 | 167.45 | 2.3990E+00 | 481.2 | 4.1701E+06 |
| 50 | 2-Pentyne | $C_5H_8$ | 627214 | 137.29 | –7447.1 | –19.01 | 2.1415E–02 | 1 | 163.83 | 2.0462E–01 | 519 | 4.0198E+06 |
| 51 | 1-Hexyne | $C_6H_{10}$ | 693027 | 133.2 | –7492.9 | –18.405 | 2.2062E–02 | 1 | 141.25 | 3.9157E–04 | 516.2 | 3.6352E+06 |
| 52 | 2-Hexyne | $C_6H_{10}$ | 764352 | 123.71 | –7639 | –16.451 | 1.6495E–02 | 1 | 183.65 | 5.4026E–01 | 549 | 3.5301E+06 |
| 53 | 3–Hexyne | $C_6H_{10}$ | 928494 | 47.091 | –5104 | –3.6371 | 5.1621E–04 | 1 | 170.05 | 2.1950E–01 | 544 | 3.5397E+06 |
| 54 | 1-Heptyne | $C_7H_{12}$ | 628717 | 66.447 | –6395.6 | –6.3848 | 1.1250E–17 | 6 | 192.22 | 6.7026E–01 | 559 | 3.1343E+06 |
| 55 | 1-Octyne | $C_8H_{14}$ | 629050 | 82.353 | –7240.6 | –9.1843 | 5.8038E–03 | 1 | 193.55 | 1.0092E–01 | 585 | 2.8202E+06 |
| 56 | Vinylacetylene[1] | $C_4H_4$ | 689974 | 55.682 | –4439.3 | –5.0136 | 1.9650E–17 | 6 | 173.15 | 6.6899E+01 | 454 | 4.8874E+06 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 57 | Cyclopentane | $C_5H_{10}$ | 287923 | 51.434 | −4770.6 | −4.3515 | 1.9605E−17 | 6 | 179.28 | 9.4420E+00 | 511.76 | 4.5028E+06 |
| 58 | Methylcyclopentane | $C_6H_{12}$ | 96377 | 79.673 | −6086.6 | −8.7933 | 7.4046E−06 | 2 | 130.73 | 6.7059E−05 | 532.79 | 3.7808E+06 |
| 59 | Ethylcyclopentane | $C_7H_{14}$ | 1640897 | 88.622 | −7011 | −10.038 | 7.4481E−06 | 2 | 134.71 | 3.7061E−06 | 569.52 | 3.3970E+06 |
| 60 | Cyclohexane | $C_6H_{12}$ | 110827 | 116.51 | −7103.3 | −15.49 | 1.6959E−02 | 1 | 279.69 | 5.3802E+03 | 553.58 | 4.0958E+06 |
| 61 | Methylcyclohexane | $C_7H_{14}$ | 108872 | 92.611 | −7077.8 | −10.684 | 8.1239E−06 | 2 | 146.58 | 1.5256E−04 | 572.19 | 3.4828E+06 |
| 62 | 1,1-Dimethylcyclohexane | $C_8H_{16}$ | 590669 | 81.184 | −6927 | −8.8498 | 5.4580E−06 | 2 | 239.66 | 6.0584E+01 | 591.15 | 2.9387E+06 |
| 63 | Ethylcyclohexane | $C_8H_{16}$ | 1678917 | 80.208 | −7203.2 | −8.6023 | 4.5901E−06 | 2 | 161.84 | 3.5747E−04 | 609.15 | 3.0411E+06 |
| 64 | Cyclopentene | $C_5H_8$ | 142290 | 49.88 | −4649.7 | −4.1191 | 1.9564E−17 | 6 | 138.13 | 1.6884E−02 | 507 | 4.8062E+06 |
| 65 | 1-Methylcyclopentene | $C_6H_{10}$ | 693890 | 52.732 | −5286.9 | −4.4509 | 1.0883E−17 | 6 | 146.62 | 3.9787E−03 | 542 | 4.1303E+06 |
| 66 | Cyclohexene | $C_6H_{10}$ | 110838 | 88.184 | −6624.9 | −10.059 | 8.2566E−06 | 2 | 169.67 | 1.0377E−01 | 560.4 | 4.3922E+06 |
| 67 | Benzene | $C_6H_6$ | 71432 | 83.918 | −6517.7 | −9.3453 | 7.1182E−06 | 2 | 278.68 | 4.7620E+03 | 562.16 | 4.8819E+06 |
| 68 | Toluene | $C_7H_8$ | 108883 | 80.877 | −6902.4 | −8.7761 | 5.8034E−06 | 2 | 178.18 | 4.2348E−02 | 591.8 | 4.1012E+06 |
| 69 | *o*-Xylene | $C_8H_{10}$ | 95476 | 90.356 | −7948.7 | −10.081 | 5.9756E−06 | 2 | 247.98 | 2.1968E+01 | 630.33 | 3.7424E+06 |
| 70 | *m*-Xylene | $C_8H_{10}$ | 108383 | 84.782 | −7598.3 | −9.2612 | 5.5445E−06 | 2 | 225.3 | 3.2099E+00 | 617.05 | 3.5286E+06 |
| 71 | *p*-Xylene | $C_8H_{10}$ | 106423 | 85.475 | −7595.8 | −9.378 | 5.6875E−06 | 2 | 286.41 | 5.8144E+02 | 616.23 | 3.4984E+06 |
| 72 | Ethylbenzene | $C_8H_{10}$ | 100414 | 88.09 | −7688.3 | −9.7708 | 5.8844E−06 | 2 | 178.15 | 4.0140E−03 | 617.2 | 3.5968E+06 |
| 73 | Propylbenzene | $C_9H_{12}$ | 103651 | 136.83 | −9544.8 | −18.190 | 1.6590E−02 | 1 | 324.18 | 2.0014E+03 | 638.32 | 3.2001E+06 |
| 74 | 1,2,4-Trimethylbenzene | $C_9H_{12}$ | 95636 | 60.658 | −7260.4 | −5.3772 | 4.5816E−18 | 6 | 229.33 | 7.9735E−01 | 649.13 | 3.2533E+06 |
| 75 | Isopropylbenzene | $C_9H_{12}$ | 98828 | 143.62 | −9687.7 | −19.305 | 1.7703E−02 | 1 | 177.14 | 3.8034E−04 | 631.1 | 3.1837E+06 |
| 76 | 1,3,5-Trimethylbenzene | $C_9H_{12}$ | 108678 | 48.603 | −6545.2 | −3.6412 | 1.9307E−18 | 6 | 228.42 | 1.1889E+00 | 637.36 | 3.1119E+06 |
| 77 | *p*-Isopropyltoluene | $C_{10}H_{14}$ | 99876 | 107.71 | −9402.7 | −12.545 | 6.6661E−06 | 2 | 205.25 | 9.9261E−03 | 653.15 | 2.7957E+06 |
| 78 | Naphthalene | $C_{10}H_8$ | 91203 | 62.447 | −8109 | −5.5571 | 2.0800E−18 | 6 | 353.43 | 9.9229E+02 | 748.35 | 3.9941E+06 |
| 79 | Biphenyl | $C_{12}H_{10}$ | 92524 | 76.811 | −9878.5 | −7.4384 | 2.0436E−18 | 6 | 342.2 | 9.3752E+01 | 789.26 | 3.8615E+06 |
| 80 | Styrene | $C_8H_8$ | 100425 | 105.93 | −8685.9 | −12.42 | 7.5583E−06 | 2 | 242.54 | 1.0613E+01 | 636 | 3.8234E+06 |
| 81 | *m*-Terphenyl | $C_{18}H_{14}$ | 92068 | 88.044 | −13367 | −8.6482 | 8.7874E−19 | 6 | 360 | 1.0112E+00 | 924.85 | 3.5297E+06 |
| 82 | Methanol | $CH_4O$ | 67561 | 81.768 | −6876 | −8.7078 | 7.1926E−06 | 2 | 175.47 | 1.1147E−01 | 512.64 | 8.1402E+06 |
| 83 | Ethanol | $C_2H_6O$ | 64175 | 74.475 | −7164.3 | −7.327 | 3.1340E−06 | 2 | 159.05 | 4.8459E−04 | 513.92 | 6.1171E+06 |
| 84 | 1-Propanol | $C_3H_8O$ | 71238 | 88.134 | −8498.6 | −9.0766 | 8.3303E−18 | 6 | 146.95 | 3.0828E−07 | 536.78 | 5.1214E+06 |
| 85 | 1-Butanol | $C_4H_{10}O$ | 71363 | 93.173 | −9185.9 | −9.7464 | 4.7796E−18 | 6 | 184.51 | 5.7220E−04 | 563.05 | 4.3392E+06 |
| 86 | 2-Butanol | $C_4H_{10}O$ | 78922 | 152.54 | −11111 | −19.025 | 1.0426E−05 | 2 | 158.45 | 1.1323E−06 | 536.05 | 4.2014E+06 |
| 87 | 2-Propanol | $C_3H_8O$ | 67630 | 76.964 | −7623.8 | −7.4924 | 5.9436E−18 | 6 | 185.28 | 3.6606E−02 | 508.3 | 4.7908E+06 |
| 88 | 2-Methyl-2-propanol | $C_4H_{10}O$ | 75650 | 172.31 | −11590 | −22.118 | 1.3709E−05 | 2 | 298.97 | 5.9356E+03 | 506.21 | 3.9910E+06 |
| 89 | 1-Pentanol | $C_5H_{12}O$ | 71410 | 168.96 | −12659 | −21.366 | 1.1591E−05 | 2 | 195.56 | 3.1816E−04 | 586.15 | 3.8657E+06 |
| 90 | 2-Methyl-1-butanol | $C_5H_{12}O$ | 137326 | 410.44 | −20262 | −62.366 | 6.3353E−02 | 1 | 203 | 3.7992E−04 | 565 | 3.8749E+06 |
| 91 | 3-Methyl-1-butanol | $C_5H_{12}O$ | 123513 | 107.02 | −10237 | −11.695 | 6.8003E−18 | 6 | 155.95 | 2.1036E−08 | 577.2 | 3.9013E+06 |
| 92 | 1-Hexanol | $C_6H_{14}O$ | 111273 | 117.31 | −11239 | −13.149 | 9.3676E−18 | 6 | 228.55 | 3.7401E−02 | 611.35 | 3.4557E+06 |
| 93 | 1-Heptanol | $C_7H_{16}O$ | 111706 | 160.08 | −14095 | −19.211 | 1.7043E−17 | 6 | 239.15 | 1.6990E−02 | 631.9 | 3.1810E+06 |
| 94 | Cyclohexanol | $C_6H_{12}O$ | 108930 | 135.01 | −12238 | −15.702 | 1.0349E−17 | 6 | 296.6 | 7.9382E+01 | 650 | 4.2456E+06 |
| 95 | Ethylene glycol | $C_2H_6O_2$ | 107211 | 79.276 | −10105 | −7.521 | 7.3408E−19 | 6 | 260.15 | 2.4834E−01 | 719.7 | 7.7100E+06 |
| 96 | 1,2-Propylene glycol | $C_3H_8O_2$ | 57556 | 212.8 | −15420 | −28.109 | 2.1564E−05 | 2 | 213.15 | 9.2894E−05 | 626 | 6.0413E+06 |
| 97 | Phenol | $C_6H_6O$ | 108952 | 95.444 | −10113 | −10.09 | 6.7603E−18 | 6 | 314.06 | 1.8798E+02 | 694.25 | 6.0585E+06 |
| 98 | *o*-Cresol | $C_7H_8O$ | 95487 | 210.88 | −13928 | −29.483 | 2.5182E−02 | 1 | 304.19 | 6.5326E+01 | 697.55 | 5.0583E+06 |
| 99 | *m*-Cresol | $C_7H_8O$ | 108394 | 95.403 | −10581 | −10.004 | 4.3032E−18 | 6 | 285.39 | 5.8624E+00 | 705.85 | 4.5221E+06 |
| 100 | *p*-Cresol | $C_7H_8O$ | 106445 | 118.53 | −11957 | −13.293 | 8.6988E−18 | 6 | 307.93 | 3.4466E+01 | 704.65 | 5.1507E+06 |
| 101 | Dimethyl ether | $C_2H_6O$ | 115106 | 44.704 | −3525.6 | −3.4444 | 5.4574E−17 | 6 | 131.65 | 3.0496E+00 | 400.1 | 5.2735E+06 |
| 102 | Methyl ethyl ether | $C_3H_8O$ | 540670 | 205.79 | −9834.5 | −28.739 | 3.5317E−05 | 2 | 160 | 5.3423E−01 | 437.8 | 4.4658E+06 |
| 103 | Methyl *n*-propyl ether | $C_4H_{10}O$ | 557175 | 50.83 | −4781.7 | −4.1773 | 9.4076E−18 | 6 | 133.97 | 4.8875E−03 | 476.3 | 3.7721E+06 |
| 104 | Methyl isopropyl ether | $C_4H_{10}O$ | 598538 | 55.096 | −4793.2 | −4.8689 | 2.9518E−17 | 6 | 127.93 | 2.4971E−03 | 464.5 | 3.8892E+06 |
| 105 | Methyl-*n*-butyl ether | $C_5H_{12}O$ | 628284 | 102.04 | −6954.9 | −12.278 | 1.2131E−05 | 2 | 157.48 | 1.9430E−02 | 510 | 3.3089E+06 |
| 106 | Methyl isobutyl ether | $C_5H_{12}O$ | 625445 | 58.165 | −5362.1 | −5.2568 | 2.0194E−17 | 6 | 150 | 1.9801E−02 | 497 | 3.4130E+06 |
| 107 | Methyl *tert*-butyl ether | $C_5H_{12}O$ | 1634044 | 55.875 | −5131.6 | −4.9604 | 1.9123E−17 | 6 | 164.55 | 5.3566E−01 | 497.1 | 3.4106E+06 |
| 108 | Diethyl ether | $C_4H_{10}O$ | 60297 | 136.9 | −6954.3 | −19.254 | 2.4508E−02 | 1 | 156.85 | 3.9545E−01 | 466.7 | 3.6412E+06 |
| 109 | Ethyl propyl ether | $C_5H_{12}O$ | 628320 | 143.11 | −8353.7 | −18.751 | 2.0620E−05 | 2 | 145.65 | 7.3931E−04 | 500.23 | 3.3729E+06 |
| 110 | Ethyl isopropyl ether | $C_5H_{12}O$ | 625547 | 57.723 | −5236.9 | −5.2136 | 2.2998E−17 | 6 | 140 | 4.3092E−03 | 489 | 3.4145E+06 |
| 111 | Methyl phenyl ether | $C_7H_8O$ | 100663 | 128.06 | −9307.7 | −16.693 | 1.4919E−02 | 1 | 235.65 | 2.4466E+00 | 645.6 | 4.2731E+06 |
| 112 | Diphenyl ether | $C_{12}H_{10}O$ | 101848 | 59.969 | −8585.5 | −5.1538 | 1.9983E−18 | 6 | 300.03 | 7.0874E+00 | 766.8 | 3.0971E+06 |

**TABLE 2-6 Vapor Pressure of Inorganic and Organic Liquids** (*Continued*)

| Cmpd. no. | Name | Formula | CAS no. | C1 | C2 | C3 | C4 | C5 | $T_{min}$, K | $P_s$ at $T_{min}$ | $T_{max}$, K | $P_s$ at $T_{max}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 113 | Formaldehyde | $CH_2O$ | 50000 | 101.51 | –4917.2 | –13.765 | 2.2031E–02 | 1 | 181.15 | 8.8700E+02 | 408 | 6.5935E+06 |
| 114 | Acetaldehyde | $C_2H_4O$ | 75070 | 193.69 | –8036.7 | –29.502 | 4.3678E–02 | 1 | 150.15 | 3.2320E–01 | 466 | 5.5652E+06 |
| 115 | 1-Propanal | $C_3H_6O$ | 123386 | 80.581 | –5896.1 | –8.9301 | 8.2236E–06 | 2 | 170 | 1.3133E+00 | 504.4 | 4.9189E+06 |
| 116 | 1-Butanal | $C_4H_8O$ | 123728 | 99.33 | –7083.6 | –11.733 | 1.0027E–05 | 2 | 176.75 | 3.1699E–01 | 537.2 | 4.3232E+06 |
| 117 | 1-Pentanal | $C_5H_{10}O$ | 110623 | 149.58 | –8890 | –20.697 | 2.2101E–02 | 1 | 182 | 5.2282E–02 | 566.1 | 3.9685E+06 |
| 118 | 1-Hexanal | $C_6H_{12}O$ | 66251 | 81.507 | –7776.8 | –8.4516 | 1.5143E–17 | 6 | 217.15 | 1.2473E+00 | 591 | 3.4607E+06 |
| 119 | 1-Heptanal | $C_7H_{14}O$ | 111717 | 107.17 | –9070.3 | –12.503 | 7.4446E–06 | 2 | 229.8 | 1.1177E+00 | 617 | 3.1829E+06 |
| 120 | 1-Octanal | $C_8H_{16}O$ | 124130 | 250.25 | –16162 | –33.927 | 2.2349E–05 | 2 | 246 | 4.1640E–01 | 638.1 | 2.9704E+06 |
| 121 | 1-Nonanal | $C_9H_{18}O$ | 124196 | 337.71 | –18506 | –50.224 | 4.7345E–02 | 1 | 255.15 | 3.4172E–01 | 658 | 2.7430E+06 |
| 122 | 1-Decanal | $C_{10}H_{20}O$ | 112312 | 201.64 | –15133 | –26.264 | 1.4625E–05 | 2 | 267.15 | 4.8648E–01 | 674.2 | 2.5989E+06 |
| 123 | Acetone | $C_3H_6O$ | 67641 | 69.006 | –5599.6 | –7.0985 | 6.2237E–06 | 2 | 178.45 | 2.7851E+00 | 508.2 | 4.7091E+06 |
| 124 | Methyl ethyl ketone | $C_4H_8O$ | 78933 | 72.698 | –6143.6 | –7.5779 | 5.6476E–06 | 2 | 186.48 | 1.3904E+00 | 535.5 | 4.1201E+06 |
| 125 | 2-Pentanone | $C_5H_{10}O$ | 107879 | 84.635 | –7078.4 | –9.3 | 6.2702E–06 | 2 | 196.29 | 7.5235E–01 | 561.08 | 3.7062E+06 |
| 126 | Methyl isopropyl ketone | $C_5H_{10}O$ | 563804 | 308.74 | –13693 | –47.557 | 5.7002E–02 | 1 | 181.15 | 2.2648E–02 | 553 | 3.8413E+06 |
| 127 | 2-Hexanone | $C_6H_{12}O$ | 591786 | 65.841 | –7042 | –6.1376 | 7.2196E–18 | 6 | 217.35 | 1.5111E+00 | 587.05 | 3.3120E+06 |
| 128 | Methyl isobutyl ketone | $C_6H_{12}O$ | 108101 | 153.23 | –10055 | –19.848 | 1.6426E–05 | 2 | 189.15 | 3.3536E–02 | 571.4 | 3.2659E+06 |
| 129 | 3-Methyl-2-pentanone | $C_6H_{12}O$ | 565617 | 64.641 | –6457.4 | –6.218 | 3.4543E–06 | 2 | 167.15 | 3.2662E–03 | 573 | 3.3213E+06 |
| 130 | 3-Pentanone | $C_5H_{10}O$ | 96220 | 44.286 | –5415.1 | –3.0913 | 1.8580E–18 | 6 | 234.18 | 7.3422E+01 | 560.95 | 3.6993E+06 |
| 131 | Ethyl isopropyl ketone | $C_6H_{12}O$ | 565695 | 206.77 | –12537 | –27.894 | 2.2462E–05 | 2 | 200 | 6.0339E–02 | 567 | 3.3424E+06 |
| 132 | Diisopropyl ketone | $C_7H_{14}O$ | 565800 | 96.919 | –8014.2 | –11.093 | 7.3452E–06 | 2 | 204.81 | 3.9036E–01 | 576 | 3.0606E+06 |
| 133 | Cyclohexanone | $C_6H_{10}O$ | 108941 | 95.118 | –8300.4 | –10.796 | 6.5037E–06 | 2 | 242 | 6.9667E+00 | 653 | 4.0126E+06 |
| 134 | Methyl phenyl ketone | $C_8H_8O$ | 98862 | 62.688 | –8088.8 | –5.5434 | 2.0774E–18 | 6 | 292.81 | 3.5899E+01 | 709.5 | 3.8451E+06 |
| 135 | Formic acid | $CH_2O_2$ | 64186 | 50.323 | –5378.2 | –4.203 | 3.4697E–06 | 2 | 281.45 | 2.4024E+03 | 588 | 5.8074E+06 |
| 136 | Acetic acid | $C_2H_4O_2$ | 64197 | 53.27 | –6304.5 | –4.2985 | 8.8865E–18 | 6 | 289.81 | 1.2769E+03 | 591.95 | 5.7390E+06 |
| 137 | Propionic acid | $C_3H_6O_2$ | 79094 | 54.552 | –7149.4 | –4.2769 | 1.1843E–18 | 6 | 252.45 | 1.3142E+01 | 600.81 | 4.6080E+06 |
| 138 | *n*-Butyric acid | $C_4H_8O_2$ | 107926 | 93.815 | –9942.2 | –9.8019 | 9.3124E–18 | 6 | 267.95 | 6.7754E+00 | 615.7 | 4.0705E+06 |
| 139 | Isobutyric acid | $C_4H_8O_2$ | 79312 | 110.38 | –10540 | –12.262 | 1.4310E–17 | 6 | 227.15 | 7.8244E–02 | 605 | 3.6834E+06 |
| 140 | Benzoic acid | $C_7H_6O_2$ | 65850 | 88.513 | –11829 | –8.6826 | 2.3248E–19 | 6 | 395.45 | 7.9550E+02 | 751 | 4.4691E+06 |
| 141 | Acetic anhydride | $C_4H_6O_3$ | 108247 | 100.95 | –8873.2 | –11.451 | 6.1316E–06 | 2 | 200.15 | 2.1999E–02 | 606 | 3.9702E+06 |
| 142 | Methyl formate | $C_2H_4O_2$ | 107313 | 77.184 | –5606.1 | –8.392 | 7.8468E–06 | 2 | 174.15 | 6.8808E+00 | 487.2 | 5.9829E+06 |
| 143 | Methyl acetate | $C_3H_6O_2$ | 79209 | 61.267 | –5618.6 | –5.6473 | 2.1080E–17 | 6 | 175.15 | 1.0170E+00 | 506.55 | 4.6948E+06 |
| 144 | Methyl propionate | $C_4H_8O_2$ | 554121 | 70.717 | –6439.7 | –6.9845 | 2.0129E–17 | 6 | 185.65 | 6.3409E–01 | 530.6 | 4.0278E+06 |
| 145 | Methyl *n*-butyrate | $C_5H_{10}O_2$ | 623427 | 71.87 | –6885.7 | –7.0944 | 1.4903E–17 | 6 | 187.35 | 1.3435E–01 | 554.5 | 3.4797E+06 |
| 146 | Ethyl formate | $C_3H_6O_2$ | 109944 | 73.833 | –5817 | –7.809 | 6.3200E–06 | 2 | 193.55 | 1.8119E+01 | 508.4 | 4.7080E+06 |
| 147 | Ethyl acetate | $C_4H_8O_2$ | 141786 | 66.824 | –6227.6 | –6.41 | 1.7914E–17 | 6 | 189.6 | 1.4318E+00 | 523.3 | 3.8502E+06 |
| 148 | Ethyl propionate | $C_5H_{10}O_2$ | 105373 | 105.64 | –8007 | –12.477 | 9.0000E–06 | 2 | 199.25 | 7.7988E–01 | 546 | 3.3365E+06 |
| 149 | Ethyl *n*-butyrate | $C_6H_{12}O_2$ | 105544 | 57.661 | –6346.5 | –5.032 | 8.2534E–18 | 6 | 175.15 | 1.0390E–02 | 571 | 2.9352E+06 |
| 150 | *n*-Propyl formate | $C_4H_8O_2$ | 110747 | 104.08 | –7535.9 | –12.348 | 9.6020E–06 | 2 | 180.25 | 2.1101E–01 | 538 | 4.0310E+06 |
| 151 | *n*-Propyl acetate | $C_5H_{10}O_2$ | 109604 | 115.16 | –8433.9 | –13.934 | 1.0346E–05 | 2 | 178.15 | 1.7113E–02 | 549.73 | 3.3657E+06 |
| 152 | *n*-Butyl acetate | $C_6H_{12}O_2$ | 123864 | 71.34 | –7285.8 | –6.9459 | 9.9895E–18 | 6 | 199.65 | 1.4347E–01 | 579.15 | 3.1097E+06 |
| 153 | Methyl benzoate | $C_8H_8O_2$ | 93583 | 82.976 | –9226.1 | –8.4427 | 5.9115E–18 | 6 | 260.75 | 1.8653E+00 | 693 | 3.5896E+06 |
| 154 | Ethyl benzoate | $C_9H_{10}O_2$ | 93890 | 53.024 | –7676.8 | –4.1593 | 1.6850E–18 | 6 | 238.45 | 1.4385E–01 | 698 | 3.2190E+06 |
| 155 | Vinyl acetate | $C_4H_6O_2$ | 108054 | 57.406 | –5702.8 | –5.0307 | 1.1042E–17 | 6 | 180.35 | 7.0586E–01 | 519.13 | 3.9298E+06 |
| 156 | Methylamine | $CH_5N$ | 74895 | 75.206 | –5082.8 | –8.0919 | 8.1130E–06 | 2 | 179.69 | 1.7671E+02 | 430.05 | 7.4139E+06 |
| 157 | Dimethylamine | $C_2H_7N$ | 124403 | 71.738 | –5302 | –7.3324 | 6.4200E–17 | 6 | 180.96 | 7.5575E+01 | 437.2 | 5.2583E+06 |
| 158 | Trimethylamine | $C_3H_9N$ | 75503 | 134.68 | –6055.8 | –19.415 | 2.8619E–02 | 1 | 156.08 | 9.9206E+00 | 433.25 | 4.1020E+06 |
| 159 | Ethylamine | $C_2H_7N$ | 75047 | 81.56 | –5596.9 | –9.0779 | 8.7920E–06 | 2 | 192.15 | 1.5183E+02 | 456.15 | 5.5937E+06 |
| 160 | Diethylamine | $C_4H_{11}N$ | 109897 | 49.314 | –4949 | –3.9256 | 9.1978E–18 | 6 | 223.35 | 3.7411E+02 | 496.6 | 3.6744E+06 |
| 161 | Triethylamine | $C_6H_{15}N$ | 121448 | 56.55 | –5681.9 | –4.9815 | 1.2363E–17 | 6 | 158.45 | 1.0646E–02 | 535.15 | 3.0373E+06 |
| 162 | *n*-Propylamine | $C_3H_9N$ | 107108 | 58.398 | –5312.7 | –5.2876 | 1.9913E–06 | 2 | 188.36 | 1.3004E+01 | 496.95 | 4.7381E+06 |
| 163 | di-*n*-Propylamine | $C_6H_{15}N$ | 142847 | 54 | –6018.5 | –4.4981 | 9.9684E–18 | 6 | 210.15 | 3.6942E+00 | 550 | 3.1113E+06 |
| 164 | Isopropylamine | $C_3H_9N$ | 75310 | 136.66 | –7201.5 | –18.934 | 2.2255E–02 | 1 | 177.95 | 7.7251E+00 | 471.85 | 4.5404E+06 |
| 165 | Diisopropylamine | $C_6H_{15}N$ | 108189 | 462.84 | –18227 | –73.734 | 9.2794E–02 | 1 | 176.85 | 4.4724E–03 | 523.1 | 3.1987E+06 |
| 166 | Aniline | $C_6H_7N$ | 62533 | 66.287 | –8207.1 | –6.0132 | 2.8414E–18 | 6 | 267.13 | 7.1322E+00 | 699 | 5.3514E+06 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 167 | *N*-Methylaniline | $C_7H_9N$ | 100618 | 70.843 | –8517.5 | –6.7007 | 5.6411E–18 | 6 | 216.15 | 1.0207E–02 | 701.55 | 5.1935E+06 |
| 168 | *N,N*-Dimethylaniline | $C_8H_{11}N$ | 121697 | 51.352 | –7160 | –4.0127 | 8.1481E–07 | 2 | 275.6 | 1.7940E+01 | 687.15 | 3.6262E+06 |
| 169 | Ethylene oxide | $C_2H_4O$ | 75218 | 91.944 | –5293.4 | –11.682 | 1.4902E–02 | 1 | 160.65 | 7.7879E+00 | 469.15 | 7.2553E+06 |
| 170 | Furan | $C_4H_4O$ | 110009 | 74.738 | –5417 | –8.0636 | 7.4700E–06 | 2 | 187.55 | 5.0026E+01 | 490.15 | 5.5497E+06 |
| 171 | Thiophene | $C_4H_4S$ | 110021 | 89.171 | –6860.3 | –10.104 | 7.4769E–06 | 2 | 234.94 | 1.8538E+02 | 579.35 | 5.7145E+06 |
| 172 | Pyridine | $C_5H_5N$ | 110861 | 82.154 | –7211.3 | –8.8646 | 5.2528E–06 | 2 | 231.51 | 2.0535E+01 | 619.95 | 5.6356E+06 |
| 173 | Formamide | $CH_3NO$ | 75127 | 100.3 | –10763 | –10.946 | 3.8503E–06 | 2 | 275.6 | 1.0350E+00 | 771 | 7.7514E+06 |
| 174 | *N,N*-Dimethylformamide | $C_3H_7NO$ | 68122 | 82.762 | –7955.5 | –8.8038 | 4.2431E–06 | 2 | 212.72 | 1.9532E–01 | 649.6 | 4.3653E+06 |
| 175 | Acetamide | $C_2H_5NO$ | 60355 | 125.81 | –12376 | –14.589 | 5.0824E–06 | 2 | 353.33 | 3.3637E+02 | 761 | 6.5688E+06 |
| 176 | *N*-Methylacetamide | $C_3H_7NO$ | 79163 | 79.128 | –9523.9 | –7.7355 | 3.1616E–18 | 6 | 301.15 | 2.8618E+01 | 718 | 4.9973E+06 |
| 177 | Acetonitrile | $C_2H_3N$ | 75058 | 58.302 | –5385.6 | –5.4954 | 5.3634E–06 | 2 | 229.32 | 1.8694E+02 | 545.5 | 4.8517E+06 |
| 178 | Propionitrile | $C_3H_5N$ | 107120 | 82.699 | –6703.5 | –9.1506 | 7.5424E–06 | 2 | 180.26 | 1.6936E–01 | 564.4 | 4.1906E+06 |
| 179 | *n*-Butyronitrile | $C_4H_7N$ | 109740 | 66.32 | –6714.9 | –6.3087 | 1.3516E–17 | 6 | 161.25 | 6.1777E–04 | 582.25 | 3.7870E+06 |
| 180 | Benzonitrile | $C_7H_5N$ | 100470 | 55.463 | –7430.8 | –4.548 | 1.7501E–18 | 6 | 260.4 | 5.1063E+00 | 699.35 | 4.2075E+06 |
| 181 | Methyl mercaptan | $CH_4S$ | 74931 | 54.15 | –4337.7 | –4.8127 | 4.5000E–17 | 6 | 150.18 | 3.1479E+00 | 469.95 | 7.2309E+06 |
| 182 | Ethyl mercaptan | $C_2H_6S$ | 75081 | 65.551 | –5027.4 | –6.6853 | 6.3208E–06 | 2 | 125.26 | 1.1384E–03 | 499.15 | 5.4918E+06 |
| 183 | *n*-Propyl mercaptan | $C_3H_8S$ | 107039 | 62.165 | –5624 | –5.8595 | 2.0597E–17 | 6 | 159.95 | 6.5102E–02 | 536.6 | 4.6272E+06 |
| 184 | *n*-Butyl mercaptan | $C_4H_{10}S$ | 109795 | 65.382 | –6262.4 | –6.2585 | 1.4943E–17 | 6 | 157.46 | 2.3532E–03 | 570.1 | 3.9730E+06 |
| 185 | Isobutyl mercaptan | $C_4H_{10}S$ | 513440 | 61.736 | –5909.2 | –5.7554 | 1.5119E–17 | 6 | 128.31 | 4.7502E–06 | 559 | 4.0603E+06 |
| 186 | *sec*-Butyl mercaptan | $C_4H_{10}S$ | 513531 | 60.649 | –5785.9 | –5.6113 | 1.5877E–17 | 6 | 133.02 | 3.3990E–05 | 554 | 4.0598E+06 |
| 187 | Dimethyl sulfide | $C_2H_6S$ | 75183 | 83.485 | –5711.7 | –9.4999 | 9.8449E–06 | 2 | 174.88 | 7.9009E+00 | 503.04 | 5.5324E+06 |
| 188 | Methyl ethyl sulfide | $C_3H_8S$ | 624895 | 79.07 | –6114.1 | –8.631 | 6.5333E–06 | 2 | 167.23 | 2.2456E–01 | 533 | 4.2610E+06 |
| 189 | Diethyl sulfide | $C_4H_{10}S$ | 352932 | 60.867 | –5969.6 | –5.5979 | 1.4530E–17 | 6 | 169.2 | 4.3401E–02 | 557.15 | 3.9629E+06 |
| 190 | Fluoromethane | $CH_3F$ | 593533 | 59.123 | –3043.7 | –6.1845 | 1.6637E–05 | 2 | 131.35 | 4.3287E+02 | 317.42 | 5.8754E+06 |
| 191 | Chloromethane | $CH_3Cl$ | 74873 | 64.697 | –4048.1 | –6.8066 | 1.0371E–05 | 2 | 175.43 | 8.7091E+02 | 416.25 | 6.6905E+06 |
| 192 | Trichloromethane | $CHCl_3$ | 67663 | 146.43 | –7792.3 | –20.614 | 2.4578E–02 | 1 | 207.15 | 5.2512E+01 | 536.4 | 5.5543E+06 |
| 193 | Tetrachloromethane | $CCl_4$ | 56235 | 78.441 | –6128.1 | –8.5766 | 6.8465E–06 | 2 | 250.33 | 1.1225E+03 | 556.35 | 4.5436E+06 |
| 194 | Bromomethane | $CH_3Br$ | 74839 | 72.586 | –4698.6 | –7.9966 | 1.1553E–05 | 2 | 179.47 | 1.9544E+02 | 467 | 7.9972E+06 |
| 195 | Fluoroethane | $C_2H_5F$ | 353366 | 56.639 | –3576.5 | –5.5801 | 9.8969E–06 | 2 | 129.95 | 8.3714E+00 | 375.31 | 5.0060E+06 |
| 196 | Chloroethane | $C_2H_5Cl$ | 75003 | 70.159 | –4786.7 | –7.5387 | 9.3370E–06 | 2 | 134.8 | 1.1658E–01 | 460.35 | 5.4578E+06 |
| 197 | Bromoethane | $C_2H_5Br$ | 74964 | 62.217 | –5113.3 | –5.9761 | 4.7174E–17 | 6 | 154.55 | 3.7155E–01 | 503.8 | 6.2903E+06 |
| 198 | 1-Chloropropane | $C_3H_7Cl$ | 540545 | 79.24 | –5718.8 | –8.789 | 8.4486E–06 | 2 | 150.35 | 6.9630E–02 | 503.15 | 4.5812E+06 |
| 199 | 2-Chloropropane | $C_3H_7Cl$ | 75296 | 46.854 | –4445.5 | –3.6533 | 1.3260E–17 | 6 | 155.97 | 9.0844E–01 | 489 | 4.5097E+06 |
| 200 | 1,1-Dichloropropane | $C_3H_6Cl_2$ | 78999 | 83.495 | –6661.4 | –9.2386 | 6.7652E–06 | 2 | 200 | 4.5248E+00 | 560 | 4.2394E+06 |
| 201 | 1,2-Dichloropropane | $C_3H_6Cl_2$ | 78875 | 65.955 | –6015.6 | –6.5509 | 4.3172E–06 | 2 | 172.71 | 8.2532E–02 | 572 | 4.2319E+06 |
| 202 | Vinyl chloride | $C_2H_3Cl$ | 75014 | 91.432 | –5141.7 | –10.981 | 1.4318E–05 | 2 | 119.36 | 1.9178E–02 | 432 | 5.7495E+06 |
| 203 | Fluorobenzene | $C_6H_5F$ | 462066 | 51.915 | –5439 | –4.2896 | 8.7527E–18 | 6 | 230.94 | 1.5142E+02 | 560.09 | 4.5437E+06 |
| 204 | Chlorobenzene | $C_6H_5Cl$ | 108907 | 54.144 | –6244.4 | –4.5343 | 4.7030E–18 | 6 | 227.95 | 8.4456E+00 | 632.35 | 4.5293E+06 |
| 205 | Bromobenzene | $C_6H_5Br$ | 108861 | 63.749 | –7130.2 | –5.879 | 5.2136E–18 | 6 | 242.43 | 7.8364E+00 | 670.15 | 4.5196E+06 |
| 206 | Air[3] | | 132259100 | 21.662 | –692.39 | –0.39208 | 4.7574E–03 | 1 | 59.15 | 5.6421E+03 | 132.45 | 3.7934E+06 |
| 207 | Hydrogen | $H_2$ | 1333740 | 12.69 | –94.896 | 1.1125 | 3.2915E–04 | 2 | 13.95 | 7.2116E+03 | 33.19 | 1.3154E+06 |
| 208 | Helium-4[4] | He | 7440597 | 11.533 | –8.99 | 0.6724 | 2.7430E–01 | 1 | 1.76 | 1.4625E+03 | 5.2 | 2.2845E+05 |
| 209 | Neon | Ne | 7440019 | 29.755 | –271.06 | –2.6081 | 5.2700E–04 | 2 | 24.56 | 4.3800E+04 | 44.4 | 2.6652E+06 |
| 210 | Argon | Ar | 7440371 | 42.127 | –1093.1 | –4.1425 | 5.7254E–05 | 2 | 83.78 | 6.8721E+04 | 150.86 | 4.8963E+06 |
| 211 | Fluorine | $F_2$ | 7782414 | 42.393 | –1103.3 | –4.1203 | 5.7815E–05 | 2 | 53.48 | 2.5272E+02 | 144.12 | 5.1674E+06 |
| 212 | Chlorine | $Cl_2$ | 7782505 | 71.334 | –3855 | –8.5171 | 1.2378E–02 | 1 | 172.12 | 1.3660E+03 | 417.15 | 7.7930E+06 |
| 213 | Bromine | $Br_2$ | 7726956 | 108.26 | –6592 | –14.16 | 1.6043E–02 | 1 | 265.85 | 5.8534E+03 | 584.15 | 1.0276E+07 |
| 214 | Oxygen | $O_2$ | 7782447 | 51.245 | –1200.2 | –6.4361 | 2.8405E–02 | 1 | 54.36 | 1.4754E+02 | 154.58 | 5.0206E+06 |
| 215 | Nitrogen | $N_2$ | 7727379 | 58.282 | –1084.1 | –8.3144 | 4.4127E–02 | 1 | 63.15 | 1.2508E+04 | 126.2 | 3.3906E+06 |
| 216 | Ammonia | $NH_3$ | 7664417 | 90.483 | –4669.7 | –11.607 | 1.7194E–02 | 1 | 195.41 | 6.1111E+03 | 405.65 | 1.1301E+07 |
| 217 | Hydrazine | $N_2H_4$ | 302012 | 76.858 | –7245.2 | –8.22 | 6.1557E–03 | 1 | 274.69 | 4.0847E+02 | 653.15 | 1.4731E+07 |
| 218 | Nitrous oxide | $N_2O$ | 10024972 | 96.512 | –4045 | –12.277 | 2.8860E–05 | 2 | 182.3 | 8.6908E+04 | 309.57 | 7.2782E+06 |

**TABLE 2-6 Vapor Pressure of Inorganic and Organic Liquids** (*Concluded*)

| Cmpd. no. | Name | Formula | CAS no. | C1 | C2 | C3 | C4 | C5 | $T_{min}$, K | $P_s$ at $T_{min}$ | $T_{max}$, K | $P_s$ at $T_{max}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 219 | Nitric oxide | NO | 10102439 | 72.974 | –2650 | –8.261 | 9.7000E–15 | 6 | 109.5 | 2.1956E+04 | 180.15 | 6.5156E+06 |
| 220 | Cyanogen | $C_2N_2$ | 460195 | 88.589 | –5059.9 | –10.483 | 1.5403E–05 | 2 | 245.25 | 7.3385E+04 | 400.15 | 5.9438E+06 |
| 221 | Carbon monoxide | CO | 630080 | 45.698 | –1076.6 | –4.8814 | 7.5673E–05 | 2 | 68.15 | 1.5430E+04 | 132.92 | 3.4940E+06 |
| 222 | Carbon dioxide | $CO_2$ | 124389 | 140.54 | –4735 | –21.268 | 4.0909E–02 | 1 | 216.58 | 5.1867E+05 | 304.21 | 7.3896E+06 |
| 223 | Carbon disulfide | $CS_2$ | 75150 | 67.114 | –4820.4 | –7.5303 | 9.1695E–03 | 1 | 161.11 | 1.4944E+00 | 552 | 8.0408E+06 |
| 224 | Hydrogen fluoride | HF | 7664393 | 59.544 | –4143.8 | –6.1764 | 1.4161E–05 | 2 | 189.79 | 3.3683E+02 | 461.15 | 6.4872E+06 |
| 225 | Hydrogen chloride | HCl | 7647010 | 104.27 | –3731.2 | –15.047 | 3.1340E–02 | 1 | 158.97 | 1.3522E+04 | 324.65 | 8.3564E+06 |
| 226 | Hydrogen bromide[2] | HBr | 10035106 | 29.315 | –2424.5 | –1.1354 | 2.3806E–18 | 6 | 185.15 | 2.9501E+04 | 363.15 | 8.4627E+06 |
| 227 | Hydrogen cyanide | HCN | 74908 | 36.75 | –3927.1 | –2.1245 | 3.8948E–17 | 6 | 259.83 | 1.8687E+04 | 456.65 | 5.3527E+06 |
| 228 | Hydrogen sulfide | $H_2S$ | 7783064 | 85.584 | –3839.9 | –11.199 | 1.8848E–02 | 1 | 187.68 | 2.2873E+04 | 373.53 | 8.9988E+06 |
| 229 | Sulfur dioxide | $SO_2$ | 7446095 | 47.365 | –4084.5 | –3.6469 | 1.7990E–17 | 6 | 197.67 | 1.6743E+03 | 430.75 | 7.8596E+06 |
| 230 | Sulfur trioxide | $SO_3$ | 7446119 | 180.99 | –12060 | –22.839 | 7.2350E–17 | 6 | 289.95 | 2.0934E+04 | 490.85 | 8.1919E+06 |
| 231 | Water | $H_2O$ | 7732185 | 73.649 | –7258.2 | –7.3037 | 4.1653E–06 | 2 | 273.16 | 6.1056E+02 | 647.13 | 2.1940E+07 |

All substances are listed in alphabetical order in Table 2-6*a*.

Compiled from Daubert, T. E., R. P. Danner, H. M. Sibul, and C. C. Stebbins, DIPPR Data Compilation of Pure Compound Properties, Project 801 Sponsor Release, July, 1993, Design Institute for Physical Property Data, AIChE, New York, NY; and from Thermodynamics Research Center, "Selected Values of Properties of Hydrocarbons and Related Compounds," Thermodynamics Research Center Hydrocarbon Project, Texas A&M University, College Station, Texas (extant 1994).

Temperatures are in K; vapor pressures are in Pa.

$P_a \times 9.869233E{-}06$ = atm; $P_a \times 1.450377E{-}04$ = psia; vapor pressure = $\exp [C1 + (C2/T) + C3 \times \ln (T) + C4 \times T^{C5}]$.

[1] Decomposes violently on heating. Forms explosive peroxides with air or oxygen. Polymerizes under pressure and heat.

[2] Coefficients are hypothetical above the decomposition temperature.

[3] At the bubble point.

[4] Exhibits superfluid properties below 2.2 K.

**TABLE 2-6*a* Alphabetical Index to Substances in Tables 2-6, 2-30, 2-164, 2-193, 2-196, 2-198, and 2-221**

| Name | Synonym | Cmpd. no. | Formula |
|---|---|---|---|
| Acetaldehyde | Ethanal | 114 | $C_2H_4O$ |
| Acetamide | | 175 | $C_2H_5NO$ |
| Acetic acid | Ethanoic acid | 136 | $C_2H_4O_2$ |
| Acetic anhydride | | 141 | $C_4H_6O_3$ |
| Acetone | 2-Propanone | 123 | $C_3H_6O$ |
| Acetonitrile | Methyl cyanide | 177 | $C_2H_3N$ |
| Acetophenone | Methyl phenyl ketone | 134 | $C_8H_8O$ |
| Acetylene | | 45 | $C_2H_2$ |
| Air | | 206 | |
| Ammonia | | 216 | $NH_3$ |
| Aniline | | 166 | $C_6H_7N$ |
| Anisole | Methyl phenyl ether | 111 | $C_7H_8O$ |
| Argon | | 210 | Ar |
| Benzene | | 67 | $C_6H_6$ |
| Benzoic acid | | 140 | $C_7H_6O_2$ |
| Benzonitrile | Phenyl cyanide | 180 | $C_7H_5N$ |
| Biphenyl | 1,1′-Biphenyl | 79 | $C_{12}H_{10}$ |
| Bromine | | 213 | $Br_2$ |
| Bromobenzene | | 205 | $C_6H_5Br$ |
| Bromoethane | Ethyl bromide | 197 | $C_2H_5Br$ |
| Bromomethane | Methyl bromide | 194 | $CH_3Br$ |
| 1,2-Butadiene | | 42 | $C_4H_6$ |
| 1,3-Butadiene | | 43 | $C_4H_6$ |
| *n*-Butane | | 4 | $C_4H_{10}$ |
| 1-Butanol | | 85 | $C_4H_{10}O$ |
| 2-Butanol | *sec*-Butyl alcohol | 86 | $C_4H_{10}O$ |
| 1-Butene | | 30 | $C_4H_8$ |
| *cis*-2-Butene | *Z*-2-Butene | 31 | $C_4H_8$ |
| *trans*-2-Butene | *E*-2-Butene | 32 | $C_4H_8$ |
| *n*-Butyl acetate | | 152 | $C_6H_{12}O_2$ |
| *n*-Butyl mercaptan | 1-Butanethiol | 184 | $C_4H_{10}S$ |
| *sec*-Butyl mercaptan | 2-Butanethiol | 186 | $C_4H_{10}S$ |
| Butyraldehyde | Butanal | 116 | $C_4H_8O$ |
| *n*-Butyric acid | | 138 | $C_4H_8O_2$ |
| *n*-Butyronitrile | Propyl cyanide | 179 | $C_4H_7N$ |
| Carbon dioxide | | 222 | $CO_2$ |
| Carbon disulfide | | 223 | $CS_2$ |
| Carbon monoxide | | 221 | CO |
| Carbon tetrachloride | Tetrachloromethane | 193 | $CCl_4$ |
| Chlorine | | 212 | $Cl_2$ |
| Chlorobenzene | | 204 | $C_6H_5Cl$ |
| Chloroethane | Ethyl chloride | 196 | $C_2H_5Cl$ |
| Chloroform | Trichloromethane | 192 | $CHCl_3$ |
| Chloromethane | Methyl chloride | 191 | $CH_3Cl$ |
| 1-Chloropropane | Propyl chloride | 198 | $C_3H_7Cl$ |
| 2-Chloropropane | Isopropyl chloride | 199 | $C_3H_7Cl$ |
| *o*-Cresol | 2-Methylphenol | 98 | $C_7H_8O$ |
| *m*-Cresol | 3-Methylphenol | 99 | $C_7H_8O$ |
| *p*-Cresol | 4-Methylphenol | 100 | $C_7H_8O$ |
| Cumene | Isopropylbenzene | 75 | $C_9H_{12}$ |
| Cyanogen | | 220 | $C_2N_2$ |
| Cyclohexane | | 60 | $C_6H_{12}$ |
| Cyclohexanol | Cyclohexyl alcohol | 94 | $C_6H_{12}O$ |
| Cyclohexanone | Cyclohexyl ketone | 133 | $C_6H_{10}O$ |
| Cyclohexene | | 66 | $C_6H_{10}$ |
| Cyclopentane | | 57 | $C_5H_{10}$ |
| Cyclopentene | | 64 | $C_5H_8$ |
| *p*-Cymene | *p*-Isopropyltoluene | 77 | $C_{10}H_{14}$ |
| 1-Decanal | | 122 | $C_{10}H_{20}O$ |
| *n*-Decane | | 10 | $C_{10}H_{22}$ |
| 1-Decene | | 38 | $C_{10}H_{20}$ |
| 1,1-Dichloropropane | | 200 | $C_3H_6Cl_2$ |
| 1,2-Dichloropropane | | 201 | $C_3H_6Cl_2$ |
| Diethylamine | | 160 | $C_4H_{11}N$ |
| Diethyl ether | Ethyl ether | 108 | $C_4H_{10}O$ |
| Diethyl sulfide | Ethyl sulfide | 189 | $C_4H_{10}S$ |
| Diisopropylamine | | 165 | $C_6H_{15}N$ |
| Diisopropyl ketone | 2,4-Dimethyl-3-pentanone | 132 | $C_7H_{14}O$ |
| Dimethylacetylene | 2-Butyne | 47 | $C_4H_6$ |
| Dimethylamine | | 157 | $C_2H_7N$ |
| *N*,*N*-Dimethylaniline | *N*,*N*-Dimethylbenzamine | 168 | $C_8H_{11}N$ |
| 2,3-Dimethylbutane | Diisopropyl | 23 | $C_6H_{14}$ |
| 1,1-Dimethylcyclohexane | | 62 | $C_8H_{16}$ |
| Dimethyl ether | Methyl ether | 101 | $C_2H_6O$ |
| 1-Hexene | | 34 | $C_6H_{12}$ |
| 1-Hexyne | | 51 | $C_6H_{10}$ |
| 2-Hexyne | | 52 | $C_6H_{10}$ |
| 3-Hexyne | | 53 | $C_6H_{10}$ |
| Hydrazine | | 217 | $N_2H_4$ |
| Hydrogen | | 207 | $H_2$ |
| Hydrogen bromide | | 226 | HBr |
| Hydrogen chloride | | 225 | HCl |
| Hydrogen cyanide | | 227 | HCN |
| Hydrogen fluoride | | 224 | HF |
| Hydrogen sulfide | | 228 | $H_2S$ |
| Isobutyl mercaptan | 2-Methyl-1-propanethiol | 185 | $C_4H_{10}S$ |
| Isobutyric acid | 2-Methylpropanoic acid | 139 | $C_4H_8O_2$ |
| Isooctane | 2,2,4-Trimethylpentane | 27 | $C_8H_{18}$ |
| Isoprene | 2-Methyl-1,3-butadiene | 44 | $C_5H_8$ |
| Isopropylamine | | 164 | $C_3H_9N$ |
| Mesitylene | 1,3,5-Trimethylbenzene | 76 | $C_9H_{12}$ |
| Methane | | 1 | $CH_4$ |
| Methanol | Methyl alcohol | 82 | $CH_4O$ |
| *N*-Methylacetamide | | 176 | $C_3H_7NO$ |
| Methyl acetate | | 143 | $C_3H_6O_2$ |
| Methylacetylene | | 46 | $C_3H_4$ |
| Methylamine | | 156 | $CH_5N$ |
| *N*-Methylaniline | | 167 | $C_7H_9N$ |
| Methyl benzoate | | 153 | $C_8H_8O_2$ |
| 2-Methylbutane | Isopentane | 22 | $C_5H_{12}$ |
| 2-Methyl-1-butanol | | 90 | $C_5H_{12}O$ |
| 3-Methyl-1-butanol | Isoamyl alcohol | 91 | $C_5H_{12}O$ |
| 2-Methyl-1-butene | | 40 | $C_5H_{10}$ |
| 2-Methyl-2-butene | Amylene | 41 | $C_5H_{10}$ |
| Methyl butyl ether | | 105 | $C_5H_{12}O$ |
| 3-Methyl-1-butyne | | 48 | $C_5H_8$ |
| Methyl butyrate | | 145 | $C_5H_{10}O_2$ |
| Methylcyclohexane | | 61 | $C_7H_{14}$ |
| Methylcyclopentane | | 58 | $C_6H_{12}$ |
| 1-Methylcyclopentene | | 65 | $C_6H_{10}$ |
| Methyl ethyl ether | | 102 | $C_3H_8O$ |
| Methyl ethyl ketone | 2-Butanone | 124 | $C_4H_8O$ |
| Methyl ethyl sulfide | 2-Thiabutane | 188 | $C_3H_8S$ |
| Methyl formate | | 142 | $C_2H_4O_2$ |
| Methyl isobutyl ether | | 106 | $C_5H_{12}O$ |
| Methyl isobutyl ketone | | 128 | $C_6H_{12}O$ |
| Methyl isopropyl ether | | 104 | $C_4H_{10}O$ |
| Methyl isopropyl ketone | | 126 | $C_5H_{10}O$ |
| Methyl mercaptan | Methanethiol | 181 | $CH_4S$ |
| 2-Methylpentane | Isohexane | 24 | $C_6H_{14}$ |
| 3-Methyl-2-pentanone | Methyl *sec*-butyl ketone | 129 | $C_6H_{12}O$ |
| 2-Methylpropane | Isobutane | 21 | $C_4H_{10}$ |
| 2-Methyl-2-propanol | *tert*-Butyl alcohol | 88 | $C_4H_{10}O$ |
| 2-Methylpropene | Isobutene | 39 | $C_4H_8$ |
| Methyl propionate | | 144 | $C_4H_8O_2$ |
| Methyl propyl ether | | 103 | $C_4H_{10}O$ |
| Methyl *tert*-butyl ether | | 107 | $C_5H_{12}O$ |
| Naphthalene | | 78 | $C_{10}H_8$ |
| Neon | | 209 | Ne |
| Nitric oxide | | 219 | NO |
| Nitrogen | | 215 | $N_2$ |
| Nitrous oxide | | 218 | $N_2O$ |
| *n*-Nonadecane | | 19 | $C_{19}H_{40}$ |
| 1-Nonanal | *n*-Nonaldehyde | 121 | $C_9H_{18}O$ |
| *n*-Nonane | | 9 | $C_9H_{20}$ |
| 1-Nonene | | 37 | $C_9H_{18}$ |
| *n*-Octadecane | | 18 | $C_{18}H_{38}$ |
| 1-Octanal | *n*-Octaldehyde | 120 | $C_8H_{16}O$ |
| *n*-Octane | | 8 | $C_8H_{18}$ |
| 1-Octene | | 36 | $C_8H_{16}$ |
| 1-Octyne | | 55 | $C_8H_{14}$ |
| Oxygen | | 214 | $O_2$ |
| *n*-Pentadecane | | 15 | $C_{15}H_{32}$ |
| 1-Pentanal | Valeraldehyde | 117 | $C_5H_{10}O$ |
| *n*-Pentane | | 5 | $C_5H_{12}$ |
| 1-Pentanol | *n*-Amyl alcohol | 89 | $C_5H_{12}O$ |

**TABLE 2-6*a*** **Alphabetical Index to Substances in Tables 2-6, 2-30, 2-164, 2-193, 2-196, 2-198, and 2-221** (*Concluded*)

| Name | Synonym | Cmpd. no. | Formula | Name | Synonym | Cmpd. no. | Formula |
|---|---|---|---|---|---|---|---|
| *N,N*-Dimethylformamide | | 174 | $C_3H_7NO$ | 2-Pentanone | Methyl *n*-propyl ketone | 125 | $C_5H_{10}O$ |
| 2,3-Dimethylpentane | | 25 | $C_7H_{16}$ | 3-Pentanone | Diethyl ketone | 130 | $C_5H_{10}O$ |
| Dimethyl sulfide | Methyl sulfide | 187 | $C_2H_6S$ | 1-Pentene | | 33 | $C_5H_{10}$ |
| Diphenyl ether | | 112 | $C_{12}H_{10}O$ | 1-Pentyne | | 49 | $C_5H_8$ |
| *n*-Dodecane | | 12 | $C_{12}H_{26}$ | 2-Pentyne | | 50 | $C_5H_8$ |
| | | | | Phenol | | 97 | $C_6H_6O$ |
| *n*-Eicosane | | 20 | $C_{20}H_{42}$ | 1-Propanal | Propionaldehyde | 115 | $C_3H_6O$ |
| Ethane | | 2 | $C_2H_6$ | *n*-Propane | | 3 | $C_3H_8$ |
| Ethanol | Ethyl alcohol | 83 | $C_2H_6O$ | 1-Propanol | *n*-Propyl alcohol | 84 | $C_3H_8O$ |
| Ethyl acetate | | 147 | $C_4H_8O_2$ | 2-Propanol | Isopropyl alcohol | 87 | $C_3H_8O$ |
| Ethylamine | | 159 | $C_2H_7N$ | *n*-Propionic acid | | 137 | $C_3H_6O_2$ |
| Ethylbenzene | Phenylethane | 72 | $C_8H_{10}$ | *n*-Propionitrile | Ethyl cyanide | 178 | $C_3H_5N$ |
| Ethyl benzoate | | 154 | $C_9H_{10}O_2$ | *n*-Propyl acetate | | 151 | $C_5H_{10}O_2$ |
| Ethyl butyrate | | 149 | $C_6H_{12}O_2$ | *n*-Propylamine | | 162 | $C_3H_9N$ |
| Ethylcyclohexane | | 63 | $C_8H_{16}$ | di-*n*-Propylamine | | 163 | $C_6H_{15}N$ |
| Ethylcyclopentane | | 59 | $C_7H_{14}$ | *n*-Propylbenzene | | 73 | $C_9H_{12}$ |
| Ethylene | | 28 | $C_2H_4$ | Propylene | | 29 | $C_3H_6$ |
| Ethylene glycol | 1,2-Ethanediol | 95 | $C_2H_6O_2$ | 1,2-Propylene glycol | 1,2-Propanediol | 96 | $C_3H_8O_2$ |
| Ethylene oxide | 1,2-Epoxyethane | 169 | $C_2H_4O$ | *n*-Propyl formate | | 150 | $C_4H_8O_2$ |
| Ethyl formate | | 146 | $C_3H_6O_2$ | *n*-Propyl mercaptan | Propanethiol | 183 | $C_3H_8S$ |
| Ethyl isopropyl ether | | 110 | $C_5H_{12}O$ | Pyridine | | 172 | $C_5H_5N$ |
| Ethyl isopropyl ketone | | 131 | $C_6H_{12}O$ | | | | |
| Ethyl mercaptan | Ethanethiol | 182 | $C_2H_6S$ | Styrene | | 80 | $C_8H_8$ |
| Ethyl propionate | | 148 | $C_5H_{10}O_2$ | Sulfur dioxide | | 229 | $SO_2$ |
| Ethyl propyl ether | | 109 | $C_5H_{12}O$ | Sulfur trioxide | | 230 | $SO_3$ |
| | | | | | | | |
| Fluorine | | 211 | $F_2$ | *m*-Terphenyl | | 81 | $C_{18}H_{14}$ |
| Fluorobenzene | | 203 | $C_6H_5F$ | *n*-Tetradecane | | 14 | $C_{14}H_{30}$ |
| Fluoroethane | Ethyl fluoride | 195 | $C_2H_5F$ | Thiophene | | 171 | $C_4H_4S$ |
| Fluoromethane | Methyl fluoride | 190 | $CH_3F$ | Toluene | | 68 | $C_7H_8$ |
| Formaldehyde | Methanal | 113 | $CH_2O$ | *n*-Tridecane | | 13 | $C_{13}H_{28}$ |
| Formamide | | 173 | $CH_3NO$ | Triethylamine | | 161 | $C_6H_{15}N$ |
| Formic acid | Methanoic acid | 135 | $CH_2O_2$ | Trimethylamine | | 158 | $C_3H_9N$ |
| Furan | | 170 | $C_4H_4O$ | 1,2,4-Trimethylbenzene | | 74 | $C_9H_{12}$ |
| | | | | 2,3,3-Trimethylpentane | | 26 | $C_8H_{18}$ |
| Helium-4 | | 208 | He | | | | |
| *n*-Heptadecane | | 17 | $C_{17}H_{36}$ | *n*-Undecane | | 11 | $C_{11}H_{24}$ |
| 1-Heptanal | *n*-Heptaldehyde | 119 | $C_7H_{14}O$ | | | | |
| *n*-Heptane | | 7 | $C_7H_{16}$ | Vinyl acetate | | 155 | $C_4H_6O_2$ |
| 1-Heptanol | *n*-Heptyl alcohol | 93 | $C_7H_{16}O$ | Vinylacetylene | | 56 | $C_4H_4$ |
| 1-Heptene | | 35 | $C_7H_{14}$ | Vinyl chloride | | 202 | $C_2H_3Cl$ |
| 1-Heptyne | | 54 | $C_7H_{12}$ | | | | |
| *n*-Hexadecane | | 16 | $C_{16}H_{34}$ | Water | | 231 | $H_2O$ |
| 1-Hexanal | Caproaldehyde | 118 | $C_6H_{12}O$ | | | | |
| *n*-Hexane | | 6 | $C_6H_{14}$ | *o*-Xylene | 1,2-Dimethylbenzene | 69 | $C_8H_{10}$ |
| 1-Hexanol | *n*-Hexyl alcohol | 92 | $C_6H_{14}O$ | *m*-Xylene | 1,3-Dimethylbenzene | 70 | $C_8H_{10}$ |
| 2-Hexanone | Methyl *n*-butyl ketone | 127 | $C_6H_{12}O$ | *p*-Xylene | 1,4-Dimethylbenzene | 71 | $C_8H_{10}$ |

**TABLE 2-7 Vapor Pressures of Inorganic Compounds, up to 1 atm***

| Compound | | Pressure, mm Hg | | | | | | | | | | Melting point, °C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 5 | 10 | 20 | 40 | 60 | 100 | 200 | 400 | 760 | |
| Name | Formula | Temperature, °C | | | | | | | | | | |
| Aluminum | Al | 1284 | 1421 | 1487 | 1555 | 1635 | 1684 | 1749 | 1844 | 1947 | 2056 | 660 |
| borohydride | $Al(BH_4)_3$ | | −52.2 | −42.9 | −32.5 | −20.9 | −13.4 | −3.9 | +11.2 | 28.1 | 45.9 | −64. |
| bromide | $AlBr_3$ | 81.3 | 103.8 | 118.0 | 134.0 | 150.6 | 161.7 | 176.1 | 199.8 | 227.0 | 256.3 | 97. |
| chloride | $Al_2Cl_6$ | 100.0 | 116.4 | 123.8 | 131.8 | 139.9 | 145.4 | 152.0 | 161.8 | 171.6 | 180.2 | 192.4 |
| fluoride | $AlF_3$ | 1238 | 1298 | 1324 | 1350 | 1378 | 1398 | 1422 | 1457 | 1496 | 1537 | 1040 |
| iodide | $AlI_3$ | 178.0 | 207.7 | 225.8 | 244.2 | 265.0 | 277.8 | 294.5 | 322.0 | 354.0 | 385.5 | |
| oxide | $Al_2O_3$ | 2148 | 2306 | 2385 | 2465 | 2549 | 2599 | 2665 | 2766 | 2874 | 2977 | 2050 |
| Ammonia | $NH_3$ | −109.1 | −97.5 | −91.9 | −85.8 | −79.2 | −74.3 | −68.4 | −57.0 | −45.4 | −33.6 | −77.7 |
| heavy | $ND_3$ | | | | | | −74.0 | −67.4 | −57.0 | −45.4 | −33.4 | −74.0 |
| Ammonium bromide | $NH_4Br$ | 198.3 | 234.5 | 252.0 | 270.6 | 290.0 | 303.8 | 320.0 | 345.3 | 370.8 | 396.0 | |
| carbamate | $N_2H_6CO_2$ | −26.1 | −10.4 | −2.9 | +5.3 | 14.0 | 19.6 | 26.7 | 37.2 | 48.0 | 58.3 | |
| chloride | $NH_4Cl$ | 160.4 | 193.8 | 209.8 | 226.1 | 245.0 | 256.2 | 271.5 | 293.2 | 316.5 | 337.8 | 520 |
| cyanide | $NH_4CN$ | −50.6 | −35.7 | −28.6 | −20.9 | −12.6 | −7.4 | −0.5 | +9.6 | 20.5 | 31.7 | 36 |
| hydrogen sulfide | $NH_4HS$ | −51.1 | −36.0 | −28.7 | −20.8 | −12.3 | −7.0 | 0.0 | +10.5 | 21.8 | 33.3 | |
| iodide | $NH_4I$ | 210.9 | 247.0 | 263.5 | 282.8 | 302.8 | 316.0 | 331.8 | 355.8 | 381.0 | 404.9 | |
| Antimony | Sb | 886 | 984 | 1033 | 1084 | 1141 | 1176 | 1223 | 1288 | 1364 | 1440 | 630.5 |
| tribromide | $SbBr_3$ | 93.9 | 126.0 | 142.7 | 158.3 | 177.4 | 188.1 | 203.5 | 225.7 | 250.2 | 275.0 | 96.6 |
| trichloride | $SbCl_3$ | 49.2 | 71.4 | 85.2 | 100.6 | 117.8 | 128.3 | 143.3 | 165.9 | 192.2 | 219.0 | 73.4 |
| pentachloride | $SbCl_5$ | 22.7 | 48.6 | 61.8 | 75.8 | 91.0 | 101.0 | 114.1 | | | | 2.8 |
| triiodide | $SbI_3$ | 163.6 | 203.8 | 223.5 | 244.8 | 267.8 | 282.5 | 303.5 | 333.8 | 368.5 | 401.0 | 167 |
| trioxide | $Sb_4O_6$ | 574 | 626 | 666 | 729 | 812 | 873 | 957 | 1085 | 1242 | 1425 | 656 |
| Argon | A | −218.2 | −213.9 | −210.9 | −207.9 | −204.9 | −202.9 | −200.5 | −195.6 | −190.6 | −185.6 | −189.2 |
| Arsenic | As | 372 | 416 | 437 | 459 | 483 | 498 | 518 | 548 | 579 | 610 | 814 |
| Arsenic tribromide | $AsBr_3$ | 41.8 | 70.6 | 85.2 | 101.3 | 118.7 | 130.0 | 145.2 | 167.7 | 193.6 | 220.0 | |
| trichloride | $AsCl_3$ | −11.4 | +11.7 | +23.5 | 36.0 | 50.0 | 58.7 | 70.9 | 89.2 | 109.7 | 130.4 | −18 |
| trifluoride | $AsF_3$ | | | | | −2.5 | +4.2 | 13.2 | 26.7 | 41.4 | 56.3 | −5.9 |
| pentafluoride | $AsF_5$ | −117.9 | −108.0 | −103.1 | −98.0 | −92.4 | −88.5 | −84.3 | −75.5 | −64.0 | −52.8 | −79.8 |
| trioxide | $As_2O_3$ | 212.5 | 242.6 | 259.7 | 279.2 | 299.2 | 310.3 | 332.5 | 370.0 | 412.2 | 457.2 | 312.8 |
| Arsine | $AsH_3$ | −142.6 | −130.8 | −124.7 | −117.7 | −110.2 | −104.8 | −98.0 | −87.2 | −75.2 | −62.1 | −116.3 |
| Barium | Ba | | 984 | 1049 | 1120 | 1195 | 1240 | 1301 | 1403 | 1518 | 1638 | 850 |
| Beryllium borohydride | $Be(BH_4)_2$ | +1.0 | 19.8 | 28.1 | 36.8 | 46.2 | 51.7 | 58.6 | 69.0 | 79.7 | 90.0 | 123 |
| bromide | $BeBr_2$ | 289 | 325 | 342 | 361 | 379 | 390 | 405 | 427 | 451 | 474 | 490 |
| chloride | $BeCl_2$ | 291 | 328 | 346 | 365 | 384 | 395 | 411 | 435 | 461 | 487 | 405 |
| iodide | $BeI_2$ | 283 | 322 | 341 | 361 | 382 | 394 | 411 | 435 | 461 | 487 | 488 |
| Bismuth | Bi | 1021 | 1099 | 1136 | 1177 | 1217 | 1240 | 1271 | 1319 | 1370 | 1420 | 271 |
| tribromide | $BiBr_3$ | | 261 | 282 | 305 | 327 | 340 | 360 | 392 | 425 | 461 | 218 |
| trichloride | $BiCl_3$ | | 242 | 264 | 287 | 311 | 324 | 343 | 372 | 405 | 441 | 230 |
| Diborane hydrobromide | $B_2H_5Br$ | −93.3 | −75.3 | −66.3 | −56.4 | −45.4 | −38.2 | −29.0 | −15.4 | 0.0 | +16.3 | −104.2 |
| Borine carbonyl | $BH_3CO$ | −139.2 | −127.3 | −121.1 | −114.1 | −106.6 | −101.9 | −95.3 | −85.5 | −74.8 | −64.0 | −137.0 |
| triamine | $B_3N_3H_6$ | −63.0 | −45.0 | −35.3 | −25.0 | −13.2 | −5.8 | +4.0 | 18.5 | 34.3 | 50.6 | −58.2 |
| Boron hydrides | | | | | | | | | | | | |
| dihydrodecaborane | $B_{10}H_{14}$ | 60.0 | 80.8 | 90.2 | 100.0 | 117.4 | 127.8 | 142.3 | 163.8 | | | 99.6 |
| dihydrodiborane | $B_2H_6$ | −159.7 | −149.5 | −144.3 | −138.5 | −131.6 | −127.2 | −120.9 | −111.2 | −99.6 | −86.5 | −169 |
| dihydropentaborane | $B_5H_9$ | | −40.4 | −30.7 | −20.0 | −8.0 | −0.4 | +9.6 | 24.6 | 40.8 | 58.1 | −47.0 |
| tetrahydropentaborane | $B_5H_{11}$ | −50.2 | −29.9 | −19.9 | −9.2 | +2.7 | 10.2 | 20.1 | 34.8 | 51.2 | 67.0 | |
| tetrahydrotetraborane | $B_4H_{10}$ | −90.9 | −73.1 | −64.3 | −54.8 | −44.3 | −37.4 | −28.1 | −14.0 | +0.8 | 16.1 | −119.9 |
| Boron tribromide | $BBr_3$ | −41.4 | −20.4 | −10.1 | +1.5 | 14.0 | 22.1 | 33.5 | 50.3 | 70.0 | 91.7 | −45 |
| trichloride | $BCl_3$ | −91.5 | −75.2 | −66.9 | −57.9 | −47.8 | −41.2 | −32.4 | −18.9 | −3.6 | +12.7 | −107 |
| trifluoride | $BF_3$ | −154.6 | −145.4 | −141.3 | −136.4 | −131.0 | −127.6 | −123.0 | −115.9 | −108.3 | −100.7 | −126.8 |
| Bromine | $Br_2$ | −48.7 | −32.8 | −25.0 | −16.8 | −8.0 | −0.6 | +9.3 | 24.3 | 41.0 | 58.2 | −7.3 |
| pentafluoride | $BrF_5$ | −69.3 | −51.0 | −41.9 | −32.0 | −21.0 | −14.0 | −4.5 | +9.9 | 25.7 | 40.4 | −61.4 |
| Cadmium | Cd | 394 | 455 | 484 | 516 | 553 | 578 | 611 | 658 | 711 | 765 | 320.9 |
| chloride | $CdCl_2$ | | 618 | 656 | 695 | 736 | 762 | 797 | 847 | 908 | 967 | 568 |
| fluoride | $CdF_2$ | 1112 | 1231 | 1286 | 1344 | 1400 | 1436 | 1486 | 1561 | 1651 | 1751 | 520 |
| iodide | $CdI_2$ | 416 | 481 | 512 | 546 | 584 | 608 | 640 | 688 | 742 | 796 | 385 |
| oxide | CdO | 1000 | 1100 | 1149 | 1200 | 1257 | 1295 | 1341 | 1409 | 1484 | 1559 | |
| Calcium | Ca | | 926 | 983 | 1046 | 1111 | 1152 | 1207 | 1288 | 1388 | 1487 | 851 |
| Carbon (graphite) | C | 3586 | 3828 | 3946 | 4069 | 4196 | 4273 | 4373 | 4516 | 4660 | 4827 | |
| dioxide | $CO_2$ | −134.3 | −124.4 | −119.5 | −114.4 | −108.6 | −104.8 | −100.2 | −93.0 | −85.7 | −78.2 | −57.5 |
| disulfide | $CS_2$ | −73.8 | −54.3 | −44.7 | −34.3 | −22.5 | −15.3 | −5.1 | +10.4 | 28.0 | 46.5 | −110.8 |
| monoxide | CO | −222.0 | −217.2 | −215.0 | −212.8 | −210.0 | −208.1 | −205.7 | −201.3 | −196.3 | −191.3 | −205.0 |
| oxyselenide | COSe | −117.1 | −102.3 | −95.0 | −86.3 | −76.4 | −70.2 | −61.7 | −49.8 | −35.6 | −21.9 | |
| oxysulfide | COS | −132.4 | −119.8 | −113.3 | −106.0 | −98.3 | −93.0 | −85.9 | −75.0 | −62.7 | −49.9 | −138.8 |
| selenosulfide | CSeS | −47.3 | −26.5 | −16.0 | −4.4 | +8.6 | 17.0 | 28.3 | 45.7 | 65.2 | 85.6 | −75.2 |
| subsulfide | $C_3S_2$ | 14.0 | 41.2 | 54.9 | 69.3 | 85.6 | 96.0 | 109.9 | 130.8 | | | +0.4 |
| tetrabromide | $CBr_4$ | | | | | 96.3 | 106.3 | 119.7 | 139.7 | 163.5 | 189.5 | 90.1 |
| tetrachloride | $CCl_4$ | −50.0 | −30.0 | −19.6 | −8.2 | +4.3 | 12.3 | 23.0 | 38.3 | 57.8 | 76.7 | −22.6 |
| tetrafluoride | $CF_4$ | −184.6 | −174.1 | −169.3 | −164.3 | −158.8 | −155.4 | −150.7 | −143.6 | −135.5 | −127.7 | −183.7 |
| Cesium | Cs | 279 | 341 | 375 | 409 | 449 | 474 | 509 | 561 | 624 | 690 | 28.5 |
| bromide | CsBr | 748 | 838 | 887 | 938 | 993 | 1026 | 1072 | 1140 | 1221 | 1300 | 636 |
| chloride | CsCl | 744 | 837 | 884 | 934 | 989 | 1023 | 1069 | 1139 | 1217 | 1300 | 646 |
| fluoride | CsF | 712 | 798 | 844 | 893 | 947 | 980 | 1025 | 1092 | 1170 | 1251 | 683 |
| iodide | CsI | 738 | 828 | 873 | 923 | 976 | 1009 | 1055 | 1124 | 1200 | 1280 | 621 |

*Compiled from the extended tables published by D. R. Stull in *Ind. Eng. Chem.*, **39,** 517 (1947).

**TABLE 2-7 Vapor Pressures of Inorganic Compounds, up to 1 atm** (*Continued*)

| Compound | | Pressure, mm Hg | | | | | | | | | | Melting point, °C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 5 | 10 | 20 | 40 | 60 | 100 | 200 | 400 | 760 | |
| Name | Formula | Temperature, °C | | | | | | | | | | |
| Chlorine | $Cl_2$ | −118.0 | −106.7 | −101.6 | −93.3 | −84.5 | −79.0 | −71.7 | −60.2 | −47.3 | −33.8 | −100.7 |
| fluoride | ClF | | −143.4 | −139.0 | −134.3 | −128.8 | −125.3 | −120.8 | −114.4 | −107.0 | −100.5 | −145 |
| trifluoride | $ClF_3$ | | −80.4 | −71.8 | −62.3 | −51.3 | −44.1 | −34.7 | −20.7 | −4.9 | +11.5 | −83 |
| monoxide | $Cl_2O$ | −98.5 | −81.6 | −73.1 | −64.3 | −54.3 | −48.0 | −39.4 | −26.5 | −12.5 | +2.2 | −116 |
| dioxide | $ClO_2$ | | | −59.0 | −51.2 | −42.8 | −37.2 | −29.4 | −17.8 | −4.0 | +11.1 | −59 |
| heptoxide | $Cl_2O_7$ | −45.3 | −23.8 | −13.2 | −2.1 | +10.3 | +18.2 | 29.1 | 44.6 | 62.2 | 78.8 | −91 |
| Chlorosulfonic acid | $HSO_3Cl$ | 32.0 | 53.5 | 64.0 | 75.3 | 87.6 | 95.2 | 105.3 | 120.0 | 136.1 | 151.0 | −80 |
| Chromium | Cr | 1616 | 1768 | 1845 | 1928 | 2013 | 2067 | 2139 | 2243 | 2361 | 2482 | 1615 |
| carbonyl | $Cr(CO)_6$ | 36.0 | 58.0 | 68.3 | 79.5 | 91.2 | 98.3 | 108.0 | 121.8 | 137.2 | 151.0 | |
| oxychloride | $CrO_2Cl_2$ | −18.4 | +3.2 | 13.8 | 25.7 | 38.5 | 46.7 | 58.0 | 75.2 | 95.2 | 117.1 | |
| Cobalt chloride | $CoCl_2$ | | | | | 770 | 801 | 843 | 904 | 974 | 1050 | 735 |
| nitrosyl tricarbonyl | $Co(CO)_3NO$ | | | | −1.3 | +11.0 | 18.5 | 29.0 | 44.4 | 62.0 | 80.0 | −11 |
| Columbium fluoride | $CbF_5$ | | | 86.3 | 103.0 | 121.5 | 133.2 | 148.5 | 172.2 | 198.0 | 225.0 | 75.5 |
| Copper | Cu | 1628 | 1795 | 1879 | 1970 | 2067 | 2127 | 2207 | 2325 | 2465 | 2595 | 1083 |
| Cuprous bromide | $Cu_2Br_2$ | 572 | 666 | 718 | 777 | 844 | 887 | 951 | 1052 | 1189 | 1355 | 504 |
| chloride | $Cu_2Cl_2$ | 546 | 645 | 702 | 766 | 838 | 886 | 960 | 1077 | 1249 | 1490 | 422 |
| iodide | $Cu_2I_2$ | | 610 | 656 | 716 | 786 | 836 | 907 | 1018 | 1158 | 1336 | 605 |
| Cyanogen | $C_2N_2$ | −95.8 | −83.2 | −76.8 | −70.1 | −62.7 | −57.9 | −51.8 | −42.6 | −33.0 | −21.0 | −34.4 |
| bromide | CNBr | −35.7 | −18.3 | −10.0 | −1.0 | +8.6 | 14.7 | 22.6 | 33.8 | 46.0 | 61.5 | 58 |
| chloride | CNCl | −76.7 | −61.4 | −53.8 | −46.1 | −37.5 | −32.1 | −24.9 | −14.1 | −2.3 | +13.1 | −6.5 |
| fluoride | CNF | −134.4 | −123.8 | −118.5 | −112.8 | −106.4 | −102.3 | −97.0 | −89.2 | −80.5 | −72.6 | |
| Deuterium cyanide | DCN | −68.9 | −54.0 | −46.7 | −38.8 | −30.1 | −24.7 | −17.5 | −5.4 | +10.0 | 26.2 | −12 |
| Fluorine | $F_2$ | −223.0 | −216.9 | −214.1 | −211.0 | −207.7 | −205.6 | −202.7 | −198.3 | −193.2 | −187.9 | −223 |
| oxide | $F_2O$ | −196.1 | −186.6 | −182.3 | −177.8 | −173.0 | −170.0 | −165.8 | −159.0 | −151.9 | −144.6 | −223.9 |
| Germanium bromide | $GeBr_4$ | | 43.3 | 56.8 | 71.8 | 88.1 | 98.8 | 113.2 | 135.4 | 161.6 | 189.0 | 26.1 |
| chloride | $GeCl_4$ | −45.0 | −24.9 | −15.0 | −4.1 | +8.0 | 16.2 | 27.5 | 44.4 | 63.8 | 84.0 | −49.5 |
| hydride | $GeH_4$ | −163.0 | −151.0 | −145.3 | −139.2 | −131.6 | −126.7 | −120.3 | −111.2 | −100.2 | −88.9 | −165 |
| Trichlorogermane | $GeHCl_3$ | −41.3 | −22.3 | −13.0 | −3.0 | +8.8 | 16.2 | 26.5 | 41.6 | 58.3 | 75.0 | −71.1 |
| Tetramethylgermane | $Ge(CH_3)_4$ | −73.2 | −54.6 | −45.2 | −35.0 | −23.4 | −16.2 | −6.3 | +8.8 | 26.0 | 44.0 | −88 |
| Digermane | $Ge_2H_6$ | −88.7 | −69.8 | −60.1 | −49.9 | −38.2 | −30.7 | −20.3 | −4.7 | +13.3 | 31.5 | −109 |
| Trigermane | $Ge_3H_8$ | −36.9 | −12.8 | −0.9 | +11.8 | 26.3 | 35.5 | 47.9 | 67.0 | 88.6 | 110.8 | −105.6 |
| Gold | Au | 1869 | 2059 | 2154 | 2256 | 2363 | 2431 | 2521 | 2657 | 2807 | 2966 | 1063 |
| Helium | He | −271.7 | −271.5 | −271.3 | −271.1 | −270.7 | −270.6 | −270.3 | −269.8 | −269.3 | −268.6 | |
| para-Hydrogen | $H_2$ | −263.3 | −261.9 | −261.3 | −260.4 | −259.6 | −258.9 | −257.9 | −256.3 | −254.5 | −252.5 | −259.1 |
| Hydrogen bromide | HBr | −138.8 | −127.4 | −121.8 | −115.4 | −108.3 | −103.8 | −97.7 | −88.1 | −78.0 | −66.5 | −87.0 |
| chloride | HCl | −150.8 | −140.7 | −135.6 | −130.0 | −123.8 | −119.6 | −114.0 | −105.2 | −95.3 | −84.8 | −114.3 |
| cyanide | HCN | −71.0 | −55.3 | −47.7 | −39.7 | −30.9 | −25.1 | −17.8 | −5.3 | +10.2 | 25.9 | −13.2 |
| fluoride | $H_2F_2$ | | −74.7 | −65.8 | −56.0 | −45.0 | −37.9 | −28.2 | −13.2 | +2.5 | 19.7 | −83.7 |
| iodide | HI | −123.3 | −109.6 | −102.3 | −94.5 | −85.6 | −79.8 | −72.1 | −60.3 | −48.3 | −35.1 | −50.9 |
| oxide (water) | $H_2O$ | −17.3 | +1.2 | 11.2 | 22.1 | 34.0 | 41.5 | 51.6 | 66.5 | 83.0 | 100.0 | 0.0 |
| sulfide | $H_2S$ | −134.3 | −122.4 | −116.3 | −109.7 | −102.3 | −97.9 | −91.6 | −82.3 | −71.8 | −60.4 | −85.5 |
| disulfide | HSSH | −43.2 | −24.4 | −15.2 | −5.1 | +6.0 | 12.8 | 22.0 | 35.3 | 49.6 | 64.0 | −89.7 |
| selenide | $H_2Se$ | −115.3 | −103.4 | −97.9 | −91.8 | −84.7 | −80.2 | −74.2 | −65.2 | −53.6 | −41.1 | −64 |
| telluride | $H_2Te$ | −96.4 | −82.4 | −75.4 | −67.8 | −59.1 | −53.7 | −45.7 | −32.4 | −17.2 | −2.0 | −49.0 |
| Iodine | $I_2$ | 38.7 | 62.2 | 73.2 | 84.7 | 97.5 | 105.4 | 116.5 | 137.3 | 159.8 | 183.0 | 112.9 |
| heptafluoride | $IF_7$ | −87.0 | −70.7 | −63.0 | −54.5 | −45.3 | −39.4 | −31.9 | −20.7 | −8.3 | +4.0 | 5.5 |
| Iron | Fe | 1787 | 1957 | 2039 | 2128 | 2224 | 2283 | 2360 | 2475 | 2605 | 2735 | 1535 |
| pentacarbonyl | $Fe(CO)_5$ | | −6.5 | +4.6 | 16.7 | 30.3 | 39.1 | 50.3 | 68.0 | 86.1 | 105.0 | −21 |
| Ferric chloride | $Fe_2Cl_6$ | 194.0 | 221.8 | 235.5 | 246.0 | 256.8 | 263.7 | 272.5 | 285.0 | 298.0 | 319.0 | 304 |
| Ferrous chloride | $FeCl_2$ | | | 700 | 737 | 779 | 805 | 842 | 897 | 961 | 1026 | |
| Krypton | Kr | −199.3 | −191.3 | −187.2 | −182.9 | −178.4 | −175.7 | −171.8 | −165.9 | −159.0 | −152.0 | −156.7 |
| Lead | Pb | 973 | 1099 | 1162 | 1234 | 1309 | 1358 | 1421 | 1519 | 1630 | 1744 | 327.5 |
| bromide | $PbBr_2$ | 513 | 578 | 610 | 646 | 686 | 711 | 745 | 796 | 856 | 914 | 373 |
| chloride | $PbCl_2$ | 547 | 615 | 648 | 684 | 725 | 750 | 784 | 833 | 893 | 954 | 501 |
| fluoride | $PbF_2$ | | 861 | 904 | 950 | 1003 | 1036 | 1080 | 1144 | 1219 | 1293 | 855 |
| iodide | $PbI_2$ | 479 | 540 | 571 | 605 | 644 | 668 | 701 | 750 | 807 | 872 | 402 |
| oxide | PbO | 943 | 1039 | 1085 | 1134 | 1189 | 1222 | 1265 | 1330 | 1402 | 1472 | 890 |
| sulfide | PbS | 852 | 928 | 975 | 1005 | 1048 | 1074 | 1108 | 1160 | 1221 | 1281 | 1114 |
| Lithium | Li | 723 | 838 | 881 | 940 | 1003 | 1042 | 1097 | 1178 | 1273 | 1372 | 186 |
| bromide | LiBr | 748 | 840 | 888 | 939 | 994 | 1028 | 1076 | 1147 | 1226 | 1310 | 547 |
| chloride | LiCl | 783 | 880 | 932 | 987 | 1045 | 1081 | 1129 | 1203 | 1290 | 1382 | 614 |
| fluoride | LiF | 1047 | 1156 | 1211 | 1270 | 1333 | 1372 | 1425 | 1503 | 1591 | 1681 | 870 |
| iodide | LiI | 723 | 802 | 841 | 883 | 927 | 955 | 993 | 1049 | 1110 | 1171 | 446 |
| Magnesium | Mg | 621 | 702 | 743 | 789 | 838 | 868 | 909 | 967 | 1034 | 1107 | 651 |
| chloride | $MgCl_2$ | 778 | 877 | 930 | 988 | 1050 | 1088 | 1142 | 1223 | 1316 | 1418 | 712 |
| Manganese | Mn | 1292 | 1434 | 1505 | 1583 | 1666 | 1720 | 1792 | 1900 | 2029 | 2151 | 1260 |
| chloride | $MnCl_2$ | | 736 | 778 | 825 | 879 | 913 | 960 | 1028 | 1108 | 1190 | 650 |
| Mercury | Hg | 126.2 | 164.8 | 184.0 | 204.6 | 228.8 | 242.0 | 261.7 | 290.7 | 323.0 | 357.0 | −38.9 |
| Mercuric bromide | $HgBr_2$ | 136.5 | 165.3 | 179.8 | 194.3 | 211.5 | 221.0 | 237.8 | 262.7 | 290.0 | 319.0 | 237 |
| chloride | $HgCl_2$ | 136.2 | 166.0 | 180.2 | 195.8 | 212.5 | 222.2 | 237.0 | 256.5 | 275.5 | 304.0 | 277 |
| iodide | $HgI_2$ | 157.5 | 189.2 | 204.5 | 220.0 | 238.2 | 249.0 | 261.8 | 291.0 | 324.2 | 354.0 | 259 |
| Molybdenum | Mo | 3102 | 3393 | 3535 | 3690 | 3859 | 3964 | 4109 | 4322 | 4553 | 4804 | 2622 |
| hexafluoride | $MoF_6$ | −65.5 | −49.0 | −40.8 | −32.0 | −22.1 | −16.2 | −8.0 | +4.1 | 17.2 | 36.0 | 17 |
| oxide | $MoO_3$ | 734 | 785 | 814 | 851 | 892 | 917 | 955 | 1014 | 1082 | 1151 | 795 |

**TABLE 2-7 Vapor Pressures of Inorganic Compounds, up to 1 atm** (*Continued*)

| Compound | | Pressure, mm Hg | | | | | | | | | | Melting point, °C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 5 | 10 | 20 | 40 | 60 | 100 | 200 | 400 | 760 | |
| Name | Formula | Temperature, °C | | | | | | | | | | |
| Neon | Ne | −257.3 | −255.5 | −254.6 | −253.7 | −252.6 | −251.9 | −251.0 | −249.7 | −248.1 | −246.0 | −248.7 |
| Nickel | Ni | 1810 | 1979 | 2057 | 2143 | 2234 | 2289 | 2364 | 2473 | 2603 | 2732 | 1452 |
| carbonyl | $Ni(CO)_4$ | | | | | −23.0 | −15.9 | −6.0 | +8.8 | 25.8 | 42.5 | −25 |
| chloride | $NiCl_2$ | 671 | 731 | 759 | 789 | 821 | 840 | 866 | 904 | 945 | 987 | 1001 |
| Nitrogen | $N_2$ | −226.1 | −221.3 | −219.1 | −216.8 | −214.0 | −212.3 | −209.7 | −205.6 | −200.9 | −195.8 | −210.0 |
| Nitric oxide | NO | −184.5 | −180.6 | −178.2 | −175.3 | −171.7 | −168.9 | −166.0 | −162.3 | −156.8 | −151.7 | −161 |
| Nitrogen dioxide | $NO_2$ | −55.6 | −42.7 | −36.7 | −30.4 | −23.9 | −19.9 | −14.7 | −5.0 | +8.0 | 21.0 | −9.3 |
| Nitrogen pentoxide | $N_2O_5$ | −36.8 | −23.0 | −16.7 | −10.0 | −2.9 | +1.8 | 7.4 | 15.6 | 24.4 | 32.4 | 30 |
| Nitrous oxide | $N_2O$ | −143.4 | −133.4 | −128.7 | −124.0 | −118.3 | −114.9 | −110.3 | −103.6 | −96.2 | −85.5 | −90.9 |
| Nitrosyl chloride | NOCl | | | | | −60.2 | −54.2 | −46.3 | −34.0 | −20.3 | −6.4 | −64.5 |
| fluoride | NOF | −132.0 | −120.3 | −114.3 | −107.8 | −100.3 | −95.7 | −88.8 | −79.2 | −68.2 | −56.0 | −134 |
| Osmium tetroxide (yellow) | $OsO_4$ | 3.2 | 22.0 | 31.3 | 41.0 | 51.7 | 59.4 | 71.5 | 89.5 | 109.3 | 130.0 | 56 |
| (white) | $OsO_4$ | −5.6 | +15.6 | 26.0 | 37.4 | 50.5 | 59.4 | 71.5 | 89.5 | 109.3 | 130.0 | 42 |
| Oxygen | $O_2$ | −219.1 | −213.4 | −210.6 | −207.5 | −204.1 | −201.9 | −198.8 | −194.0 | −188.8 | −183.1 | −218.7 |
| Ozone | $O_3$ | −180.4 | −168.6 | −163.2 | −157.2 | −150.7 | −146.7 | −141.0 | −132.6 | −122.5 | −111.1 | −251 |
| Phosgene | $COCl_2$ | −92.9 | −77.0 | −69.3 | −60.3 | −50.3 | −44.0 | −35.6 | −22.3 | −7.6 | +8.3 | −104 |
| Phosphorus (yellow) | P | 76.6 | 111.2 | 128.0 | 146.2 | 166.7 | 179.8 | 197.3 | 222.7 | 251.0 | 280.0 | 44.1 |
| (violet) | P | 237 | 271 | 287 | 306 | 323 | 334 | 349 | 370 | 391 | 417 | 590 |
| tribromide | $PBr_3$ | 7.8 | 34.4 | 47.8 | 62.4 | 79.0 | 89.8 | 103.6 | 125.2 | 149.7 | 175.3 | −40 |
| trichloride | $PCl_3$ | −51.6 | −31.5 | −21.3 | −10.2 | +2.3 | 10.2 | 21.0 | 37.6 | 56.9 | 74.2 | −111.8 |
| pentachloride | $PCl_5$ | 55.5 | 74.0 | 83.2 | 92.5 | 102.5 | 108.3 | 117.0 | 131.3 | 147.2 | 162.0 | |
| Phosphine | $PH_3$ | | | | | −129.4 | −125.0 | −118.8 | −109.4 | −98.3 | −87.5 | −132.5 |
| Phosphonium bromide | $PH_4Br$ | −43.7 | −28.5 | −21.2 | −13.3 | −5.0 | +0.3 | 7.4 | 17.6 | 28.0 | 38.3 | |
| chloride | $PH_4Cl$ | −91.0 | −79.6 | −74.0 | −68.0 | −61.5 | −57.3 | −52.0 | −44.0 | −35.4 | −27.0 | −28.5 |
| iodide | $PH_4I$ | −25.2 | −9.0 | −1.1 | +7.3 | 16.1 | 21.9 | 29.3 | 39.9 | 51.6 | 62.3 | |
| Phosphorus trioxide | $P_4O_6$ | | 39.7 | 53.0 | 67.8 | 84.0 | 94.2 | 108.3 | 129.0 | 150.3 | 173.1 | 22.5 |
| pentoxide | $P_4O_{10}$ | 384 | 424 | 442 | 462 | 481 | 493 | 510 | 532 | 556 | 591 | 569 |
| oxychloride | $POCl_3$ | | | 2.0 | 13.6 | 27.3 | 35.8 | 47.4 | 65.0 | 84.3 | 105.1 | 2 |
| thiobromide | $PSBr_3$ | 50.0 | 72.4 | 83.6 | 95.5 | 108.0 | 116.0 | 126.3 | 141.8 | 157.8 | 175.0 | 38 |
| thiochloride | $PSCl_3$ | −18.3 | +4.6 | 16.1 | 29.0 | 42.7 | 51.8 | 63.8 | 82.0 | 102.3 | 124.0 | −36.2 |
| Platinum | Pt | 2730 | 3007 | 3146 | 3302 | 3469 | 3574 | 3714 | 3923 | 4169 | 4407 | 1755 |
| Potassium | K | 341 | 408 | 443 | 483 | 524 | 550 | 586 | 643 | 708 | 774 | 62.3 |
| bromide | KBr | 795 | 892 | 940 | 994 | 1050 | 1087 | 1137 | 1212 | 1297 | 1383 | 730 |
| chloride | KCl | 821 | 919 | 968 | 1020 | 1078 | 1115 | 1164 | 1239 | 1322 | 1407 | 790 |
| fluoride | KF | 885 | 988 | 1039 | 1096 | 1156 | 1193 | 1245 | 1323 | 1411 | 1502 | 880 |
| hydroxide | KOH | 719 | 814 | 863 | 918 | 976 | 1013 | 1064 | 1142 | 1233 | 1327 | 380 |
| iodide | KI | 745 | 840 | 887 | 938 | 995 | 1030 | 1080 | 1152 | 1238 | 1324 | 723 |
| Radon | Rn | −144.2 | −132.4 | −126.3 | −119.2 | −111.3 | −106.2 | −99.0 | −87.7 | −75.0 | −61.8 | −71 |
| Rhenium heptoxide | $Re_2O_7$ | 212.5 | 237.5 | 248.0 | 261.0 | 272.0 | 280.0 | 289.0 | 307.0 | 336.0 | 362.4 | 296 |
| Rubidium | Rb | 297 | 358 | 389 | 422 | 459 | 482 | 514 | 563 | 620 | 679 | 38.5 |
| bromide | RbBr | 781 | 876 | 923 | 975 | 1031 | 1066 | 1114 | 1186 | 1267 | 1352 | 682 |
| chloride | RbCl | 792 | 887 | 937 | 990 | 1047 | 1084 | 1133 | 1207 | 1294 | 1381 | 715 |
| fluoride | RbF | 921 | 982 | 1016 | 1052 | 1096 | 1123 | 1168 | 1239 | 1322 | 1408 | 760 |
| iodide | RbI | 748 | 839 | 884 | 935 | 991 | 1026 | 1072 | 1141 | 1223 | 1304 | 642 |
| Selenium | Se | 356 | 413 | 442 | 473 | 506 | 527 | 554 | 594 | 637 | 680 | 217 |
| dioxide | $SeO_2$ | 157.0 | 187.7 | 202.5 | 217.5 | 234.1 | 244.6 | 258.0 | 277.0 | 297.7 | 317.0 | 340 |
| hexafluoride | $SeF_6$ | −118.6 | −105.2 | −98.9 | −92.3 | −84.7 | −80.0 | −73.9 | −64.8 | −55.2 | −45.8 | −34.7 |
| oxychloride | $SeOCl_2$ | 34.8 | 59.8 | 71.9 | 84.2 | 98.0 | 106.5 | 118.0 | 134.6 | 151.7 | 168.0 | 8.5 |
| tetrachloride | $SeCl_4$ | 74.0 | 96.3 | 107.4 | 118.1 | 130.1 | 137.8 | 147.5 | 161.0 | 176.4 | 191.5 | |
| Silicon | Si | 1724 | 1835 | 1888 | 1942 | 2000 | 2036 | 2083 | 2151 | 2220 | 2287 | 1420 |
| dioxide | $SiO_2$ | | | 1732 | 1798 | 1867 | 1911 | 1969 | 2053 | 2141 | 2227 | 1710 |
| tetrachloride | $SiCl_4$ | −63.4 | −44.1 | −34.4 | −24.0 | −12.1 | −4.8 | +5.4 | 21.0 | 38.4 | 56.8 | −68.8 |
| tetrafluoride | $SiF_4$ | −144.0 | −134.8 | −130.4 | −125.9 | −120.8 | −117.5 | −113.3 | −170.2 | −100.7 | −94.8 | −90 |
| Trichlorofluorosilane | $SiFCl_3$ | −92.6 | −76.4 | −68.3 | −59.0 | −48.8 | −42.2 | −33.2 | −19.3 | −4.0 | +12.2 | −120.8 |
| Iodosilane | $SiH_3I$ | | −53.0 | −47.7 | −33.4 | −21.8 | −14.3 | −4.4 | +10.7 | 27.9 | 45.4 | −57.0 |
| Diiodosilane | $SiH_2I_2$ | | 3.8 | 18.0 | 34.1 | 52.6 | 64.0 | 79.4 | 101.8 | 125.5 | 149.5 | −1.0 |
| Disiloxan | $(SiH_3)_2O$ | −112.5 | −95.8 | −88.2 | −79.8 | −70.4 | −64.2 | −55.9 | −43.5 | −29.3 | −15.4 | −144.2 |
| Trisilane | $Si_3H_8$ | −68.9 | −49.7 | −40.0 | −29.0 | −16.9 | −9.0 | +1.6 | 17.8 | 35.5 | 53.1 | −117.2 |
| Trisilazane | $(SiH_3)_3N$ | −68.7 | −49.9 | −40.4 | −30.0 | −18.5 | −11.0 | −1.1 | +14.0 | 31.0 | 48.7 | −105.7 |
| Tetrasilane | $Si_4H_{10}$ | −27.7 | −6.2 | +4.3 | 15.8 | 28.4 | 36.6 | 47.4 | 63.6 | 81.7 | 100.0 | −93.6 |
| Octachlorotrisilane | $Si_3Cl_8$ | 46.3 | 74.7 | 89.3 | 104.2 | 121.5 | 132.0 | 146.0 | 166.2 | 189.5 | 211.4 | |
| Hexachlorodisiloxane | $(SiCl_3)_2O$ | −5.0 | 17.8 | 29.4 | 41.5 | 55.2 | 63.8 | 75.4 | 92.5 | 113.6 | 135.6 | −33.2 |
| Hexachlorodisilane | $Si_2Cl_6$ | +4.0 | 27.4 | 38.8 | 51.5 | 65.3 | 73.9 | 85.4 | 102.2 | 120.6 | 139.0 | −1.2 |
| Tribromosilane | $SiHBr_3$ | −30.5 | −8.0 | +3.4 | 16.0 | 30.0 | 39.2 | 51.6 | 70.2 | 90.2 | 111.8 | −73.5 |
| Trichlorosilane | $SiHCl_3$ | −80.7 | −62.6 | −53.4 | −43.8 | −32.9 | −25.8 | −16.4 | −1.8 | +14.5 | 31.8 | −126.6 |
| Trifluorosilane | $SiHF_3$ | −152.0 | −142.7 | −138.2 | −132.9 | −127.3 | −123.7 | −118.7 | −111.3 | −102.8 | −95.0 | −131.4 |
| Dibromosilane | $SiH_2Br_2$ | −60.9 | −40.0 | −29.4 | −18.0 | −5.2 | +3.2 | 14.1 | 31.6 | 50.7 | 70.5 | −70.2 |
| Difluorosilane | $SiH_2F_2$ | −146.7 | −136.0 | −130.4 | −124.3 | −117.6 | −113.3 | −107.3 | −98.3 | −87.6 | −77.8 | |
| Monobromosilane | $SiH_3Br$ | | −85.7 | −77.3 | −68.3 | −57.8 | −51.1 | −42.3 | −28.6 | −13.3 | +2.4 | −93.9 |
| Monochlorosilane | $SiH_3Cl$ | −117.8 | −104.3 | −97.7 | −90.1 | −81.8 | −76.0 | −68.5 | −57.0 | −44.5 | −30.4 | |
| Monofluorosilane | $SiH_3F$ | −153.0 | −145.5 | −141.2 | −136.3 | −130.8 | −127.2 | −122.4 | −115.2 | −106.8 | −98.0 | |
| Tribromofluorosilane | $SiFBr_3$ | −46.1 | −25.4 | −15.1 | −3.7 | +9.2 | 17.4 | 28.6 | 45.7 | 64.6 | 83.8 | −82.5 |
| Dichlorodifluorosilane | $SiF_2Cl_2$ | −124.7 | −110.5 | −102.9 | −94.5 | −85.0 | −78.6 | −70.3 | −58.0 | −45.0 | −31.8 | −139.7 |
| Trifluorobromosilane | $SiF_3Br$ | | | | | | | | −69.8 | −55.9 | −41.7 | −70.5 |

**TABLE 2-7 Vapor Pressures of Inorganic Compounds, up to 1 atm** (*Concluded*)

| Compound | | Pressure, mm Hg | | | | | | | | | | Melting point, °C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 5 | 10 | 20 | 40 | 60 | 100 | 200 | 400 | 760 | |
| Name | Formula | Temperature, °C | | | | | | | | | | |
| Trifluorochlorosilane | $SiF_3Cl$ | −144.0 | −133.0 | −127.0 | −120.5 | −112.8 | −108.2 | −101.7 | −91.7 | −81.0 | −70.0 | −142 |
| Hexafluorodisilane | $Si_2F_6$ | −81.0 | −68.8 | −63.1 | −57.0 | −50.6 | −46.7 | −41.7 | −34.2 | −26.4 | −18.9 | −18.6 |
| Dichlorofluorobromosilane | $SiFCl_2Br$ | −86.5 | −68.4 | −59.0 | −48.8 | −37.0 | −29.0 | −19.5 | −3.2 | +15.4 | 35.4 | −112.3 |
| Dibromochlorofluorosilane | $SiFClBr_2$ | −65.2 | −45.5 | −35.6 | −24.5 | −12.0 | −4.7 | +6.3 | 23.0 | 43.0 | 59.5 | −99.3 |
| Silane | $SiH_4$ | −179.3 | −168.6 | −163.0 | −156.9 | −150.3 | −146.3 | −140.5 | −131.6 | −122.0 | −111.5 | −185 |
| Disilane | $Si_2H_6$ | −114.8 | −99.3 | −91.4 | −82.7 | −72.8 | −66.4 | −57.5 | −44.6 | −29.0 | −14.3 | −132.6 |
| Silver | Ag | 1357 | 1500 | 1575 | 1658 | 1743 | 1795 | 1865 | 1971 | 2090 | 2212 | 960.5 |
| chloride | AgCl | 912 | 1019 | 1074 | 1134 | 1200 | 1242 | 1297 | 1379 | 1467 | 1564 | 455 |
| iodide | AgI | 820 | 927 | 983 | 1045 | 1111 | 1152 | 1210 | 1297 | 1400 | 1506 | 552 |
| Sodium | Na | 439 | 511 | 549 | 589 | 633 | 662 | 701 | 758 | 823 | 892 | 97.5 |
| bromide | NaBr | 806 | 903 | 952 | 1005 | 1063 | 1099 | 1148 | 1220 | 1304 | 1392 | 755 |
| chloride | NaCl | 865 | 967 | 1017 | 1072 | 1131 | 1169 | 1220 | 1296 | 1379 | 1465 | 800 |
| cyanide | NaCN | 817 | 928 | 983 | 1046 | 1115 | 1156 | 1214 | 1302 | 1401 | 1497 | 564 |
| fluoride | NaF | 1077 | 1186 | 1240 | 1300 | 1363 | 1403 | 1455 | 1531 | 1617 | 1704 | 992 |
| hydroxide | NaOH | 739 | 843 | 897 | 953 | 1017 | 1057 | 1111 | 1192 | 1286 | 1378 | 318 |
| iodide | NaI | 767 | 857 | 903 | 952 | 1005 | 1039 | 1083 | 1150 | 1225 | 1304 | 651 |
| Strontium | Sr | | 847 | 898 | 953 | 1018 | 1057 | 1111 | 1192 | 1285 | 1384 | 800 |
| Strontium oxide | SrO | 2068 | 2198 | 2262 | 2333 | 2410 | | | | | | 2430 |
| Sulfur | S | 183.8 | 223.0 | 243.8 | 264.7 | 288.3 | 305.5 | 327.2 | 359.7 | 399.6 | 444.6 | 112.8 |
| monochloride | $S_2Cl_2$ | −7.4 | +15.7 | 27.5 | 40.0 | 54.1 | 63.2 | 75.3 | 93.5 | 115.4 | 138.0 | −80 |
| hexafluoride | $SF_6$ | −132.7 | −120.6 | −114.7 | −108.4 | −101.5 | −96.8 | −90.9 | −82.3 | −72.6 | −63.5 | −50.2 |
| Sulfuryl chloride | $SO_2Cl_2$ | | −35.1 | −24.8 | −13.4 | −1.0 | +7.2 | 17.8 | 33.7 | 51.3 | 69.2 | −54.1 |
| Sulfur dioxide | $SO_2$ | −95.5 | −83.0 | −76.8 | −69.7 | −60.5 | −54.6 | −46.9 | −35.4 | −23.0 | −10.0 | −73.2 |
| trioxide (α) | $SO_3$ | −39.0 | −23.7 | −16.5 | −9.1 | −1.0 | +4.0 | 10.5 | 20.5 | 32.6 | 44.8 | 16.8 |
| trioxide (β) | $SO_3$ | −34.0 | −19.2 | −12.3 | −4.9 | +3.2 | 8.0 | 14.3 | 23.7 | 32.6 | 44.8 | 32.3 |
| trioxide (γ) | $SO_3$ | −15.3 | −2.0 | +4.3 | 11.1 | 17.9 | 21.4 | 28.0 | 35.8 | 44.0 | 51.6 | 62.1 |
| Tellurium | Te | 520 | 605 | 650 | 697 | 753 | 789 | 838 | 910 | 997 | 1087 | 452 |
| chloride | $TeCl_4$ | | | 233 | 253 | 273 | 287 | 304 | 330 | 360 | 392 | 224 |
| fluoride | $TeF_6$ | −111.3 | −98.8 | −92.4 | −86.0 | −78.4 | −73.8 | −67.9 | −57.3 | −48.2 | −38.6 | −37.8 |
| Thallium | Tl | 825 | 931 | 983 | 1040 | 1103 | 1143 | 1196 | 1274 | 1364 | 1457 | 3035 |
| Thallous bromide | TlBr | | 490 | 522 | 559 | 598 | 621 | 653 | 703 | 759 | 819 | 460 |
| chloride | TlCl | | 487 | 517 | 550 | 589 | 612 | 645 | 694 | 748 | 807 | 430 |
| iodide | TlI | 440 | 502 | 531 | 567 | 607 | 631 | 663 | 712 | 763 | 823 | 440 |
| Thionyl bromide | $SOBr_2$ | −6.7 | +18.4 | 31.0 | 44.1 | 58.8 | 68.3 | 80.6 | 99.0 | 119.2 | 139.5 | −52.2 |
| Thionyl chloride | $SOCl_2$ | −52.9 | −32.4 | −21.9 | −10.5 | +2.2 | 10.4 | 21.4 | 37.9 | 56.5 | 75.4 | −104.5 |
| Tin | Sn | 1492 | 1634 | 1703 | 1777 | 1855 | 1903 | 1968 | 2063 | 2169 | 2270 | 231.9 |
| Stannic bromide | $SnBr_4$ | | 58.3 | 72.7 | 88.1 | 105.5 | 116.2 | 131.0 | 152.8 | 177.7 | 204.7 | 31.0 |
| Stannous chloride | $SnCl_2$ | 316 | 366 | 391 | 420 | 450 | 467 | 493 | 533 | 577 | 623 | 246.8 |
| Stannic chloride | $SnCl_4$ | −22.7 | −1.0 | +10.0 | 22.0 | 35.2 | 43.5 | 54.7 | 72.0 | 92.1 | 113.0 | −30.2 |
| iodide | $SnI_4$ | | 156.0 | 175.8 | 196.2 | 218.8 | 234.2 | 254.2 | 283.5 | 315.5 | 348.0 | 144.5 |
| hydride | $SnH_4$ | −140.0 | −125.8 | −118.5 | −111.2 | −102.3 | −96.6 | −89.2 | −78.0 | −65.2 | −52.3 | −149.9 |
| Tin tetramethyl | $Sn(CH_3)_4$ | −51.3 | −31.0 | −20.6 | −9.3 | +3.5 | 11.7 | 22.8 | 39.8 | 58.5 | 78.0 | |
| trimethyl-ethyl | $Sn(CH_3)_3{\cdot}C_2H_5$ | −30.0 | −7.6 | +3.8 | 16.1 | 30.0 | 38.4 | 50.0 | 67.3 | 87.6 | 108.8 | |
| trimethyl-propyl | $Sn(CH_3)_3{\cdot}C_3H_7$ | −12.0 | +10.7 | 21.8 | 34.0 | 48.5 | 57.5 | 69.8 | 88.0 | 109.6 | 131.7 | |
| Titanium chloride | $TiCl_4$ | −13.9 | +9.4 | 21.3 | 34.2 | 48.4 | 58.0 | 71.0 | 90.5 | 112.7 | 136.0 | −30 |
| Tungsten | W | 3990 | 4337 | 4507 | 4690 | 4886 | 5007 | 5168 | 5403 | 5666 | 5927 | 3370 |
| Tungsten hexafluoride | $WF_6$ | −71.4 | −56.5 | −49.2 | −41.5 | −33.0 | −27.5 | −20.3 | −10.0 | +1.2 | 17.3 | −0.5 |
| Uranium hexafluoride | $UF_6$ | −38.8 | −22.0 | −13.8 | −5.2 | +4.4 | 10.4 | 18.2 | 30.0 | 42.7 | 55.7 | 69.2 |
| Vanadyl trichloride | $VOCl_3$ | −23.2 | +0.2 | 12.2 | 26.6 | 40.0 | 49.8 | 62.5 | 82.0 | 103.5 | 127.2 | |
| Xenon | Xe | −168.5 | −158.2 | −152.8 | −147.1 | −141.2 | −137.7 | −132.8 | −125.4 | −117.1 | −108.0 | −111.6 |
| Zinc | Zn | 487 | 558 | 593 | 632 | 673 | 700 | 736 | 788 | 844 | 907 | 419.4 |
| chloride | $ZnCl_2$ | 428 | 481 | 508 | 536 | 566 | 584 | 610 | 648 | 689 | 732 | 365 |
| fluoride | $ZnF_2$ | 970 | 1055 | 1086 | 1129 | 1175 | 1207 | 1254 | 1329 | 1417 | 1497 | 872 |
| diethyl | $Zn(C_2H_5)_2$ | −22.4 | 0.0 | +11.7 | 24.2 | 38.0 | 47.2 | 59.1 | 77.0 | 97.3 | 118.0 | −28 |
| Zirconium bromide | $ZrBr_4$ | 207 | 237 | 250 | 266 | 281 | 289 | 301 | 318 | 337 | 357 | 450 |
| chloride | $ZrCl_4$ | 190 | 217 | 230 | 243 | 259 | 268 | 279 | 295 | 312 | 331 | 437 |
| iodide | $ZrI_4$ | 264 | 297 | 311 | 329 | 344 | 355 | 369 | 389 | 409 | 431 | 499 |

**TABLE 2-8 Vapor Pressures of Organic Compounds, up to 1 atm***

| Compound | | Pressure, mm Hg | | | | | | | | | | Melting point, °C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 5 | 10 | 20 | 40 | 60 | 100 | 200 | 400 | 760 | |
| Name | Formula | Temperature, °C | | | | | | | | | | |
| Acenaphthalene | $C_{12}H_{10}$ | | 114.8 | 131.2 | 148.7 | 168.2 | 181.2 | 197.5 | 222.1 | 250.0 | 277.5 | 95 |
| Acetal | $C_6H_{14}O_2$ | −23.0 | −2.3 | +8.0 | 19.6 | 31.9 | 39.8 | 50.1 | 66.3 | 84.0 | 102.2 | |
| Acetaldehyde | $C_2H_4O$ | −81.5 | −65.1 | −56.8 | −47.8 | −37.8 | −31.4 | −22.6 | −10.0 | +4.9 | 20.2 | −123.5 |
| Acetamide | $C_2H_5NO$ | 65.0 | 92.0 | 105.0 | 120.0 | 135.8 | 145.8 | 158.0 | 178.3 | 200.0 | 222.0 | 81 |
| Acetanilide | $C_8H_9NO$ | 114.0 | 146.6 | 162.0 | 180.0 | 199.6 | 211.8 | 227.2 | 250.5 | 277.0 | 303.8 | 113.5 |
| Acetic acid | $C_2H_4O_2$ | −17.2 | +6.3 | 17.5 | 29.9 | 43.0 | 51.7 | 63.0 | 80.0 | 99.0 | 118.1 | 16.7 |
| anhydride | $C_4H_6O_3$ | 1.7 | 24.8 | 36.0 | 48.3 | 62.1 | 70.8 | 82.2 | 100.0 | 119.8 | 139.6 | −73 |
| Acetone | $C_3H_6O$ | −59.4 | −40.5 | −31.1 | −20.8 | −9.4 | −2.0 | +7.7 | 22.7 | 39.5 | 56.5 | −94.6 |
| Acetonitrile | $C_2H_3N$ | −47.0 | −26.6 | −16.3 | −5.0 | +7.7 | 15.9 | 27.0 | 43.7 | 62.5 | 81.8 | −41 |
| Acetophenone | $C_8H_8O$ | 37.1 | 64.0 | 78.0 | 92.4 | 109.4 | 119.8 | 133.6 | 154.2 | 178.0 | 202.4 | 20.5 |
| Acetyl chloride | $C_2H_3OCl$ | −50.0 | −35.0 | −27.6 | −19.6 | −10.4 | −4.5 | +3.2 | 16.1 | 32.0 | 50.8 | −112.0 |
| Acetylene | $C_2H_2$ | −142.9 | −133.0 | −128.2 | −122.8 | −116.7 | −112.8 | −107.9 | −100.3 | −92.0 | −84.0 | −81.5 |
| Acridine | $C_{13}H_9N$ | 129.4 | 165.8 | 184.0 | 203.5 | 224.2 | 238.7 | 256.0 | 284.0 | 314.3 | 346.0 | 110.5 |
| Acrolein (2-propenal) | $C_3H_4O$ | −64.5 | −46.0 | −36.7 | −26.3 | −15.0 | −7.5 | +2.5 | 17.5 | 34.5 | 52.5 | −87.7 |
| Acrylic acid | $C_3H_4O_2$ | +3.5 | 27.3 | 39.0 | 52.0 | 66.2 | 75.0 | 86.1 | 103.3 | 122.0 | 141.0 | 14 |
| Adipic acid | $C_6H_{10}O_4$ | 159.5 | 191.0 | 205.5 | 222.0 | 240.5 | 251.0 | 265.0 | 287.8 | 312.5 | 337.5 | 152 |
| Allene (propadiene) | $C_3H_4$ | −120.6 | −108.0 | −101.0 | −93.4 | −85.2 | −78.8 | −72.5 | −61.3 | −48.5 | −35.0 | −136 |
| Allyl alcohol (propen-1-ol-3) | $C_3H_6O$ | −20.0 | +0.2 | 10.5 | 21.7 | 33.4 | 40.3 | 50.0 | 64.5 | 80.2 | 96.6 | −129 |
| chloride (3-chloropropene) | $C_3H_5Cl$ | −70.0 | −52.0 | −42.9 | −32.8 | −21.2 | −14.1 | −4.5 | 10.4 | 27.5 | 44.6 | −136.4 |
| isopropyl ether | $C_6H_{12}O$ | −43.7 | −23.1 | −12.9 | −1.8 | +10.9 | 18.7 | 29.0 | 44.3 | 61.7 | 79.5 | |
| isothiocyanate | $C_4H_5NS$ | −2.0 | +25.3 | 38.3 | 52.1 | 67.4 | 76.2 | 89.5 | 108.0 | 129.8 | 150.7 | −80 |
| *n*-propyl ether | $C_6H_{12}O$ | −39.0 | −18.2 | −7.9 | +3.7 | 16.4 | 25.0 | 35.8 | 52.6 | 71.4 | 90.5 | |
| 4-Allylveratrole | $C_{11}H_{14}O_2$ | 85.0 | 113.9 | 127.0 | 142.8 | 158.3 | 169.6 | 183.7 | 204.0 | 226.2 | 248.0 | |
| iso-Amyl acetate | $C_7H_{14}O_2$ | 0.0 | +23.7 | 35.2 | 47.8 | 62.1 | 71.0 | 83.2 | 101.3 | 121.5 | 142.0 | |
| *n*-Amyl alcohol | $C_5H_{12}O$ | +13.6 | 34.7 | 44.9 | 55.8 | 68.0 | 75.5 | 85.8 | 102.0 | 119.8 | 137.8 | |
| iso-Amyl alcohol | $C_5H_{12}O$ | +10.0 | 30.9 | 40.8 | 51.7 | 63.4 | 71.0 | 80.7 | 95.8 | 113.7 | 130.6 | −117.2 |
| *sec*-Amyl alcohol (2-pentanol) | $C_5H_{12}O$ | +1.5 | 22.1 | 32.2 | 42.6 | 54.1 | 61.5 | 70.7 | 85.7 | 102.3 | 119.7 | |
| *tert*-Amyl alcohol | $C_5H_{12}O$ | −12.9 | +7.2 | 17.2 | 27.9 | 38.8 | 46.0 | 55.3 | 69.7 | 85.7 | 101.7 | −11.9 |
| *sec*-Amylbenzene | $C_{11}H_{16}$ | 29.0 | 55.8 | 69.2 | 83.8 | 100.0 | 110.4 | 124.1 | 145.2 | 168.0 | 193.0 | |
| iso-Amyl benzoate | $C_{12}H_{16}O_2$ | 72.0 | 104.5 | 121.6 | 139.7 | 158.3 | 171.4 | 186.8 | 210.2 | 235.8 | 262.0 | |
| bromide (1-bromo-3-methylbutane) | $C_5H_{11}Br$ | −20.4 | +2.1 | 13.6 | 26.1 | 39.8 | 48.7 | 60.4 | 78.7 | 99.4 | 120.4 | |
| *n*-butyrate | $C_9H_{18}O_2$ | 21.2 | 47.1 | 59.9 | 74.0 | 90.0 | 99.8 | 113.1 | 133.2 | 155.3 | 178.6 | |
| formate | $C_6H_{12}O_2$ | −17.5 | +5.4 | 17.1 | 30.0 | 44.0 | 53.3 | 65.4 | 83.2 | 102.7 | 123.3 | |
| iodide (1-iodo-3-methylbutane) | $C_5H_{11}I$ | −2.5 | +21.9 | 34.1 | 47.6 | 62.3 | 71.9 | 84.4 | 103.8 | 125.8 | 148.2 | |
| isobutyrate | $C_9H_{18}O_2$ | 14.8 | 40.1 | 52.8 | 66.6 | 81.8 | 91.7 | 104.4 | 124.2 | 146.0 | 168.8 | |
| Amyl isopropionate | $C_8H_{16}O_2$ | +8.5 | 33.7 | 46.3 | 60.0 | 75.5 | 85.2 | 97.6 | 117.3 | 138.4 | 160.2 | |
| iso-Amyl isovalerate | $C_{10}H_{20}O_2$ | 27.0 | 54.4 | 68.6 | 83.8 | 100.6 | 110.3 | 125.1 | 146.1 | 169.5 | 194.0 | |
| *n*-Amyl levulinate | $C_{10}H_{18}O_3$ | 81.3 | 110.0 | 124.0 | 139.7 | 155.8 | 165.2 | 180.5 | 203.1 | 227.4 | 253.2 | |
| iso-Amyl levulinate | $C_{10}H_{18}O_3$ | 75.6 | 104.0 | 118.8 | 134.4 | 151.7 | 162.6 | 177.0 | 198.1 | 222.7 | 247.9 | |
| nitrate | $C_5H_{11}NO_3$ | +5.2 | 28.8 | 40.3 | 53.5 | 67.6 | 76.3 | 88.6 | 106.7 | 126.5 | 147.5 | |
| 4-*tert*-Amylphenol | $C_{11}H_{16}O$ | | 109.8 | 125.5 | 142.3 | 160.3 | 172.6 | 189.0 | 213.0 | 239.5 | 266.0 | 93 |
| Anethole | $C_{10}H_{12}O$ | 62.6 | 91.6 | 106.0 | 121.8 | 139.3 | 149.8 | 164.2 | 186.1 | 210.5 | 235.3 | 22.5 |
| Angelonitrile | $C_5H_7N$ | −8.0 | +15.0 | 28.0 | 41.0 | 55.8 | 65.2 | 77.5 | 96.3 | 117.7 | 140.0 | |
| Aniline | $C_6H_7N$ | 34.8 | 57.9 | 69.4 | 82.0 | 96.7 | 106.0 | 119.9 | 140.1 | 161.9 | 184.4 | −6.2 |
| 2-Anilinoethanol | $C_8H_{11}NO$ | 104.0 | 134.3 | 149.6 | 165.7 | 183.7 | 194.0 | 209.5 | 230.6 | 254.5 | 279.6 | |
| Anisaldehyde | $C_8H_8O_2$ | 73.2 | 102.6 | 117.8 | 133.5 | 150.5 | 161.7 | 176.7 | 199.0 | 223.0 | 248.0 | 2.5 |
| *o*-Anisidine (2-methoxyaniline) | $C_7H_9NO$ | 61.0 | 88.0 | 101.7 | 116.1 | 132.0 | 142.1 | 155.2 | 175.3 | 197.3 | 218.5 | 5.2 |
| Anthracene | $C_{14}H_{10}$ | 145.0 | 173.5 | 187.2 | 201.9 | 217.5 | 231.8 | 250.0 | 279.0 | 310.2 | 342.0 | 217.5 |
| Anthraquinone | $C_{14}H_8O_2$ | 190.0 | 219.4 | 234.2 | 248.3 | 264.3 | 273.3 | 285.0 | 314.6 | 346.2 | 379.9 | 286 |
| Azelaic acid | $C_9H_{16}O_4$ | 178.3 | 210.4 | 225.5 | 242.4 | 260.0 | 271.8 | 286.5 | 309.6 | 332.8 | 356.5 | 106.5 |
| Azelaldehyde | $C_9H_{16}O$ | 33.3 | 58.4 | 71.6 | 85.0 | 100.2 | 110.0 | 123.0 | 142.1 | 163.4 | 185.0 | |
| Azobenzene | $C_{12}H_{10}N_2$ | 103.5 | 135.7 | 151.5 | 168.3 | 187.9 | 199.8 | 216.0 | 240.0 | 266.1 | 293.0 | 68 |
| Benzal chloride (α,α-Dichlorotoluene) | $C_7H_6Cl_2$ | 35.4 | 64.0 | 78.7 | 94.3 | 112.1 | 123.4 | 138.3 | 160.7 | 187.0 | 214.0 | −16.1 |
| Benzaldehyde | $C_7H_6O$ | 26.2 | 50.1 | 62.0 | 75.0 | 90.1 | 99.6 | 112.5 | 131.7 | 154.1 | 179.0 | −26 |
| Benzanthrone | $C_{17}H_{10}O$ | 225.0 | 274.5 | 297.2 | 322.5 | 350.0 | 368.8 | 390.0 | 426.5 | | | 174 |
| Benzene | $C_6H_6$ | −36.7 | −19.6 | −11.5 | −2.6 | +7.6 | 15.4 | 26.1 | 42.2 | 60.6 | 80.1 | +5.5 |
| Benzenesulfonylchloride | $C_6H_5ClO_2S$ | 65.9 | 96.5 | 112.0 | 129.0 | 147.7 | 158.2 | 174.5 | 198.0 | 224.0 | 251.5 | 14.5 |
| Benzil | $C_{14}H_{10}O_2$ | 128.4 | 165.2 | 183.0 | 202.8 | 224.5 | 238.2 | 255.8 | 283.5 | 314.3 | 347.0 | 95 |
| Benzoic acid | $C_7H_6O_2$ | 96.0 | 119.5 | 132.1 | 146.7 | 162.6 | 172.8 | 186.2 | 205.8 | 227.0 | 249.2 | 121.7 |
| anhydride | $C_{14}H_{10}O_3$ | 143.8 | 180.0 | 198.0 | 218.0 | 239.8 | 252.7 | 270.4 | 299.1 | 328.8 | 360.0 | 42 |
| Benzoin | $C_{14}H_{12}O_2$ | 135.6 | 170.2 | 188.1 | 207.0 | 227.6 | 241.7 | 258.0 | 284.4 | 313.5 | 343.0 | 132 |
| Benzonitrile | $C_7H_5N$ | 28.2 | 55.3 | 69.2 | 83.4 | 99.6 | 109.8 | 123.5 | 144.1 | 166.7 | 190.6 | −12.9 |
| Benzophenone | $C_{13}H_{10}O$ | 108.2 | 141.7 | 157.6 | 175.8 | 195.7 | 208.2 | 224.4 | 249.8 | 276.8 | 305.4 | 48.5 |
| Benzotrichloride (α,α,α-Trichlorotoluene) | $C_7H_5Cl_3$ | 45.8 | 73.7 | 87.6 | 102.7 | 119.8 | 130.0 | 144.3 | 165.6 | 189.2 | 213.5 | −21.2 |
| Benzotrifluoride (α,α,α-Trifluorotoluene) | $C_7H_5F_3$ | −32.0 | −10.3 | −0.4 | 12.2 | 25.7 | 34.0 | 45.3 | 62.5 | 82.0 | 102.2 | −29.3 |
| Benzoyl bromide | $C_7H_5BrO$ | 47.0 | 75.4 | 89.8 | 105.4 | 122.6 | 133.4 | 147.7 | 169.2 | 193.7 | 218.5 | 0 |
| chloride | $C_7H_5ClO$ | 32.1 | 59.1 | 73.0 | 87.6 | 103.8 | 114.7 | 128.0 | 149.5 | 172.8 | 197.2 | −0.5 |
| nitrile | $C_8H_5NO$ | 44.5 | 71.7 | 85.5 | 100.2 | 116.6 | 127.0 | 141.0 | 161.3 | 185.0 | 208.0 | 33.5 |
| Benzyl acetate | $C_9H_{10}O_2$ | 45.0 | 73.4 | 87.6 | 102.3 | 119.6 | 129.8 | 144.0 | 165.5 | 189.0 | 213.5 | −51.5 |
| alcohol | $C_7H_8O$ | 58.0 | 80.8 | 92.6 | 105.8 | 119.8 | 129.3 | 141.7 | 160.0 | 183.0 | 204.7 | −15.3 |

*Compiled from the extended tables published by D. R. Stull in *Ind. Eng. Chem.*, **39,** 517 (1947). For information on fuels see Hibbard, N.A.C.A. Research Mem. E56I21, 1956. For methane see Johnson (ed.), WADD-TR-60-56, 1960.

**TABLE 2-8 Vapor Pressures of Organic Compounds, up to 1 atm** (*Continued*)

| Compound | | Pressure, mm Hg | | | | | | | | | | Melting point, °C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 5 | 10 | 20 | 40 | 60 | 100 | 200 | 400 | 760 | |
| Name | Formula | Temperature, °C | | | | | | | | | | |
| Benzylamine | $C_7H_9N$ | 29.0 | 54.8 | 67.7 | 81.8 | 97.3 | 107.3 | 120.0 | 140.0 | 161.3 | 184.5 | |
| Benzyl bromide (α-bromotoluene) | $C_7H_7Br$ | 32.2 | 59.6 | 73.4 | 88.3 | 104.8 | 115.6 | 129.8 | 150.8 | 175.2 | 198.5 | –4 |
| chloride (α-chlorotoluene) | $C_7H_7Cl$ | 22.0 | 47.8 | 60.8 | 75.0 | 90.7 | 100.5 | 114.2 | 134.0 | 155.8 | 179.4 | –39 |
| cinnamate | $C_{16}H_{14}O_2$ | 173.8 | 206.3 | 221.5 | 239.3 | 255.8 | 267.0 | 281.5 | 303.8 | 326.7 | 350.0 | 39 |
| Benzyldichlorosilane | $C_7H_8Cl_2Si$ | 45.3 | 70.2 | 83.2 | 96.7 | 111.8 | 121.3 | 133.5 | 152.0 | 173.0 | 194.3 | |
| Benzyl ethyl ether | $C_9H_{12}O$ | 26.0 | 52.0 | 65.0 | 79.6 | 95.4 | 105.5 | 118.9 | 139.6 | 161.5 | 185.0 | |
| phenyl ether | $C_{13}H_{12}O$ | 95.4 | 127.7 | 144.0 | 160.7 | 180.1 | 192.6 | 209.2 | 233.2 | 259.8 | 287.0 | |
| isothiocyanate | $C_8H_7NS$ | 79.5 | 107.8 | 121.8 | 137.0 | 153.0 | 163.8 | 177.7 | 198.0 | 220.4 | 243.0 | |
| Biphenyl | $C_{12}H_{10}$ | 70.6 | 101.8 | 117.0 | 134.2 | 152.5 | 165.2 | 180.7 | 204.2 | 229.4 | 254.9 | 69.5 |
| 1-Biphenyloxy-2,3-epoxypropane | $C_{15}H_{14}O_2$ | 135.3 | 169.9 | 187.2 | 205.8 | 226.3 | 239.7 | 255.0 | 280.4 | 309.8 | 340.0 | |
| *d*-Bornyl acetate | $C_{12}H_{20}O_2$ | 46.9 | 75.7 | 90.2 | 106.0 | 123.7 | 135.7 | 149.8 | 172.0 | 197.5 | 223.0 | 29 |
| Bornyl *n*-butyrate | $C_{14}H_{24}O_2$ | 74.0 | 103.4 | 118.0 | 133.8 | 150.7 | 161.8 | 176.4 | 198.0 | 222.2 | 247.0 | |
| formate | $C_{11}H_{18}O_2$ | 47.0 | 74.8 | 89.3 | 104.0 | 121.2 | 131.7 | 145.8 | 166.4 | 190.2 | 214.0 | |
| isobutyrate | $C_{14}H_{24}O_2$ | 70.0 | 99.8 | 114.0 | 130.0 | 147.2 | 157.6 | 172.2 | 194.2 | 218.2 | 243.0 | |
| propionate | $C_{13}H_{22}O_2$ | 64.6 | 93.7 | 108.0 | 123.7 | 140.4 | 151.2 | 165.7 | 187.5 | 211.2 | 235.0 | |
| Brassidic acid | $C_{22}H_{42}O_2$ | 209.6 | 241.7 | 256.0 | 272.9 | 290.0 | 301.5 | 316.2 | 336.8 | 359.6 | 382.5 | 61.5 |
| Bromoacetic acid | $C_2H_3BrO_2$ | 54.7 | 81.6 | 94.1 | 108.2 | 124.0 | 133.8 | 146.3 | 165.8 | 186.7 | 208.0 | 49.5 |
| 4-Bromoanisole | $C_7H_7BrO$ | 48.8 | 77.8 | 91.9 | 107.8 | 125.0 | 136.0 | 150.1 | 172.7 | 197.5 | 223.0 | 12.5 |
| Bromobenzene | $C_6H_5Br$ | +2.9 | 27.8 | 40.0 | 53.8 | 68.6 | 78.1 | 90.8 | 110.1 | 132.3 | 156.2 | –30.7 |
| 4-Bromobiphenyl | $C_{12}H_9Br$ | 98.0 | 133.7 | 150.6 | 169.8 | 190.8 | 204.5 | 221.8 | 248.2 | 277.7 | 310.0 | 90.5 |
| 1-Bromo-2-butanol | $C_4H_9BrO$ | 23.7 | 45.4 | 55.8 | 67.2 | 79.5 | 87.0 | 97.6 | 112.1 | 128.3 | 145.0 | |
| 1-Bromo-2-butanone | $C_4H_7BrO$ | +6.2 | 30.0 | 41.8 | 54.2 | 68.2 | 77.3 | 89.2 | 107.0 | 126.3 | 147.0 | |
| *cis*-1-Bromo-1-butene | $C_4H_7Br$ | –44.0 | –23.2 | –12.8 | –1.4 | +11.5 | 19.8 | 30.8 | 47.8 | 66.8 | 86.2 | |
| *trans*-1-Bromo-1-butene | $C_4H_7Br$ | –38.4 | –17.0 | –6.4 | +5.4 | 18.4 | 27.2 | 38.1 | 55.7 | 75.0 | 94.7 | –100.3 |
| 2-Bromo-1-butene | $C_4H_7Br$ | –47.3 | –27.0 | –16.8 | –5.3 | +7.2 | 15.4 | 26.3 | 42.8 | 61.9 | 81.0 | –133.4 |
| *cis*-2-Bromo-2-butene | $C_4H_7Br$ | –39.0 | –17.9 | –7.2 | +4.6 | 17.7 | 26.2 | 37.5 | 54.5 | 74.0 | 93.9 | –111.2 |
| *trans*-2-Bromo-2-butene | $C_4H_7Br$ | –45.0 | –24.1 | –13.8 | –2.4 | +10.5 | 18.7 | 29.9 | 46.5 | 66.0 | 85.5 | –114.6 |
| 1,4-Bromochlorobenzene | $C_6H_4BrCl$ | 32.0 | 59.5 | 72.7 | 87.8 | 103.8 | 114.8 | 128.0 | 149.5 | 172.6 | 196.9 | |
| 1-Bromo-1-chloroethane | $C_2H_4BrCl$ | –36.0 | –18.0 | –9.4 | 0.0 | +10.4 | 17.0 | 28.0 | 44.7 | 63.4 | 82.7 | 16.6 |
| 1-Bromo-2-chloroethane | $C_2H_4BrCl$ | –28.8 | –7.0 | +4.1 | 16.0 | 29.7 | 38.0 | 49.5 | 66.8 | 86.0 | 106.7 | –16.6 |
| 2-Bromo-4,6-dichlorophenol | $C_6H_3BrCl_2O$ | 84.0 | 115.6 | 130.8 | 147.7 | 165.8 | 177.6 | 193.2 | 216.5 | 242.0 | 268.0 | 68 |
| 1-Bromo-4-ethyl benzene | $C_8H_9Br$ | 30.4 | 42.5 | 74.0 | 90.2 | 108.5 | 121.0 | 135.5 | 156.5 | 182.0 | 206.0 | –45.0 |
| (2-Bromoethyl)-benzene | $C_8H_9Br$ | 48.0 | 76.2 | 90.5 | 105.8 | 123.2 | 133.8 | 148.2 | 169.8 | 194.0 | 219.0 | |
| 2-Bromoethyl 2-chloroethyl ether | $C_4H_8BrClO$ | 36.5 | 63.2 | 76.3 | 90.8 | 106.6 | 116.4 | 129.8 | 150.0 | 172.3 | 195.8 | |
| (2-Bromoethyl)-cyclohexane | $C_8H_{15}Br$ | 38.7 | 66.6 | 80.5 | 95.8 | 113.0 | 123.7 | 138.0 | 160.0 | 186.2 | 213.0 | |
| 1-Bromoethylene | $C_2H_3Br$ | –95.4 | –77.8 | –68.8 | –58.8 | –48.1 | –41.2 | –31.9 | –17.2 | –1.1 | +15.8 | –138 |
| Bromoform (tribromomethane) | $CHBr_3$ | | 22.0 | 34.0 | 48.0 | 63.6 | 73.4 | 85.9 | 106.1 | 127.9 | 150.5 | 8.5 |
| 1-Bromonaphthalene | $C_{10}H_7Br$ | 84.2 | 117.5 | 133.6 | 150.2 | 170.2 | 183.5 | 198.8 | 224.2 | 252.0 | 281.1 | 5.5 |
| 2-Bromo-4-phenylphenol | $C_{12}H_9BrO$ | 100.0 | 135.4 | 152.3 | 171.8 | 193.8 | 207.0 | 224.5 | 251.0 | 280.2 | 311.0 | 95 |
| 3-Bromopyridine | $C_5H_4BrN$ | 16.8 | 42.0 | 55.2 | 69.1 | 84.1 | 94.1 | 107.8 | 127.7 | 150.0 | 173.4 | |
| 2-Bromotoluene | $C_7H_7Br$ | 24.4 | 49.7 | 62.3 | 76.0 | 91.0 | 100.0 | 112.0 | 133.6 | 157.3 | 181.8 | –28 |
| 3-Bromotoluene | $C_7H_7Br$ | 14.8 | 50.8 | 64.0 | 78.1 | 93.9 | 104.1 | 117.8 | 138.0 | 160.0 | 183.7 | 39.8 |
| 4-Bromotoluene | $C_7H_7Br$ | 10.3 | 47.5 | 61.1 | 75.2 | 91.8 | 102.3 | 116.4 | 137.4 | 160.2 | 184.5 | 28.5 |
| 3-Bromo-2,4,6-trichlorophenol | $C_6H_2BrCl_3O$ | 112.4 | 146.2 | 163.2 | 181.8 | 200.5 | 213.0 | 229.3 | 253.0 | 278.0 | 305.8 | |
| 2-Bromo-1,4-xylene | $C_8H_9Br$ | 37.5 | 65.0 | 78.8 | 94.0 | 110.6 | 121.6 | 135.7 | 156.4 | 181.0 | 206.7 | +9.5 |
| 1,2-Butadiene (methyl allene) | $C_4H_6$ | –89.0 | –72.7 | –64.2 | –54.9 | –44.3 | –37.5 | –28.3 | –14.2 | +1.8 | 18.5 | |
| 1,3-Butadiene | $C_4H_6$ | –102.8 | –87.6 | –79.7 | –71.0 | –61.3 | –55.1 | –46.8 | –33.9 | –19.3 | –4.5 | –108.9 |
| *n*-Butane | $C_4H_{10}$ | –101.5 | –85.7 | –77.8 | –68.9 | –59.1 | –52.8 | –44.2 | –31.2 | –16.3 | –0.5 | –135 |
| iso-Butane (2-methylpropane) | $C_4H_{10}$ | –109.2 | –94.1 | –86.4 | –77.9 | –68.4 | –62.4 | –54.1 | –41.5 | –27.1 | –11.7 | –145 |
| 1,3-Butanediol | $C_4H_{10}O_2$ | 22.2 | 67.5 | 85.3 | 100.0 | 117.4 | 127.5 | 141.2 | 161.0 | 183.8 | 206.5 | 77 |
| 1,2,3-Butanetriol | $C_4H_{10}O_3$ | 102.0 | 132.0 | 146.0 | 161.0 | 178.0 | 188.0 | 202.5 | 222.0 | 243.5 | 264.0 | |
| 1-Butene | $C_4H_8$ | –104.8 | –89.4 | –81.6 | –73.0 | –63.4 | –57.2 | –48.9 | –36.2 | –21.7 | –6.3 | –130 |
| *cis*-2-Butene | $C_4H_8$ | –96.4 | –81.1 | –73.4 | –64.6 | –54.7 | –48.4 | –39.8 | –26.8 | –12.0 | +3.7 | –138.9 |
| *trans*-2-Butene | $C_4H_8$ | –99.4 | –84.0 | –76.3 | –67.5 | –57.6 | –51.3 | –42.7 | –29.7 | –14.8 | +0.9 | –105.4 |
| 3-Butenenitrile | $C_4H_5N$ | –19.6 | +2.9 | 14.1 | 26.6 | 40.0 | 48.8 | 60.2 | 78.0 | 98.0 | 119.0 | |
| iso-Butyl acetate | $C_6H_{12}O_2$ | –21.2 | +1.4 | 12.8 | 25.5 | 39.2 | 48.0 | 59.7 | 77.6 | 97.5 | 118.0 | –98.9 |
| *n*-Butyl acrylate | $C_7H_{12}O_2$ | –0.5 | +23.5 | 35.5 | 48.6 | 63.4 | 72.6 | 85.1 | 104.0 | 125.2 | 147.4 | –64.6 |
| alcohol | $C_4H_{10}O$ | –1.2 | +20.0 | 30.2 | 41.5 | 53.4 | 60.3 | 70.1 | 84.3 | 100.8 | 117.5 | –79.9 |
| iso-Butyl alcohol | $C_4H_{10}O$ | –9.0 | +11.6 | 21.7 | 32.4 | 44.1 | 51.7 | 61.5 | 75.9 | 91.4 | 108.0 | –108 |
| *sec*-Butyl alcohol | $C_4H_{10}O$ | –12.2 | +7.2 | 16.9 | 27.3 | 38.1 | 45.2 | 54.1 | 67.9 | 83.9 | 99.5 | –114.7 |
| *tert*-Butyl alcohol | $C_4H_{10}O$ | –20.4 | –3.0 | +5.5 | 14.3 | 24.5 | 31.0 | 39.8 | 52.7 | 68.0 | 82.9 | 25.3 |
| iso-Butyl amine | $C_4H_{11}N$ | –50.0 | –31.0 | –21.0 | –10.3 | +1.3 | 8.8 | 18.8 | 32.0 | 50.7 | 68.6 | –85.0 |
| *n*-Butylbenzene | $C_{10}H_{14}$ | 22.7 | 48.8 | 62.0 | 76.3 | 92.4 | 102.6 | 116.2 | 136.9 | 159.2 | 183.1 | –88.0 |
| iso-Butylbenzene | $C_{10}H_{14}$ | 14.1 | 40.5 | 53.7 | 67.8 | 83.3 | 93.3 | 107.0 | 127.2 | 149.6 | 172.8 | –51.5 |
| *sec*-Butylbenzene | $C_{10}H_{14}$ | 18.6 | 44.2 | 57.0 | 70.6 | 86.2 | 96.0 | 109.5 | 128.8 | 150.3 | 173.5 | –75.5 |
| *tert*-Butylbenzene | $C_{10}H_{14}$ | 13.0 | 39.0 | 51.7 | 65.6 | 80.8 | 90.6 | 103.8 | 123.7 | 145.8 | 168.5 | –58 |
| iso-Butyl benzoate | $C_{11}H_{14}O_2$ | 64.0 | 93.6 | 108.6 | 124.2 | 141.8 | 152.0 | 166.4 | 188.2 | 212.8 | 237.0 | |
| *n*-Butyl bromide (1-bromobutane) | $C_4H_9Br$ | –33.0 | –11.2 | –0.3 | +11.6 | 24.8 | 33.4 | 44.7 | 62.0 | 81.7 | 101.6 | –112.4 |
| iso-Butyl *n*-butyrate | $C_8H_{16}O_2$ | +4.6 | 30.0 | 42.2 | 56.1 | 71.7 | 81.3 | 94.0 | 113.9 | 135.7 | 156.9 | |
| carbamate | $C_5H_{11}NO_2$ | | 83.7 | 96.4 | 110.1 | 125.3 | 134.6 | 147.2 | 165.7 | 186.0 | 206.5 | 65 |
| Butyl carbitol (diethylene glycol butyl ether) | $C_8H_{18}O_3$ | 70.0 | 95.7 | 107.8 | 120.5 | 135.5 | 146.0 | 159.8 | 181.2 | 205.0 | 231.2 | |
| *n*-Butyl chloride (1-chlorobutane) | $C_4H_9Cl$ | –49.0 | –28.9 | –18.6 | –7.4 | +5.0 | 13.0 | 24.0 | 40.0 | 58.8 | 77.8 | –123.1 |
| iso-Butyl chloride | $C_4H_9Cl$ | –53.8 | –34.3 | –24.5 | –13.8 | –1.9 | +5.9 | 16.0 | 32.0 | 50.0 | 68.9 | –131.2 |

**TABLE 2-8 Vapor Pressures of Organic Compounds, up to 1 atm** (*Continued*)

| Compound | | Pressure, mm Hg | | | | | | | | | | Melting point, °C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 5 | 10 | 20 | 40 | 60 | 100 | 200 | 400 | 760 | |
| Name | Formula | Temperature, °C | | | | | | | | | | |
| *sec*-Butyl chloride (2-Chlorobutane) | $C_4H_9Cl$ | −60.2 | −39.8 | −29.2 | −17.7 | −5.0 | +3.4 | 14.2 | 31.5 | 50.0 | 68.0 | −131.3 |
| *tert*-Butyl chloride | $C_4H_9Cl$ | | | | | −19.0 | −11.4 | −1.0 | +14.6 | 32.6 | 51.0 | −26.5 |
| *sec*-Butyl chloroacetate | $C_6H_{11}ClO_2$ | 17.0 | 41.8 | 54.6 | 68.2 | 83.6 | 93.0 | 105.5 | 124.1 | 146.0 | 167.8 | |
| 2-*tert*-Butyl-4-cresol | $C_{11}H_{16}O$ | 70.0 | 98.0 | 112.0 | 127.2 | 143.9 | 153.7 | 167.0 | 187.8 | 210.0 | 232.6 | |
| 4-*tert*-Butyl-2-cresol | $C_{11}H_{16}O$ | 74.3 | 103.7 | 118.0 | 134.0 | 150.8 | 161.7 | 176.2 | 197.8 | 221.8 | 247.0 | |
| iso-Butyl dichloroacetate | $C_6H_{10}Cl_2O_2$ | 28.6 | 54.3 | 67.5 | 81.4 | 96.7 | 106.6 | 119.8 | 139.2 | 160.0 | 183.0 | |
| 2,3-Butylene glycol (2,3-butanediol) | $C_4H_{10}O_2$ | 44.0 | 68.4 | 80.3 | 93.4 | 107.8 | 116.3 | 127.8 | 145.6 | 164.0 | 182.0 | 22.5 |
| 2-Butyl-2-ethylbutane-1,3-diol | $C_{10}H_{22}O_2$ | 94.1 | 122.6 | 136.8 | 151.2 | 167.8 | 178.0 | 191.9 | 212.0 | 233.5 | 255.0 | |
| 2-*tert*-Butyl-4-ethylphenol | $C_{12}H_{15}O$ | 76.3 | 106.2 | 121.0 | 137.0 | 154.0 | 165.4 | 179.0 | 200.3 | 223.8 | 247.8 | |
| *n*-Butyl formate | $C_5H_{10}O_2$ | −26.4 | −4.7 | +6.1 | 18.0 | 31.6 | 39.8 | 51.0 | 67.9 | 86.2 | 106.0 | |
| iso-Butyl formate | $C_5H_{10}O_2$ | −32.7 | −11.4 | −0.8 | +11.0 | 24.1 | 32.4 | 43.4 | 60.0 | 79.0 | 98.2 | −95.3 |
| *sec*-Butyl formate | $C_5H_{10}O_2$ | −34.4 | −13.3 | −3.1 | +8.4 | 21.3 | 29.6 | 40.2 | 56.8 | 75.2 | 93.6 | |
| *sec*-Butyl glycolate | $C_6H_{12}O_3$ | 28.3 | 53.6 | 66.0 | 79.8 | 94.2 | 104.0 | 116.4 | 135.5 | 155.6 | 177.5 | |
| iso-Butyl iodide (1-iodo-2-methylpropane) | $C_4H_9I$ | −17.0 | +5.8 | 17.0 | 29.8 | 42.8 | 51.8 | 63.5 | 81.0 | 100.3 | 120.4 | −90.7 |
| isobutyrate | $C_8H_{16}O_2$ | +4.1 | 28.0 | 39.9 | 52.4 | 67.2 | 75.9 | 88.0 | 106.3 | 126.3 | 147.5 | −80.7 |
| isovalerate | $C_9H_{18}O_2$ | 16.0 | 41.2 | 53.8 | 67.7 | 82.7 | 92.4 | 105.2 | 124.8 | 146.4 | 168.7 | |
| levulinate | $C_9H_{16}O_3$ | 65.0 | 92.1 | 105.9 | 120.2 | 136.2 | 147.0 | 160.2 | 181.8 | 205.5 | 229.9 | |
| naphthylketone (1-isovaleronaphthone) | $C_{15}H_{16}O$ | 136.0 | 167.9 | 184.0 | 201.6 | 219.7 | 231.5 | 246.7 | 269.7 | 294.0 | 320.0 | |
| 2-*sec*-Butylphenol | $C_{10}H_{14}O$ | 57.4 | 86.0 | 100.8 | 116.1 | 133.4 | 143.9 | 157.3 | 179.7 | 203.8 | 228.0 | |
| 2-*tert*-Butylphenol | $C_{10}H_{14}O$ | 56.6 | 84.2 | 98.1 | 113.0 | 129.2 | 140.0 | 153.5 | 173.8 | 196.3 | 219.5 | |
| 4-iso-Butylphenol | $C_{10}H_{14}O$ | 72.1 | 100.9 | 115.5 | 130.3 | 147.2 | 157.0 | 171.2 | 192.1 | 214.7 | 237.0 | |
| 4-*sec*-Butylphenol | $C_{10}H_{14}O$ | 71.4 | 100.5 | 114.8 | 130.3 | 147.8 | 157.9 | 172.4 | 194.3 | 217.6 | 242.1 | |
| 4-*tert*-Butylphenol | $C_{10}H_{14}O$ | 70.0 | 99.2 | 114.0 | 129.5 | 146.0 | 156.0 | 170.2 | 191.5 | 214.0 | 238.0 | 99 |
| 2-(4-*tert*-Butylphenoxy)ethyl acetate | $C_{14}H_{20}O_3$ | 118.0 | 150.0 | 165.8 | 183.3 | 201.5 | 212.8 | 228.0 | 250.3 | 277.6 | 304.4 | |
| 4-*tert*-Butylphenyl dichlorophosphate | $C_{10}H_{13}Cl_2O_2P$ | 96.0 | 129.6 | 146.0 | 164.0 | 184.3 | 197.2 | 214.3 | 240.0 | 268.2 | 299.0 | |
| *tert*-Butyl phenyl ketone (pivalophenone) | $C_{11}H_{14}O$ | 57.8 | 85.7 | 99.0 | 114.3 | 130.4 | 140.8 | 154.0 | 175.0 | 197.7 | 220.0 | |
| iso-Butyl propionate | $C_7H_{14}O_2$ | −2.3 | +20.9 | 32.3 | 44.8 | 58.5 | 67.6 | 79.5 | 97.0 | 116.4 | 136.8 | −71 |
| 4-*tert*-Butyl-2,5-xylenol | $C_{12}H_{18}O$ | 88.2 | 119.8 | 135.0 | 151.0 | 169.8 | 180.3 | 195.0 | 217.5 | 241.3 | 265.3 | |
| 4-*tert*-Butyl-2,6-xylenol | $C_{12}H_{18}O$ | 74.0 | 103.9 | 119.0 | 135.0 | 152.2 | 163.6 | 176.0 | 196.0 | 217.8 | 239.8 | |
| 6-*tert*-Butyl-2,4-xylenol | $C_{12}H_{18}O$ | 70.3 | 100.2 | 115.0 | 131.0 | 148.5 | 158.2 | 172.0 | 192.3 | 214.2 | 236.5 | |
| 6-*tert*-Butyl-3,4-xylenol | $C_{12}H_{18}O$ | 83.9 | 113.6 | 127.0 | 143.0 | 159.7 | 170.0 | 184.0 | 204.5 | 226.7 | 249.5 | |
| Butyric acid | $C_4H_8O_2$ | 25.5 | 49.8 | 61.5 | 74.0 | 88.0 | 96.5 | 108.0 | 125.5 | 144.5 | 163.5 | −74 |
| iso-Butyric acid | $C_4H_8O_2$ | 14.7 | 39.3 | 51.2 | 64.0 | 77.8 | 86.3 | 98.0 | 115.8 | 134.5 | 154.5 | −47 |
| Butyronitrile | $C_4H_7N$ | −20.0 | +2.1 | 13.4 | 25.7 | 38.4 | 47.3 | 59.0 | 76.7 | 96.8 | 117.5 | |
| iso-Valerophenone | $C_{11}H_{14}O$ | 58.3 | 87.0 | 101.4 | 116.8 | 133.8 | 144.6 | 158.0 | 180.1 | 204.2 | 228.0 | |
| Camphene | $C_{10}H_{16}$ | | | 47.2 | 60.4 | 75.7 | 85.0 | 97.9 | 117.5 | 138.7 | 160.5 | 50 |
| Campholenic acid | $C_{10}H_{16}O_2$ | 97.6 | 125.7 | 139.8 | 153.9 | 170.0 | 180.0 | 193.7 | 212.7 | 234.0 | 256.0 | |
| *d*-Camphor | $C_{10}H_{16}O$ | 41.5 | 68.6 | 82.3 | 97.5 | 114.0 | 124.0 | 138.0 | 157.9 | 182.0 | 209.2 | 178.5 |
| Camphylamine | $C_{10}H_{19}N$ | 45.3 | 74.0 | 83.7 | 97.6 | 112.5 | 122.0 | 134.6 | 153.0 | 173.8 | 195.0 | |
| Capraldehyde | $C_{10}H_{20}O$ | 51.9 | 78.8 | 92.0 | 106.3 | 122.2 | 132.0 | 145.3 | 164.8 | 186.3 | 208.5 | |
| Capric acid | $C_{10}H_{20}O_2$ | 125.0 | 142.0 | 152.2 | 165.0 | 179.9 | 189.8 | 200.0 | 217.1 | 240.3 | 268.4 | 31.5 |
| *n*-Caproic acid | $C_6H_{12}O_2$ | 71.4 | 89.5 | 99.5 | 111.8 | 125.0 | 133.3 | 144.0 | 160.8 | 181.0 | 202.0 | −1.5 |
| iso-Caproic acid | $C_6H_{12}O_2$ | 66.2 | 83.0 | 94.0 | 107.0 | 120.4 | 129.6 | 141.4 | 158.3 | 181.0 | 207.7 | −35 |
| iso-Caprolactone | $C_6H_{10}O_2$ | 38.3 | 66.4 | 80.3 | 95.7 | 112.3 | 123.2 | 137.2 | 157.8 | 182.1 | 207.0 | |
| Capronitrile | $C_6H_{11}N$ | 9.2 | 34.6 | 47.5 | 61.7 | 76.9 | 86.8 | 99.8 | 119.7 | 141.0 | 163.7 | |
| Capryl alcohol (2-octanol) | $C_8H_{18}O$ | 32.8 | 57.6 | 70.0 | 83.3 | 98.0 | 107.4 | 119.8 | 138.0 | 157.5 | 178.5 | −38.6 |
| Caprylaldehyde | $C_8H_{16}O$ | 73.4 | 92.0 | 101.2 | 110.2 | 120.0 | 126.0 | 133.9 | 145.4 | 156.5 | 168.5 | |
| Caprylic acid (octanoic acid) | $C_8H_{16}O_2$ | 92.3 | 114.1 | 124.0 | 136.4 | 150.6 | 160.0 | 172.2 | 190.3 | 213.9 | 237.5 | 16 |
| Caprylonitrile | $C_8H_{15}N$ | 43.0 | 67.6 | 80.4 | 94.6 | 110.6 | 121.2 | 134.8 | 155.2 | 179.5 | 204.5 | |
| Carbazole | $C_{12}H_9N$ | | | | | | 248.2 | 265.0 | 292.5 | 323.0 | 354.8 | 244.8 |
| Carbon dioxide | $CO_2$ | −134.3 | −124.4 | −119.5 | −114.4 | −108.6 | −104.8 | −100.2 | −93.0 | −85.7 | −78.2 | −57.5 |
| disulfide | $CS_2$ | −73.8 | −54.3 | −44.7 | −34.3 | −22.5 | −15.3 | −5.1 | +10.4 | 28.0 | 46.5 | −110.8 |
| monoxide | CO | −222.0 | −217.2 | −215.0 | −212.8 | −210.0 | −208.1 | −205.7 | −201.3 | −196.3 | −191.3 | −205.0 |
| oxyselenide (carbonyl selenide) | COSe | −117.1 | −102.3 | −95.0 | −86.3 | −76.4 | −70.2 | −61.7 | −49.8 | −35.6 | −21.9 | |
| oxysulfide (carbonyl sulfide) | COS | −132.4 | −119.8 | −113.3 | −106.0 | −98.3 | −93.0 | −85.9 | −75.0 | −62.7 | −49.9 | −138.8 |
| tetrabromide | $CBr_4$ | | | | | 96.3 | 106.3 | 119.7 | 139.7 | 163.5 | 189.5 | 90.1 |
| tetrachloride | $CCl_4$ | −50.0 | −30.0 | −19.6 | −8.2 | +4.3 | 12.3 | 23.0 | 38.3 | 57.8 | 76.7 | −22.6 |
| tetrafluoride | $CF_4$ | −184.6 | −174.1 | −169.3 | −164.3 | −158.8 | −155.4 | −150.7 | −143.6 | −135.5 | −127.7 | −183.7 |
| Carvacrol | $C_{10}H_{14}O$ | 70.0 | 98.4 | 113.2 | 127.9 | 145.2 | 155.3 | 169.7 | 191.2 | 213.8 | 237.0 | +0.5 |
| Carvone | $C_{10}H_{14}O$ | 57.4 | 86.1 | 100.4 | 116.1 | 133.0 | 143.8 | 157.3 | 179.6 | 203.5 | 227.5 | |
| Chavibetol | $C_{10}H_{12}O_2$ | 83.6 | 113.3 | 127.0 | 143.2 | 159.8 | 170.7 | 185.5 | 206.8 | 229.8 | 254.0 | |
| Chloral (trichloroacetaldehyde) | $C_2HCl_3O$ | −37.8 | −16.0 | −5.0 | +7.2 | 20.2 | 29.1 | 40.2 | 57.8 | 77.5 | 97.7 | −57 |
| hydrate (trichloroacetaldehyde hydrate) | $C_2H_3Cl_3O_2$ | −9.8 | +10.0 | 19.5 | 29.2 | 39.7 | 46.2 | 55.0 | 68.0 | 82.1 | 96.2 | 51.7 |
| Chloranil | $C_6Cl_4O_2$ | 70.7 | 89.3 | 97.8 | 106.4 | 116.1 | 122.0 | 129.5 | 140.3 | 151.3 | 162.6 | 290 |
| Chloroacetic acid | $C_2H_3ClO_2$ | 43.0 | 68.3 | 81.0 | 94.2 | 109.2 | 118.3 | 130.7 | 149.0 | 169.0 | 189.5 | 61.2 |
| anhydride | $C_4H_4Cl_2O_3$ | 67.2 | 94.1 | 108.0 | 122.4 | 138.2 | 148.0 | 159.8 | 177.8 | 197.0 | 217.0 | 46 |
| 2-Chloroaniline | $C_6H_6ClN$ | 46.3 | 72.3 | 84.8 | 99.2 | 115.6 | 125.7 | 139.5 | 160.0 | 183.7 | 208.8 | 0 |
| 3-Chloroaniline | $C_6H_6ClN$ | 63.5 | 89.8 | 102.0 | 116.7 | 133.6 | 144.1 | 158.0 | 179.5 | 203.5 | 228.5 | −10.4 |
| 4-Chloroaniline | $C_6H_6ClN$ | 59.3 | 87.9 | 102.1 | 117.8 | 135.0 | 145.8 | 159.9 | 182.3 | 206.6 | 230.5 | 70.5 |
| Chlorobenzene | $C_6H_5Cl$ | −13.0 | +10.6 | 22.2 | 35.3 | 49.7 | 58.3 | 70.7 | 89.4 | 110.0 | 132.2 | −45.2 |
| 2-Chlorobenzotrichloride (2-α,α,α-tetrachlorotoluene) | $C_7H_4Cl_4$ | 69.0 | 101.8 | 117.9 | 135.8 | 155.0 | 167.8 | 185.0 | 208.0 | 233.0 | 262.1 | 28.7 |

**TABLE 2-8 Vapor Pressures of Organic Compounds, up to 1 atm** (*Continued*)

| Compound | | Pressure, mm Hg | | | | | | | | | | Melting point, °C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 5 | 10 | 20 | 40 | 60 | 100 | 200 | 400 | 760 | |
| Name | Formula | Temperature, °C | | | | | | | | | | |
| 2-Chlorobenzotrifluoride (2-chloro-α,α,α-trifluorotoluene) | $C_7H_4ClF_3$ | 0.0 | 24.7 | 37.1 | 50.6 | 65.9 | 75.4 | 88.3 | 108.3 | 130.0 | 152.2 | –6.0 |
| 2-Chlorobiphenyl | $C_{12}H_9Cl$ | 89.3 | 109.8 | 134.7 | 151.2 | 169.9 | 182.1 | 197.0 | 219.6 | 243.8 | 267.5 | 34 |
| 4-Chlorobiphenyl | $C_{12}H_9Cl$ | 96.4 | 129.8 | 146.0 | 164.0 | 183.8 | 196.0 | 212.5 | 237.8 | 264.5 | 292.9 | 75.5 |
| α-Chlorocrotonic acid | $C_4H_5ClO_2$ | 70.0 | 95.6 | 108.0 | 121.2 | 135.6 | 144.4 | 155.9 | 173.8 | 193.2 | 212.0 | |
| Chlorodifluoromethane | $CHClF_2$ | –122.8 | –110.2 | –103.7 | –96.5 | –88.6 | –83.4 | –76.4 | –65.8 | –53.6 | –40.8 | –160 |
| Chlorodimethylphenylsilane | $C_8H_{11}ClSi$ | 29.8 | 56.7 | 70.0 | 84.7 | 101.2 | 111.5 | 124.7 | 145.5 | 168.6 | 193.5 | |
| 1-Chloro-2-ethoxybenzene | $C_8H_9ClO$ | 45.8 | 72.8 | 86.5 | 101.5 | 117.8 | 127.8 | 141.8 | 162.0 | 185.5 | 208.0 | |
| 2-(2-Chloroethoxy) ethanol | $C_4H_9ClO_2$ | 53.0 | 78.3 | 90.7 | 104.1 | 118.4 | 127.5 | 139.5 | 157.2 | 176.5 | 196.0 | |
| bis-2-Chloroethyl acetacetal | $C_6H_{12}Cl_2O_2$ | 56.2 | 83.7 | 97.6 | 112.2 | 127.8 | 138.0 | 150.7 | 169.8 | 190.5 | 212.6 | |
| 1-Chloro-2-ethylbenzene | $C_8H_9Cl$ | 17.2 | 43.0 | 56.1 | 70.3 | 86.2 | 96.4 | 110.0 | 130.2 | 152.2 | 177.6 | –80.2 |
| 1-Chloro-3-ethylbenzene | $C_8H_9Cl$ | 18.6 | 45.2 | 58.1 | 73.0 | 89.2 | 99.6 | 113.6 | 133.8 | 156.7 | 181.1 | –53.3 |
| 1-Chloro-4-ethylbenzene | $C_8H_9Cl$ | 19.2 | 46.4 | 60.0 | 75.5 | 91.8 | 102.0 | 116.0 | 137.0 | 159.8 | 184.3 | –62.6 |
| 2-Chloroethyl chloroacetate | $C_4H_6Cl_2O_2$ | 46.0 | 72.1 | 86.0 | 100.0 | 116.0 | 126.2 | 140.0 | 159.8 | 182.2 | 205.0 | |
| 2-Chloroethyl 2-chloroisopropyl ether | $C_5H_{10}Cl_2O$ | 24.7 | 50.1 | 63.0 | 77.2 | 92.4 | 102.2 | 115.8 | 135.7 | 156.5 | 180.0 | |
| 2-Chloroethyl 2-chloropropyl ether | $C_5H_{10}Cl_2O$ | 29.8 | 56.5 | 70.0 | 84.8 | 101.5 | 111.8 | 125.6 | 146.3 | 169.8 | 194.1 | |
| 2-Chloroethyl α-methylbenzyl ether | $C_{10}H_{13}ClO$ | 62.3 | 91.4 | 106.0 | 121.8 | 139.6 | 150.0 | 164.8 | 186.3 | 210.8 | 235.0 | |
| Chloroform (trichloromethane) | $CHCl_3$ | –58.0 | –39.1 | –29.7 | –19.0 | –7.1 | +0.5 | 10.4 | 25.9 | 42.7 | 61.3 | –63.5 |
| 1-Chloronaphthalene | $C_{10}H_7Cl$ | 80.6 | 104.8 | 118.6 | 134.4 | 153.2 | 165.6 | 180.4 | 204.2 | 230.8 | 259.3 | –20 |
| 4-Chlorophenethyl alcohol | $C_8H_9ClO$ | 84.0 | 114.3 | 129.0 | 145.0 | 162.0 | 173.5 | 188.1 | 210.0 | 234.5 | 259.3 | |
| 2-Chlorophenol | $C_6H_5ClO$ | 12.1 | 38.2 | 51.2 | 65.9 | 82.0 | 92.0 | 106.0 | 126.4 | 149.8 | 174.5 | 7 |
| 3-Chlorophenol | $C_6H_5ClO$ | 44.2 | 72.0 | 86.1 | 101.7 | 118.0 | 129.4 | 143.0 | 164.8 | 188.7 | 214.0 | 32.5 |
| 4-Chlorophenol | $C_6H_5ClO$ | 49.8 | 78.2 | 92.2 | 108.1 | 125.0 | 136.1 | 150.0 | 172.0 | 196.0 | 220.0 | 42 |
| 2-Chloro-3-phenylphenol | $C_{12}H_9ClO$ | 118.0 | 152.2 | 169.7 | 186.7 | 207.4 | 219.6 | 237.0 | 261.3 | 289.4 | 317.5 | +6 |
| 2-Chloro-6-phenylphenol | $C_{12}H_9ClO$ | 119.8 | 153.7 | 170.7 | 189.8 | 208.2 | 220.0 | 237.1 | 261.6 | 289.5 | 317.0 | |
| Chloropicrin (trichloronitromethane) | $CCl_3NO_2$ | –25.5 | –3.3 | +7.8 | 20.0 | 33.8 | 42.3 | 53.8 | 71.8 | 91.8 | 111.9 | –64 |
| 1-Chloropropene | $C_3H_5Cl$ | –81.3 | –63.4 | –54.1 | –44.0 | –32.7 | –25.1 | –15.1 | +1.3 | 18.0 | 37.0 | –99.0 |
| 2-Chloropyridine | $C_5H_4ClN$ | 13.3 | 38.8 | 51.7 | 65.8 | 81.7 | 91.6 | 104.6 | 125.0 | 147.7 | 170.2 | |
| 3-Chlorostyrene | $C_8H_7Cl$ | 25.3 | 51.3 | 65.2 | 80.0 | 96.5 | 107.2 | 121.2 | 142.2 | 165.7 | 190.0 | |
| 4-Chlorostyrene | $C_8H_7Cl$ | 28.0 | 54.5 | 67.5 | 82.0 | 98.0 | 108.5 | 122.0 | 143.5 | 166.0 | 191.0 | –15.0 |
| 1-Chlorotetradecane | $C_{14}H_{29}Cl$ | 98.5 | 131.8 | 148.2 | 166.2 | 187.0 | 199.8 | 215.5 | 240.3 | 267.5 | 296.0 | +0.9 |
| 2-Chlorotoluene | $C_7H_7Cl$ | +5.4 | 30.6 | 43.2 | 56.9 | 72.0 | 81.8 | 94.7 | 115.0 | 137.1 | 159.3 | |
| 3-Chlorotoluene | $C_7H_7Cl$ | +4.8 | 30.3 | 43.2 | 57.4 | 73.0 | 83.2 | 96.3 | 116.6 | 139.7 | 162.3 | |
| 4-Chlorotoluene | $C_7H_7Cl$ | +5.5 | 31.0 | 43.8 | 57.8 | 73.5 | 83.3 | 96.6 | 117.1 | 139.8 | 162.3 | +7.3 |
| Chlorotriethylsilane | $C_6H_{15}ClSi$ | –4.9 | +19.8 | 32.0 | 45.5 | 60.2 | 69.5 | 82.3 | 101.6 | 123.6 | 146.3 | |
| 1-Chloro-1,2,2-trifluoroethylene | $C_2ClF_3$ | –116.0 | –102.5 | –95.9 | –88.2 | –79.7 | –74.1 | –66.7 | –55.0 | –41.7 | –27.9 | –157.5 |
| Chlorotrifluoromethane | $CClF_3$ | –149.5 | –139.2 | –134.1 | –128.5 | –121.9 | –117.3 | –111.7 | –102.5 | –92.7 | –81.2 | |
| Chlorotrimethylsilane | $C_3H_9ClSi$ | –62.8 | –43.6 | –34.0 | –23.2 | –11.4 | –4.0 | +6.0 | 21.9 | 39.4 | 57.9 | |
| *trans*-Cinnamic acid | $C_9H_8O_2$ | 127.5 | 157.8 | 173.0 | 189.5 | 207.1 | 217.8 | 232.4 | 253.3 | 276.7 | 300.0 | 133 |
| Cinnamyl alcohol | $C_9H_{10}O$ | 72.6 | 102.5 | 117.8 | 133.7 | 151.0 | 162.0 | 177.8 | 199.8 | 224.6 | 250.0 | 33 |
| Cinnamylaldehyde | $C_9H_8O$ | 76.1 | 105.8 | 120.0 | 135.7 | 152.2 | 163.7 | 177.7 | 199.3 | 222.4 | 246.0 | –7.5 |
| Citraconic anhydride | $C_5H_4O_3$ | 47.1 | 74.8 | 88.9 | 103.8 | 120.3 | 131.3 | 145.4 | 165.8 | 189.8 | 213.5 | |
| *cis*-α-Citral | $C_{10}H_{16}O$ | 61.7 | 90.0 | 103.9 | 119.4 | 135.9 | 146.3 | 160.0 | 181.8 | 205.0 | 228.0 | |
| *d*-Citronellal | $C_{10}H_{18}O$ | 44.0 | 71.4 | 84.8 | 99.8 | 116.1 | 126.2 | 140.1 | 160.0 | 183.8 | 206.5 | |
| Citronellic acid | $C_{10}H_{18}O_2$ | 99.5 | 127.3 | 141.4 | 155.6 | 171.9 | 182.1 | 195.4 | 214.5 | 236.6 | 257.0 | |
| Citronellol | $C_{10}H_{20}O$ | 66.4 | 93.6 | 107.0 | 121.5 | 137.2 | 147.2 | 159.8 | 179.8 | 201.0 | 221.5 | |
| Citronellyl acetate | $C_{12}H_{22}O_2$ | 74.7 | 100.2 | 113.0 | 126.0 | 140.5 | 149.7 | 161.0 | 178.8 | 197.8 | 217.0 | |
| Coumarin | $C_9H_6O_2$ | 106.0 | 137.8 | 153.4 | 170.0 | 189.0 | 200.5 | 216.5 | 240.0 | 264.7 | 291.0 | 70 |
| *o*-Cresol (2-cresol; 2-methylphenol) | $C_7H_8O$ | 38.2 | 64.0 | 76.7 | 90.5 | 105.8 | 115.5 | 127.4 | 146.7 | 168.4 | 190.8 | 30.8 |
| *m*-Cresol (3-cresol; 3-methylphenol) | $C_7H_8O$ | 52.0 | 76.0 | 87.8 | 101.4 | 116.0 | 125.8 | 138.0 | 157.3 | 179.0 | 202.8 | 10.9 |
| *p*-Cresol (4-cresol; 4-methylphenol) | $C_7H_8O$ | 53.0 | 76.5 | 88.6 | 102.3 | 117.7 | 127.0 | 140.0 | 157.3 | 179.4 | 201.8 | 35.5 |
| *cis*-Crotonic acid | $C_4H_6O_2$ | 33.5 | 57.4 | 69.0 | 82.0 | 96.0 | 104.5 | 116.3 | 133.9 | 152.2 | 171.9 | 15.5 |
| *trans*-Crotonic acid | $C_4H_6O_2$ | | | 80.0 | 93.0 | 107.8 | 116.7 | 128.0 | 146.0 | 165.5 | 185.0 | 72 |
| *cis*-Crotononitrile | $C_4H_5N$ | –29.0 | –7.1 | +4.0 | 16.4 | 30.0 | 38.5 | 50.1 | 68.0 | 88.0 | 108.0 | |
| *trans*-Crotononitrile | $C_4H_5N$ | –19.5 | +3.5 | 15.0 | 27.8 | 41.8 | 50.9 | 62.8 | 81.1 | 101.5 | 122.8 | |
| Cumene | $C_9H_{12}$ | +2.9 | 26.8 | 38.3 | 51.5 | 66.1 | 75.4 | 88.1 | 107.3 | 129.2 | 152.4 | –96.0 |
| 4-Cumidene | $C_9H_{13}N$ | 60.0 | 88.2 | 102.2 | 117.8 | 134.2 | 145.0 | 158.0 | 180.0 | 203.2 | 227.0 | |
| Cuminal | $C_{10}H_{12}O$ | 58.0 | 87.3 | 102.0 | 117.9 | 135.2 | 146.0 | 160.0 | 182.8 | 206.7 | 232.0 | |
| Cuminyl alcohol | $C_{10}H_{14}O$ | 74.2 | 103.7 | 118.0 | 133.8 | 150.3 | 161.7 | 176.2 | 197.9 | 221.7 | 246.6 | |
| 2-Cyano-2-*n*-butyl acetate | $C_7H_{11}NO_2$ | 42.0 | 68.7 | 82.0 | 96.2 | 111.8 | 121.5 | 133.8 | 152.2 | 173.4 | 195.2 | |
| Cyanogen | $C_2N_2$ | –95.8 | –83.2 | –76.8 | –70.1 | –62.7 | –57.9 | –51.8 | –42.6 | –33.0 | –21.0 | –34.4 |
| bromide | CBrN | –35.7 | –18.3 | –10.0 | –1.0 | +8.6 | 14.7 | 22.6 | 33.8 | 46.0 | 61.5 | 58 |
| chloride | CClN | –76.7 | –61.4 | –53.8 | –46.1 | –37.5 | –32.1 | –24.9 | –14.1 | –2.3 | +13.1 | –6.5 |
| iodide | CIN | 25.2 | 47.2 | 57.7 | 68.6 | 80.3 | 88.0 | 97.6 | 111.5 | 126.1 | 141.1 | |
| Cyclobutane | $C_4H_8$ | –92.0 | –76.0 | –67.9 | –58.7 | –48.4 | –41.8 | –32.8 | –18.9 | –3.4 | +12.9 | –50 |
| Cyclobutene | $C_4H_6$ | –99.1 | –83.4 | –75.4 | –66.6 | –56.4 | –50.0 | –41.2 | –27.8 | –12.2 | +2.4 | |
| Cyclohexane | $C_6H_{12}$ | –45.3 | –25.4 | –15.9 | –5.0 | +6.7 | 14.7 | 25.5 | 42.0 | 60.8 | 80.7 | +6.6 |
| Cyclohexaneethanol | $C_8H_{16}O$ | 50.4 | 77.2 | 90.0 | 104.0 | 119.8 | 129.8 | 142.7 | 161.7 | 183.5 | 205.4 | |
| Cyclohexanol | $C_6H_{12}O$ | 21.0 | 44.0 | 56.0 | 68.8 | 83.0 | 91.8 | 103.7 | 121.7 | 141.4 | 161.0 | 23.9 |
| Cyclohexanone | $C_6H_{10}O$ | +1.4 | 26.4 | 38.7 | 52.5 | 67.8 | 77.5 | 90.4 | 110.3 | 132.5 | 155.6 | –45.0 |
| 2-Cyclohexyl-4,6-dinitrophenol | $C_{12}H_{14}N_2O_5$ | 132.8 | 161.8 | 175.9 | 191.2 | 206.7 | 216.0 | 229.0 | 248.7 | 269.8 | 291.5 | |
| Cyclopentane | $C_5H_{10}$ | –68.0 | –49.6 | –40.4 | –30.1 | –18.6 | –11.3 | –1.3 | +13.8 | 31.0 | 49.3 | –93.7 |
| Cyclopropane | $C_3H_6$ | –116.8 | –104.2 | –97.5 | –90.3 | –82.3 | –77.0 | –70.0 | –59.1 | –46.9 | –33.5 | –126.6 |
| Cymene | $C_{10}H_{14}$ | 17.3 | 43.9 | 57.0 | 71.1 | 87.0 | 97.2 | 110.8 | 131.4 | 153.5 | 177.2 | –68.2 |

**TABLE 2-8 Vapor Pressures of Organic Compounds, up to 1 atm** (*Continued*)

| Compound | | Pressure, mm Hg | | | | | | | | | | Melting point, °C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 5 | 10 | 20 | 40 | 60 | 100 | 200 | 400 | 760 | |
| Name | Formula | Temperature, °C | | | | | | | | | | |
| *cis*-Decalin | $C_{10}H_{18}$ | 22.5 | 50.1 | 64.2 | 79.8 | 97.2 | 108.0 | 123.2 | 145.4 | 169.9 | 194.6 | −43.3 |
| *trans*-Decalin | $C_{10}H_{18}$ | −0.8 | +30.6 | 47.2 | 65.3 | 85.7 | 98.4 | 114.6 | 136.2 | 160.1 | 186.7 | −30.7 |
| Decane | $C_{10}H_{22}$ | 16.5 | 42.3 | 55.7 | 69.8 | 85.5 | 95.5 | 108.6 | 128.4 | 150.6 | 174.1 | −29.7 |
| Decan-2-one | $C_{10}H_{20}O$ | 44.2 | 71.9 | 85.8 | 100.7 | 117.1 | 127.8 | 142.0 | 163.2 | 186.7 | 211.0 | +3.5 |
| 1-Decene | $C_{10}H_{20}$ | 14.7 | 40.3 | 53.7 | 67.8 | 83.3 | 93.5 | 106.5 | 126.7 | 149.2 | 172.0 | |
| Decyl alcohol | $C_{10}H_{22}O$ | 69.5 | 97.3 | 111.3 | 125.8 | 142.1 | 152.0 | 165.8 | 186.2 | 208.8 | 231.0 | +7 |
| Decyltrimethylsilane | $C_{13}H_{30}Si$ | 67.4 | 96.4 | 111.0 | 126.5 | 144.0 | 154.3 | 169.5 | 191.0 | 215.5 | 240.0 | |
| Dehydroacetic acid | $C_8H_8O_4$ | 91.7 | 122.0 | 137.3 | 153.0 | 171.0 | 181.5 | 197.5 | 219.5 | 244.5 | 269.0 | |
| Desoxybenzoin | $C_{14}H_{12}O$ | 123.3 | 156.2 | 173.5 | 192.0 | 212.0 | 224.5 | 241.3 | 265.2 | 293.0 | 321.0 | 60 |
| Diacetamide | $C_4H_7NO_2$ | 70.0 | 95.0 | 108.0 | 122.6 | 138.2 | 148.0 | 160.6 | 180.8 | 202.0 | 223.0 | 78.5 |
| Diacetylene (1,3-butadiyne) | $C_4H_2$ | −82.5 | −68.0 | −61.2 | −53.8 | −45.9 | −41.0 | −34.0 | −20.9 | −6.1 | +9.7 | −34.9 |
| Diallyldichlorosilane | $C_6H_{10}Cl_2Si$ | +9.5 | 34.8 | 47.4 | 61.3 | 76.4 | 86.3 | 99.7 | 119.4 | 142.0 | 165.3 | |
| Diallyl sulfide | $C_6H_{10}S$ | −9.5 | +14.4 | 26.6 | 39.7 | 54.2 | 63.7 | 75.8 | 94.8 | 116.1 | 138.6 | −83 |
| Diisoamyl ether | $C_{10}H_{22}O$ | 18.6 | 44.3 | 57.0 | 70.7 | 86.3 | 96.0 | 109.6 | 129.0 | 150.3 | 173.4 | |
| oxalate | $C_{12}H_{22}O_4$ | 85.4 | 116.0 | 131.4 | 147.7 | 165.7 | 177.0 | 192.2 | 215.0 | 240.0 | 265.0 | |
| sulfide | $C_{10}H_{22}S$ | 43.0 | 73.0 | 87.6 | 102.7 | 120.0 | 130.6 | 145.3 | 166.4 | 191.0 | 216.0 | |
| Dibenzylamine | $C_{14}H_{15}N$ | 118.3 | 149.8 | 165.6 | 182.2 | 200.2 | 212.2 | 227.3 | 249.8 | 274.3 | 300.0 | −26 |
| Dibenzyl ketone (1,3-diphenyl-2-propanone) | $C_{15}H_{14}O$ | 125.5 | 159.8 | 177.6 | 195.7 | 216.6 | 229.4 | 246.6 | 272.3 | 301.7 | 330.5 | 34.5 |
| 1,4-Dibromobenzene | $C_6H_4Br_2$ | 61.0 | 79.3 | 87.7 | 103.6 | 120.8 | 131.6 | 146.5 | 168.5 | 192.5 | 218.6 | 87.5 |
| 1,2-Dibromobutane | $C_4H_8Br_2$ | 7.5 | 33.2 | 46.1 | 60.0 | 76.0 | 86.0 | 99.8 | 120.2 | 143.5 | 166.3 | −64.5 |
| *dl*-2,3-Dibromobutane | $C_4H_8Br_2$ | +5.0 | 30.0 | 41.6 | 56.4 | 72.0 | 82.0 | 95.3 | 115.7 | 138.0 | 160.5 | |
| *meso*-2,3-Dibromobutane | $C_4H_8Br_2$ | +1.5 | 26.6 | 39.3 | 53.2 | 68.0 | 78.0 | 91.7 | 111.8 | 134.2 | 157.3 | −34.5 |
| 1,2-Dibromodecane | $C_{10}H_{20}Br_2$ | 95.7 | 123.6 | 137.3 | 151.0 | 167.4 | 177.5 | 190.2 | 209.6 | 229.8 | 250.4 | |
| Di(2-bromoethyl) ether | $C_4H_8Br_2O$ | 47.7 | 75.3 | 88.5 | 103.6 | 119.8 | 130.0 | 144.0 | 165.0 | 188.0 | 212.5 | |
| α,β-Dibromomaleic anhydride | $C_4H_2Br_2O_3$ | 50.0 | 78.0 | 92.0 | 106.7 | 123.5 | 133.8 | 147.7 | 168.0 | 192.0 | 215.0 | |
| 1,2-Dibromo-2-methylpropane | $C_4H_8Br_2$ | −28.8 | −3.0 | +10.5 | 25.7 | 42.3 | 53.7 | 68.8 | 92.1 | 119.8 | 149.0 | −70.3 |
| 1,3-Dibromo-2-methylpropane | $C_4H_8Br_2$ | 14.0 | 40.0 | 53.0 | 67.5 | 83.5 | 93.7 | 107.4 | 117.8 | 150.6 | 174.6 | |
| 1,2-Dibromopentane | $C_5H_{10}Br_2$ | 19.8 | 45.4 | 58.0 | 72.0 | 87.4 | 97.4 | 110.1 | 130.2 | 151.8 | 175.0 | |
| 1,2-Dibromopropane | $C_3H_6Br_2$ | −7.0 | +17.3 | 29.4 | 42.3 | 57.2 | 66.4 | 78.7 | 97.8 | 118.5 | 141.6 | −55.5 |
| 1,3-Dibromopropane | $C_3H_6Br_2$ | +9.7 | 35.4 | 48.0 | 62.1 | 77.8 | 87.8 | 101.3 | 121.7 | 144.1 | 167.5 | −34.4 |
| 2,3-Dibromopropene | $C_3H_4Br_2$ | −6.0 | +17.9 | 30.0 | 43.2 | 57.8 | 67.0 | 79.5 | 98.0 | 119.5 | 141.2 | |
| 2,3-Dibromo-1-propanol | $C_3H_6Br_2O$ | 57.0 | 84.5 | 98.2 | 113.5 | 129.8 | 140.0 | 153.0 | 173.8 | 196.0 | 219.0 | |
| Diisobutylamine | $C_8H_{19}N$ | −5.1 | +18.4 | 30.6 | 43.7 | 57.8 | 67.0 | 79.2 | 97.6 | 118.0 | 139.5 | −70 |
| 2,6-Ditert-butyl-4-cresol | $C_{15}H_{24}O$ | 85.8 | 116.2 | 131.0 | 147.0 | 164.1 | 175.2 | 190.0 | 212.8 | 237.6 | 262.5 | |
| 4,6-Ditert-butyl-2-cresol | $C_{15}H_{24}O$ | 86.2 | 117.3 | 132.4 | 149.0 | 167.4 | 179.0 | 194.0 | 217.5 | 243.4 | 269.3 | |
| 4,6-Ditert-butyl-3-cresol | $C_{15}H_{24}O$ | 103.7 | 135.2 | 150.0 | 167.0 | 185.3 | 196.1 | 211.0 | 233.0 | 257.1 | 282.0 | |
| 2,6-Ditert-butyl-4-ethylphenol | $C_{16}H_{26}O$ | 89.1 | 121.4 | 137.0 | 154.0 | 172.1 | 183.9 | 198.0 | 220.0 | 244.0 | 268.6 | |
| 4,6-Ditert-butyl-3-ethylphenol | $C_{16}H_{26}O$ | 111.5 | 142.6 | 157.4 | 174.0 | 192.3 | 204.4 | 218.0 | 241.7 | 264.6 | 290.0 | |
| Diisobutyl oxalate | $C_{10}H_{18}O_4$ | 63.2 | 91.2 | 105.3 | 120.3 | 137.5 | 147.8 | 161.8 | 183.5 | 205.8 | 229.5 | |
| 2,4-Ditert-butylphenol | $C_{14}H_{22}O$ | 84.5 | 115.4 | 130.0 | 146.0 | 164.3 | 175.8 | 190.0 | 212.5 | 237.0 | 260.8 | |
| Dibutyl phthalate | $C_{16}H_{22}O_4$ | 148.2 | 182.1 | 198.2 | 216.2 | 235.8 | 247.8 | 263.7 | 287.0 | 313.5 | 340.0 | |
| sulfide | $C_8H_{18}S$ | +21.7 | 51.8 | 66.4 | 80.5 | 96.0 | 105.8 | 118.6 | 138.0 | 159.0 | 182.0 | −79.7 |
| Diisobutyl *d*-tartrate | $C_{12}H_{22}O_6$ | 117.8 | 151.8 | 169.0 | 188.0 | 208.5 | 221.6 | 239.5 | 264.7 | 294.0 | 324.0 | 73.5 |
| Dicarvacryl-mono-(6-chloro-2-xenyl) phosphate | $C_{32}H_{34}ClO_4P$ | 204.2 | 234.5 | 249.3 | 264.5 | 280.5 | 290.7 | 304.9 | 323.8 | 342.0 | 361.0 | |
| Dicarvacryl-2-tolyl phosphate | $C_{27}H_{33}O_4P$ | 180.2 | 209.3 | 221.8 | 237.0 | 251.5 | 260.3 | 272.5 | 290.0 | 309.8 | 330.0 | |
| Dichloroacetic acid | $C_2H_2Cl_2O_2$ | 44.0 | 69.8 | 82.6 | 96.3 | 111.8 | 121.5 | 134.0 | 152.3 | 173.7 | 194.4 | 9.7 |
| 1,2-Dichlorobenzene | $C_6H_4Cl_2$ | 20.0 | 46.0 | 59.1 | 73.4 | 89.4 | 99.5 | 112.9 | 133.4 | 155.8 | 179.0 | −17.6 |
| 1,3-Dichlorobenzene | $C_6H_4Cl_2$ | 12.1 | 39.0 | 52.0 | 66.2 | 82.0 | 92.2 | 105.0 | 125.9 | 149.0 | 173.0 | −24.2 |
| 1,4-Dichlorobenzene | $C_6H_4Cl_2$ | | | 54.8 | 69.2 | 84.8 | 95.2 | 108.4 | 128.3 | 150.2 | 173.9 | 53.0 |
| 1,2-Dichlorobutane | $C_4H_8Cl_2$ | −23.6 | −0.3 | +11.5 | 24.5 | 37.7 | 47.8 | 60.2 | 79.7 | 100.8 | 123.5 | |
| 2,3-Dichlorobutane | $C_4H_8Cl_2$ | −25.2 | −3.0 | +8.5 | 21.2 | 35.0 | 43.9 | 56.0 | 74.0 | 94.2 | 116.0 | −80.4 |
| 1,2-Dichloro-1,2-difluoroethylene | $C_2Cl_2F_2$ | −82.0 | −65.6 | −57.3 | −48.3 | −38.2 | −31.8 | −23.0 | −10.0 | +5.0 | 20.9 | −112 |
| Dichlorodifluoromethane | $CCl_2F_2$ | −118.5 | −104.6 | −97.8 | −90.1 | −81.6 | −76.1 | −68.6 | −57.0 | −43.9 | −29.8 | |
| Dichlorodiphenyl silane | $C_{12}H_{10}Cl_2Si$ | 109.6 | 142.4 | 158.0 | 176.0 | 195.5 | 207.5 | 223.8 | 248.0 | 275.5 | 304.0 | |
| Dichlorodiisopropyl ether | $C_6H_{12}Cl_2O$ | 29.6 | 55.2 | 68.2 | 82.2 | 97.3 | 106.9 | 119.7 | 139.0 | 159.8 | 182.7 | |
| Di(2-chloroethoxy) methane | $C_5H_{10}Cl_2O_2$ | 53.0 | 80.4 | 94.0 | 109.5 | 125.5 | 135.8 | 149.6 | 170.0 | 192.0 | 215.0 | |
| Dichloroethoxymethylsilane | $C_8H_8Cl_2OSi$ | −33.8 | −12.1 | −1.3 | +11.3 | 24.4 | 32.6 | 44.1 | 61.0 | 80.3 | 100.6 | |
| 1,2-Dichloro-3-ethylbenzene | $C_8H_8Cl_2$ | 46.0 | 75.0 | 90.0 | 105.9 | 123.8 | 135.0 | 149.8 | 172.0 | 197.0 | 222.1 | −40.8 |
| 1,2-Dichloro-4-ethylbenzene | $C_8H_8Cl_2$ | 47.0 | 77.2 | 92.3 | 109.6 | 127.5 | 139.0 | 153.3 | 176.0 | 201.7 | 226.6 | −76.4 |
| 1,4-Dichloro-2-ethylbenzene | $C_8H_8Cl_2$ | 38.5 | 68.0 | 83.2 | 99.8 | 118.0 | 129.0 | 144.0 | 166.2 | 191.5 | 216.3 | −61.2 |
| *cis*-1,2-Dichloroethylene | $C_2H_2Cl_2$ | −58.4 | −39.2 | −29.9 | −19.4 | −7.9 | −0.5 | +9.5 | 24.6 | 41.0 | 59.0 | −80.5 |
| *trans*-1,2-Dichloro ethylene | $C_2H_2Cl_2$ | −65.4 | −47.2 | −38.0 | −28.0 | −17.0 | −10.0 | −0.2 | +14.3 | 30.8 | 47.8 | −50.0 |
| Di(2-chloroethyl) ether | $C_4H_8Cl_2O$ | 23.5 | 49.3 | 62.0 | 76.0 | 91.5 | 101.5 | 114.5 | 134.0 | 155.4 | 178.5 | |
| Dichlorofluoromethane | $CHCl_2F$ | −91.3 | −75.5 | −67.5 | −58.6 | −48.8 | −42.6 | −33.9 | −20.9 | −6.2 | +8.9 | −135 |
| 1,5-Dichlorohexamethyltrisiloxane | $C_6H_{18}Cl_2O_2Si_3$ | 26.0 | 52.0 | 65.1 | 79.0 | 94.8 | 105.0 | 118.2 | 138.3 | 160.2 | 184.0 | −53.0 |
| Dichloromethylphenylsilane | $C_7H_8Cl_2Si$ | 35.7 | 63.5 | 77.4 | 92.4 | 109.5 | 120.0 | 134.2 | 155.5 | 180.2 | 205.5 | |
| 1,1-Dichloro-2-methylpropane | $C_4H_8Cl_2$ | −31.0 | −8.4 | +2.6 | 14.6 | 28.2 | 37.0 | 48.2 | 65.8 | 85.4 | 106.0 | |
| 1,2-Dichloro-2-methylpropane | $C_4H_8Cl_2$ | −25.8 | −4.2 | +6.7 | 18.7 | 32.0 | 40.2 | 51.7 | 68.9 | 87.8 | 108.0 | |
| 1,3-Dichloro-2-methylpropane | $C_4H_8Cl_2$ | −3.0 | +20.6 | 32.0 | 44.8 | 58.6 | 67.5 | 78.8 | 96.1 | 115.4 | 135.0 | |
| 2,4-Dichlorophenol | $C_6H_4Cl_2O$ | 53.0 | 80.0 | 92.8 | 107.7 | 123.4 | 133.5 | 146.0 | 165.2 | 187.5 | 210.0 | 45.0 |
| 2,6-Dichlorophenol | $C_6H_4Cl_2O$ | 59.5 | 87.6 | 101.0 | 115.5 | 131.6 | 141.8 | 154.6 | 175.5 | 197.7 | 220.0 | |

**TABLE 2-8 Vapor Pressures of Organic Compounds, up to 1 atm** (*Continued*)

| Compound | | Pressure, mm Hg | | | | | | | | | | Melting point, °C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 5 | 10 | 20 | 40 | 60 | 100 | 200 | 400 | 760 | |
| Name | Formula | Temperature, °C | | | | | | | | | | |
| α,α-Dichlorophenylacetonitrile | $C_8H_5Cl_2N$ | 56.0 | 84.0 | 98.1 | 113.8 | 130.0 | 141.0 | 154.5 | 176.2 | 199.5 | 223.5 | |
| Dichlorophenylarsine | $C_6H_5AsCl_2$ | 61.8 | 100.0 | 116.0 | 133.1 | 151.0 | 163.2 | 178.9 | 202.8 | 228.8 | 256.5 | |
| 1,2-Dichloropropane | $C_3H_6Cl_2$ | −38.5 | −17.0 | −6.1 | +6.0 | 19.4 | 28.0 | 39.4 | 57.0 | 76.0 | 96.8 | |
| 2,3-Dichlorostyrene | $C_8H_6Cl_2$ | 61.0 | 90.1 | 104.6 | 120.5 | 137.8 | 149.0 | 163.5 | 185.7 | 210.0 | 235.0 | |
| 2,4-Dichlorostyrene | $C_8H_6Cl_2$ | 53.5 | 82.2 | 97.4 | 111.8 | 129.2 | 140.0 | 153.8 | 176.0 | 200.0 | 225.0 | |
| 2,5-Dichlorostyrene | $C_8H_6Cl_2$ | 55.5 | 83.9 | 98.2 | 114.0 | 131.0 | 142.0 | 155.8 | 178.0 | 202.5 | 227.0 | |
| 2,6-Dichlorostyrene | $C_8H_6Cl_2$ | 47.8 | 75.7 | 90.0 | 105.5 | 122.4 | 133.3 | 147.6 | 169.0 | 193.5 | 217.0 | |
| 3,4-Dichlorostyrene | $C_8H_6Cl_2$ | 57.2 | 86.0 | 100.4 | 116.2 | 133.7 | 144.6 | 158.2 | 181.5 | 205.7 | 230.0 | |
| 3,5-Dichlorostyrene | $C_8H_6Cl_2$ | 53.5 | 82.2 | 97.4 | 111.8 | 129.2 | 140.0 | 153.8 | 176.0 | 200.0 | 225.0 | |
| 1,2-Dichlorotetraethylbenzene | $C_{14}H_{20}Cl_2$ | 105.6 | 138.7 | 155.0 | 172.5 | 192.2 | 204.8 | 220.7 | 245.6 | 272.8 | 302.0 | |
| 1,4-Dichlorotetraethylbenzene | $C_{14}H_{20}Cl_2$ | 91.7 | 126.1 | 143.8 | 162.0 | 183.2 | 195.8 | 212.0 | 238.5 | 265.8 | 296.5 | |
| 1,2-Dichloro-1,1,2,2-tetrafluoroethane | $C_2Cl_2F_4$ | −95.4 | −80.0 | −72.3 | −63.5 | −53.7 | −47.5 | −39.1 | −26.3 | −12.0 | +3.5 | −94 |
| Dichloro-4-tolylsilane | $C_7H_8Cl_2Si$ | 46.2 | 71.7 | 84.2 | 97.8 | 113.2 | 122.6 | 135.5 | 153.5 | 175.2 | 196.3 | |
| 3,4-Dichloro-α,α,α-trifluorotoluene | $C_7H_3Cl_2F_3$ | 11.0 | 38.3 | 52.2 | 67.3 | 84.0 | 95.0 | 109.2 | 129.0 | 150.5 | 172.8 | −12.1 |
| Dicyclopentadiene | $C_{10}H_8$ | | 34.1 | 47.6 | 62.0 | 77.9 | 88.0 | 101.7 | 121.8 | 144.2 | 166.6 | 32.9 |
| Diethoxydimethylsilane | $C_6H_{16}O_2Si$ | −19.1 | +2.4 | 13.3 | 25.3 | 38.0 | 46.3 | 57.6 | 74.2 | 93.2 | 113.5 | |
| Diethoxydiphenylsilane | $C_{16}H_{20}O_2Si$ | 111.5 | 142.8 | 157.6 | 174.3 | 193.2 | 205.0 | 220.0 | 243.8 | 259.7 | 296.0 | |
| Diethyl adipate | $C_{10}H_{18}O_4$ | 74.0 | 106.6 | 123.0 | 138.3 | 154.6 | 165.8 | 179.0 | 198.2 | 219.1 | 240.0 | −21 |
| Diethylamine | $C_4H_{11}N$ | | | −33.0 | −22.6 | −11.3 | −4.0 | +6.0 | 21.0 | 38.0 | 55.5 | −38.9 |
| *N*-Diethylaniline | $C_{10}H_{15}N$ | 49.7 | 78.0 | 91.9 | 107.2 | 123.6 | 133.8 | 147.3 | 168.2 | 192.4 | 215.5 | −34.4 |
| Diethyl arsanilate | $C_{10}H_{16}AsNO_3$ | 38.0 | 62.6 | 74.8 | 88.0 | 102.6 | 111.8 | 123.8 | 141.9 | 161.0 | 181.0 | |
| 1,2-Diethylbenzene | $C_{10}H_{14}$ | 22.3 | 48.7 | 62.0 | 76.4 | 92.5 | 102.6 | 116.2 | 136.7 | 159.0 | 183.5 | −31.4 |
| 1,3-Diethylbenzene | $C_{10}H_{14}$ | 20.7 | 46.8 | 59.9 | 74.5 | 90.4 | 100.7 | 114.4 | 134.8 | 156.9 | 181.1 | −83.9 |
| 1,4-Diethylbenzene | $C_{10}H_{14}$ | 20.7 | 47.1 | 60.3 | 74.7 | 91.1 | 101.3 | 115.3 | 136.1 | 159.0 | 183.8 | −43.2 |
| Diethyl carbonate | $C_5H_{10}O_3$ | −10.1 | +12.3 | 23.8 | 36.0 | 49.5 | 57.9 | 69.7 | 86.5 | 105.8 | 125.8 | −43 |
| *cis*-Diethyl citraconate | $C_9H_{14}O_4$ | 59.8 | 88.3 | 103.0 | 118.2 | 135.7 | 146.2 | 160.0 | 182.3 | 206.5 | 230.3 | |
| Diethyl dioxosuccinate | $C_8H_{10}O_6$ | 70.0 | 98.0 | 112.0 | 126.8 | 143.8 | 153.7 | 167.7 | 188.0 | 210.8 | 233.5 | |
| Diethylene glycol | $C_4H_{10}O_3$ | 91.8 | 120.0 | 133.8 | 148.0 | 164.3 | 174.0 | 187.5 | 207.0 | 226.5 | 244.8 | |
| Diethyleneglycol-bis-chloroacetate | $C_8H_{12}Cl_2O_5$ | 148.3 | 180.0 | 195.8 | 212.0 | 229.0 | 239.5 | 252.0 | 271.5 | 291.8 | 313.0 | |
| Diethylene glycol dimethyl ether | | | | | | | | | | | | |
| Di(2-methoxyethyl) ether | $C_6H_{14}O_3$ | 13.0 | 37.6 | 50.0 | 63.0 | 77.5 | 86.8 | 99.5 | 118.0 | 138.5 | 159.8 | |
| glycol ethyl ether | $C_6H_{14}O_3$ | 45.3 | 72.0 | 85.8 | 100.3 | 116.7 | 126.8 | 140.3 | 159.0 | 180.3 | 201.9 | |
| Diethyl ether | $C_4H_{10}O$ | −74.3 | −56.9 | −48.1 | −38.5 | 27.7 | −21.8 | −11.5 | +2.2 | 17.9 | 34.6 | −116.3 |
| ethylmalonate | $C_9H_{16}O_4$ | 50.8 | 77.8 | 91.6 | 106.0 | 122.4 | 132.4 | 146.0 | 166.0 | 188.7 | 211.5 | |
| fumarate | $C_8H_{12}O_4$ | 53.2 | 81.2 | 95.3 | 110.2 | 126.7 | 137.7 | 151.1 | 172.2 | 195.8 | 218.5 | +0.6 |
| glutarate | $C_9H_{16}O_4$ | 65.6 | 94.7 | 109.7 | 125.4 | 142.8 | 153.2 | 167.8 | 189.5 | 212.8 | 237.0 | |
| Diethylhexadecylamine | $C_{20}H_{43}N$ | 139.8 | 175.8 | 194.0 | 213.5 | 235.0 | 248.5 | 265.5 | 292.8 | 324.6 | 355.0 | |
| Diethyl itaconate | $C_9H_{14}O_4$ | 51.3 | 80.2 | 95.2 | 111.0 | 128.2 | 139.9 | 154.3 | 177.5 | 203.1 | 227.9 | |
| ketone (3-pentanone) | $C_5H_{10}O$ | −12.7 | +7.5 | 17.2 | 27.9 | 39.4 | 46.7 | 56.2 | 70.6 | 86.3 | 102.7 | −42 |
| malate | $C_8H_{14}O_5$ | 80.7 | 110.4 | 125.3 | 141.2 | 157.8 | 169.0 | 183.9 | 205.3 | 229.5 | 253.4 | |
| maleate | $C_8H_{12}O_4$ | 57.3 | 85.6 | 100.0 | 115.3 | 131.8 | 142.4 | 156.0 | 177.8 | 201.7 | 225.0 | |
| malonate | $C_7H_{12}O_4$ | 40.0 | 67.5 | 81.3 | 95.9 | 113.3 | 123.0 | 136.2 | 155.5 | 176.8 | 198.9 | −49.8 |
| mesaconate | $C_9H_{14}O_4$ | 62.8 | 91.0 | 105.3 | 120.3 | 137.3 | 147.9 | 161.6 | 183.2 | 205.8 | 229.0 | |
| oxalate | $C_6H_{10}O_4$ | 47.4 | 71.8 | 83.8 | 96.8 | 110.6 | 119.7 | 130.8 | 147.9 | 166.2 | 185.7 | −40.6 |
| phthalate | $C_{12}H_{14}O_4$ | 108.8 | 140.7 | 156.0 | 173.6 | 192.1 | 204.1 | 219.5 | 243.0 | 267.5 | 294.0 | |
| sebacate | $C_{14}H_{26}O_4$ | 125.3 | 156.2 | 172.1 | 189.8 | 207.5 | 218.4 | 234.4 | 255.8 | 280.3 | 305.5 | 1.3 |
| 2,5-Diethylstyrene | $C_{12}H_{16}$ | 49.7 | 78.4 | 92.6 | 108.5 | 125.8 | 136.8 | 151.0 | 173.2 | 198.0 | 223.0 | |
| Diethyl succinate | $C_8H_{14}O_4$ | 54.6 | 83.0 | 96.6 | 111.7 | 127.8 | 138.2 | 151.1 | 171.7 | 193.8 | 216.5 | −20.8 |
| isosuccinate | $C_8H_{14}O_4$ | 39.8 | 66.7 | 80.0 | 94.7 | 111.0 | 121.4 | 134.8 | 155.1 | 177.7 | 201.3 | |
| sulfate | $C_4H_{10}O_4S$ | 47.0 | 74.0 | 87.7 | 102.1 | 118.0 | 128.6 | 142.5 | 162.5 | 185.5 | 209.5 | −25.0 |
| sulfide | $C_4H_{10}S$ | −39.6 | −18.6 | −8.0 | +3.5 | 16.1 | 24.2 | 35.0 | 51.3 | 69.7 | 88.0 | −99.5 |
| sulfite | $C_4H_{10}O_3S$ | 10.0 | 34.2 | 46.4 | 59.7 | 74.2 | 83.8 | 96.3 | 115.8 | 137.0 | 159.0 | |
| *d*-Diethyl tartrate | $C_8H_{14}O_6$ | 102.0 | 133.0 | 148.0 | 164.2 | 182.3 | 194.0 | 208.5 | 230.4 | 254.8 | 280.0 | 17 |
| *dl*-Diethyl tartrate | $C_8H_{14}O_6$ | 100.0 | 131.7 | 147.2 | 163.8 | 181.7 | 193.2 | 208.0 | 230.0 | 254.3 | 280.0 | |
| 3,5-Diethyltoluene | $C_{11}H_{16}$ | 34.0 | 61.5 | 75.3 | 90.2 | 107.0 | 117.7 | 131.7 | 152.4 | 176.5 | 200.7 | |
| Diethylzinc | $C_4H_{10}Zn$ | −22.4 | 0.0 | +11.7 | 24.2 | 38.0 | 47.2 | 59.1 | 77.0 | 97.3 | 118.0 | −28 |
| 1-Dihydrocarvone | $C_{10}H_{16}O$ | 46.6 | 75.5 | 90.0 | 106.0 | 123.7 | 134.7 | 149.7 | 171.8 | 197.0 | 223.0 | |
| Dihydrocitronellol | $C_{10}H_{22}O$ | 68.0 | 91.7 | 103.0 | 115.0 | 127.6 | 136.7 | 145.9 | 160.2 | 176.8 | 193.5 | |
| 1,4-Dihydroxyanthraquinone | $C_{14}H_8O_4$ | 196.7 | 239.8 | 259.8 | 282.0 | 307.4 | 323.3 | 344.5 | 377.8 | 413.0 | 450.0 | 194 |
| Dimethylacetylene (2-butyne) | $C_4H_6$ | −73.0 | −57.9 | −50.5 | −42.5 | −33.9 | −27.8 | −18.8 | −5.0 | +10.6 | 27.2 | −32.5 |
| Dimethylamine | $C_2H_7N$ | −87.7 | −72.2 | −64.6 | −56.0 | −46.7 | −40.7 | −32.6 | −20.4 | −7.1 | +7.4 | −96 |
| *N*,*N*-Dimethylaniline | $C_8H_{11}N$ | 29.5 | 56.3 | 70.0 | 84.8 | 101.6 | 111.9 | 125.8 | 146.5 | 169.2 | 193.1 | +2.5 |
| Dimethyl arsanilate | $C_8H_{12}AsNO_3$ | 15.0 | 39.6 | 51.8 | 65.0 | 79.7 | 88.6 | 101.0 | 119.8 | 140.3 | 160.5 | |
| Di(α-methylbenzyl) ether | $C_{16}H_{18}O$ | 96.7 | 128.3 | 144.0 | 160.3 | 179.6 | 191.5 | 206.8 | 229.7 | 254.8 | 281.0 | |
| 2,2-Dimethylbutane | $C_6H_{14}$ | −69.3 | −50.7 | −41.5 | −31.1 | −19.5 | −12.1 | −2.0 | +13.4 | 31.0 | 49.7 | −99.8 |
| 2,3-Dimethylbutane | $C_6H_{14}$ | −63.6 | −44.5 | −34.9 | −24.1 | −12.4 | −4.9 | +5.4 | 21.1 | 39.0 | 58.0 | −128.2 |
| Dimethyl citraconate | $C_7H_{10}O_4$ | 50.8 | 78.2 | 91.8 | 106.5 | 122.6 | 132.7 | 145.8 | 165.8 | 188.0 | 210.5 | |
| 1,1-Dimethylcyclohexane | $C_8H_{16}$ | −24.4 | −1.4 | +10.3 | 23.0 | 37.3 | 45.7 | 57.9 | 76.2 | 97.2 | 119.5 | −34 |
| *cis*-1,2-Dimethylcyclohexane | $C_8H_{16}$ | −15.9 | +7.3 | 18.4 | 31.1 | 45.3 | 54.4 | 66.8 | 85.6 | 107.0 | 129.7 | −50.0 |
| *trans*-1,2-Dimethylcyclohexane | $C_8H_{16}$ | −21.1 | +1.7 | 13.0 | 25.6 | 39.7 | 48.7 | 61.0 | 79.6 | 100.9 | 123.4 | −88.0 |
| *trans*-1,3-Dimethylcyclohexane | $C_8H_{16}$ | −19.4 | +3.4 | 14.9 | 27.4 | 41.4 | 50.4 | 62.5 | 81.0 | 102.1 | 124.4 | −92.0 |
| *cis*-1,3-Dimethylcyclohexane | $C_8H_{16}$ | −22.7 | 0.0 | +11.2 | 23.6 | 37.5 | 46.4 | 58.5 | 76.9 | 97.8 | 120.1 | −76.2 |
| *cis*-1,4-Dimethylcyclohexane | $C_8H_{16}$ | −20.0 | +3.2 | 14.5 | 27.1 | 41.1 | 50.1 | 62.3 | 80.8 | 101.9 | 124.3 | −87.4 |
| *trans*-1,4-Dimethylcyclohexane | $C_8H_{16}$ | −24.3 | −1.7 | +10.1 | 22.6 | 36.5 | 45.4 | 57.6 | 76.0 | 97.0 | 119.3 | −36.9 |

**TABLE 2-8 Vapor Pressures of Organic Compounds, up to 1 atm** (*Continued*)

| Compound | | Pressure, mm Hg | | | | | | | | | | Melting point, °C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 5 | 10 | 20 | 40 | 60 | 100 | 200 | 400 | 760 | |
| Name | Formula | Temperature, °C | | | | | | | | | | |
| Dimethyl ether | $C_2H_6O$ | −115.7 | −101.1 | −93.3 | −85.2 | −76.2 | −70.4 | −62.7 | −50.9 | −37.8 | −23.7 | −138.5 |
| 2,2-Dimethylhexane | $C_8H_{18}$ | −29.7 | −7.9 | +3.1 | 15.0 | 28.2 | 36.7 | 48.2 | 65.7 | 85.6 | 106.8 | |
| 2,3-Dimethylhexane | $C_8H_{18}$ | −23.0 | −1.1 | +9.9 | 22.1 | 35.6 | 44.2 | 56.0 | 73.8 | 94.1 | 115.6 | |
| 2,4-Dimethylhexane | $C_8H_{18}$ | −26.9 | −5.3 | +5.2 | 17.2 | 30.5 | 39.0 | 50.6 | 68.1 | 88.2 | 109.4 | |
| 2,5-Dimethylhexane | $C_8H_{18}$ | −26.7 | −5.5 | +5.3 | 17.2 | 30.4 | 38.9 | 50.5 | 68.0 | 87.9 | 109.1 | −90.7 |
| 3,3-Dimethylhexane | $C_8H_{18}$ | −25.8 | −4.4 | +6.1 | 18.2 | 31.7 | 40.4 | 52.5 | 70.0 | 90.4 | 112.0 | |
| 3,4-Dimethylhexane | $C_8H_{18}$ | −22.1 | +0.2 | 11.3 | 23.5 | 37.1 | 45.8 | 57.7 | 75.6 | 96.0 | 117.7 | |
| Dimethyl itaconate | $C_7H_{10}O_4$ | 69.3 | 94.0 | 106.6 | 119.7 | 133.7 | 142.6 | 153.7 | 171.0 | 189.8 | 208.0 | 38 |
| 1-Dimethyl malate | $C_6H_{10}O_5$ | 75.4 | 104.0 | 118.3 | 133.8 | 150.1 | 160.4 | 175.1 | 196.3 | 219.5 | 242.6 | |
| Dimethyl maleate | $C_6H_8O_4$ | 45.7 | 73.0 | 86.4 | 101.3 | 117.2 | 127.1 | 140.4 | 160.0 | 182.2 | 205.0 | |
| malonate | $C_5H_8O_4$ | 35.0 | 59.8 | 72.0 | 85.0 | 100.0 | 109.7 | 121.9 | 140.0 | 159.8 | 180.7 | −62 |
| *trans*-Dimethyl mesaconate | $C_7H_{10}O_4$ | 46.8 | 74.0 | 87.8 | 102.1 | 118.0 | 127.8 | 141.5 | 161.0 | 183.5 | 206.0 | |
| 2,7-Dimethyloctane | $C_{10}H_{22}$ | +6.3 | 30.5 | 42.3 | 55.8 | 71.2 | 80.8 | 93.9 | 114.0 | 136.0 | 159.7 | −52.8 |
| Dimethyl oxalate | $C_4H_6O_4$ | 20.0 | 44.0 | 56.0 | 69.4 | 83.6 | 92.8 | 104.8 | 123.3 | 143.3 | 163.3 | |
| 2,2-Dimethylpentane | $C_7H_{16}$ | −49.0 | −28.7 | −18.7 | −7.5 | +5.0 | 13.0 | 23.9 | 40.3 | 59.2 | 79.2 | −123.7 |
| 2,3-Dimethylpentane | $C_7H_{16}$ | −42.0 | −20.8 | −10.3 | +1.1 | 13.9 | 22.1 | 33.3 | 50.1 | 69.4 | 89.8 | −135 |
| 2,4-Dimethylpentane | $C_7H_{16}$ | −48.0 | −27.4 | −17.1 | −5.9 | +6.5 | 14.5 | 25.4 | 41.8 | 60.6 | 80.5 | −119.5 |
| 3,3-Dimethylpentane | $C_7H_{16}$ | −45.9 | −25.0 | −14.4 | −2.9 | +9.9 | 18.1 | 29.3 | 46.2 | 65.5 | 86.1 | −135.0 |
| 2,3-Dimethylphenol (2,3-xylenol) | $C_8H_{10}O$ | 56.0 | 83.8 | 97.6 | 112.0 | 129.2 | 139.5 | 152.2 | 173.0 | 196.0 | 218.0 | 75 |
| 2,4-Dimethylphenol (2,4-xylenol) | $C_8H_{10}O$ | 51.8 | 78.0 | 91.3 | 105.0 | 121.5 | 131.0 | 143.0 | 161.5 | 184.2 | 211.5 | 25.5 |
| 2,5-Dimethylphenol (2,5-xylenol) | $C_8H_{10}O$ | 51.8 | 78.0 | 91.3 | 105.0 | 121.5 | 131.0 | 143.0 | 161.5 | 184.2 | 211.5 | 74.5 |
| 3,4-Dimethylphenol (3,4-xylenol) | $C_8H_{10}O$ | 66.2 | 93.8 | 107.7 | 122.0 | 138.0 | 148.0 | 161.0 | 181.5 | 203.6 | 225.2 | 62.5 |
| 3,5-Dimethylphenol (3,5-xylenol) | $C_8H_{10}O$ | 62.0 | 89.2 | 102.4 | 117.0 | 133.3 | 143.5 | 156.0 | 176.2 | 197.8 | 219.5 | 68 |
| Dimethylphenylsilane | $C_8H_{12}Si$ | +5.3 | 30.3 | 42.6 | 56.2 | 71.4 | 81.3 | 94.2 | 114.2 | 136.4 | 159.3 | |
| Dimethyl phthalate | $C_{10}H_{10}O_4$ | 100.3 | 131.8 | 147.6 | 164.0 | 182.8 | 194.0 | 210.0 | 232.7 | 257.8 | 283.7 | |
| 3,5-Dimethyl-1,2-pyrone | $C_7H_8O_2$ | 78.6 | 107.6 | 122.0 | 136.4 | 152.7 | 163.8 | 177.5 | 198.0 | 221.0 | 245.0 | 51.5 |
| 4,6-Dimethylresorcinol | $C_8H_{10}O_2$ | 49.0 | 76.8 | 90.7 | 105.8 | 122.5 | 133.2 | 147.3 | 167.8 | 192.0 | 215.0 | |
| Dimethyl sebacate | $C_{12}H_{22}O_4$ | 104.0 | 139.8 | 156.2 | 175.8 | 196.0 | 208.0 | 222.6 | 245.0 | 269.6 | 293.5 | 38 |
| 2,4-Dimethylstyrene | $C_{10}H_{12}$ | 34.2 | 61.9 | 75.8 | 90.8 | 107.7 | 118.0 | 132.3 | 153.2 | 177.5 | 202.0 | |
| 2,5-Dimethylstyrene | $C_{10}H_{12}$ | 29.0 | 55.9 | 69.0 | 84.0 | 100.2 | 110.7 | 124.7 | 145.6 | 168.7 | 193.0 | |
| α,α-Dimethylsuccinic anhydride | $C_6H_8O_3$ | 61.4 | 88.1 | 102.0 | 116.3 | 132.3 | 142.4 | 155.3 | 175.8 | 197.5 | 219.5 | |
| Dimethyl sulfide | $C_2H_6S$ | −75.6 | −58.0 | −49.2 | −39.4 | −28.4 | −21.4 | −12.0 | +2.6 | 18.7 | 36.0 | −83.2 |
| *d*-Dimethyl tartrate | $C_6H_{10}O_6$ | 102.1 | 133.2 | 148.2 | 164.3 | 182.4 | 193.8 | 208.8 | 230.5 | 255.0 | 280.0 | 61.5 |
| *dl*-Dimethyl tartrate | $C_6H_{10}O_6$ | 100.4 | 131.8 | 147.5 | 164.0 | 182.4 | 193.8 | 209.5 | 232.3 | 257.4 | 282.0 | 89 |
| *N,N*-Dimethyl-2-toluidine | $C_9H_{13}N$ | 28.8 | 54.1 | 66.2 | 80.2 | 95.0 | 105.2 | 118.1 | 138.3 | 161.5 | 184.8 | −61 |
| *N,N*-Dimethyl-4-toluidine | $C_9H_{13}N$ | 50.1 | 74.3 | 86.7 | 100.0 | 116.3 | 126.4 | 140.3 | 161.6 | 185.4 | 209.5 | |
| Di(nitrosomethyl) amine | $C_2H_5N_3O_2$ | +3.2 | 27.8 | 40.0 | 53.7 | 68.2 | 77.7 | 90.3 | 110.0 | 131.3 | 153.0 | |
| Diosphenol | $C_{10}H_{16}O_2$ | 66.7 | 95.4 | 109.0 | 124.0 | 141.2 | 151.3 | 165.6 | 186.2 | 209.5 | 232.0 | |
| 1,4-Dioxane | $C_4H_8O_2$ | −35.8 | −12.8 | −1.2 | +12.0 | 25.2 | 33.8 | 45.1 | 62.3 | 81.8 | 101.1 | 10 |
| Dipentene | $C_{10}H_{16}$ | 14.0 | 40.4 | 53.8 | 68.2 | 84.3 | 94.6 | 108.3 | 128.2 | 150.5 | 174.6 | |
| Diphenylamine | $C_{12}H_{11}N$ | 108.3 | 141.7 | 157.0 | 175.2 | 194.3 | 206.9 | 222.8 | 247.5 | 274.1 | 302.0 | 52.9 |
| Diphenyl carbinol (benzhydrol) | $C_{13}H_{12}O$ | 110.0 | 145.0 | 162.0 | 180.9 | 200.0 | 212.0 | 227.5 | 250.0 | 275.6 | 301.0 | 68.5 |
| chlorophosphate | $C_{12}H_{10}ClPO_3$ | 121.5 | 160.5 | 182.0 | 203.8 | 227.9 | 244.2 | 265.0 | 299.5 | 337.2 | 378.0 | |
| disulfide | $C_{12}H_{10}S_2$ | 131.6 | 164.0 | 180.0 | 197.0 | 214.8 | 226.2 | 241.3 | 262.6 | 285.8 | 310.0 | 61 |
| 1,2-Diphenylethane (dibenzyl) | $C_{14}H_{14}$ | 86.8 | 119.8 | 136.0 | 153.7 | 173.7 | 186.0 | 202.8 | 227.8 | 255.0 | 284.0 | 51.5 |
| Diphenyl ether | $C_{12}H_{10}O$ | 66.1 | 97.8 | 114.0 | 130.8 | 150.0 | 162.0 | 178.8 | 203.3 | 230.7 | 258.5 | 27 |
| 1,1-Diphenylethylene | $C_{14}H_{12}$ | 87.4 | 119.6 | 135.0 | 151.8 | 170.8 | 183.4 | 198.6 | 222.8 | 249.8 | 277.0 | |
| *trans*-Diphenylethylene | $C_{14}H_{12}$ | 113.2 | 145.8 | 161.0 | 179.8 | 199.0 | 211.5 | 227.4 | 251.7 | 278.3 | 306.5 | 124 |
| 1,1-Diphenylhydrazine | $C_{12}H_{12}N_2$ | 126.0 | 159.3 | 176.1 | 194.0 | 213.5 | 225.9 | 242.5 | 267.2 | 294.0 | 322.2 | 44 |
| Diphenylmethane | $C_{13}H_{12}$ | 76.0 | 107.4 | 122.8 | 139.8 | 157.8 | 170.2 | 186.3 | 210.7 | 237.5 | 264.5 | 26.5 |
| Diphenyl sulfide | $C_{12}H_{10}S$ | 96.1 | 129.0 | 145.0 | 162.0 | 182.8 | 194.8 | 211.8 | 236.8 | 263.9 | 292.5 | |
| Diphenyl-2-tolyl thiophosphate | $C_{18}H_{17}O_3PS$ | 159.7 | 179.8 | 201.6 | 215.5 | 230.6 | 240.4 | 252.5 | 270.3 | 290.0 | 310.0 | |
| 1,2-Dipropoxyethane | $C_8H_{18}O_2$ | −38.8 | −10.3 | +5.0 | 22.3 | 42.3 | 55.8 | 74.2 | 103.8 | 140.0 | 180.0 | |
| 1,2-Diisopropylbenzene | $C_{12}H_{18}$ | 40.0 | 67.8 | 81.8 | 96.8 | 114.0 | 124.3 | 138.7 | 159.8 | 184.3 | 209.0 | |
| 1,3-Diisopropylbenzene | $C_{12}H_{18}$ | 34.7 | 62.3 | 76.0 | 91.2 | 107.9 | 118.2 | 132.3 | 153.7 | 177.6 | 202.0 | −105 |
| Dipropylene glycol | $C_6H_{14}O_3$ | 73.8 | 102.1 | 116.2 | 131.3 | 147.4 | 156.5 | 169.9 | 189.9 | 210.5 | 231.8 | |
| Dipropyleneglycol monobutyl ether | $C_{10}H_{22}O_3$ | 64.7 | 92.0 | 106.0 | 120.4 | 136.3 | 146.3 | 159.8 | 180.0 | 203.8 | 227.0 | |
| isopropyl ether | $C_9H_{20}O_3$ | 46.0 | 72.8 | 86.2 | 100.8 | 117.0 | 126.8 | 140.3 | 160.0 | 183.1 | 205.6 | |
| Di-*n*-propyl ether | $C_6H_{14}O$ | −43.3 | −22.3 | −11.8 | 0.0 | +13.2 | 21.6 | 33.0 | 50.3 | 69.5 | 89.5 | −122 |
| Diisopropyl ether | $C_6H_{14}O$ | −57.0 | −37.4 | −27.4 | −16.7 | −4.5 | +3.4 | 13.7 | 30.0 | 48.2 | 67.5 | −60 |
| Di-*n*-propyl ketone (4-heptanone) | $C_7H_{14}O$ | 23.0 | 44.4 | 55.0 | 66.2 | 78.1 | 85.8 | 96.0 | 111.2 | 127.3 | 143.7 | −32.6 |
| Di-*n*-propyl oxalate | $C_8H_{14}O_4$ | 53.4 | 80.2 | 93.9 | 108.6 | 124.6 | 134.8 | 148.1 | 168.0 | 190.3 | 213.5 | |
| Diisopropyl oxalate | $C_8H_{14}O_4$ | 43.2 | 69.0 | 81.9 | 95.6 | 110.5 | 120.0 | 132.6 | 151.2 | 171.8 | 193.5 | |
| Di-*n*-propyl succinate | $C_{10}H_{18}O_4$ | 77.5 | 107.6 | 122.2 | 138.0 | 154.8 | 166.0 | 180.3 | 202.5 | 226.5 | 250.8 | |
| Di-*n*-propyl *d*-tartrate | $C_{10}H_{18}O_6$ | 115.6 | 147.7 | 163.5 | 180.4 | 199.7 | 211.7 | 227.0 | 250.1 | 275.6 | 303.0 | |
| Diisopropyl *d*-tartrate | $C_{10}H_{18}O_6$ | 103.7 | 133.7 | 148.2 | 164.0 | 181.8 | 192.6 | 207.3 | 228.2 | 251.8 | 275.0 | |
| Divinyl acetylene (1,5-hexadiene-3-yne) | $C_6H_6$ | −45.1 | −24.4 | −14.0 | −2.8 | +10.0 | 18.1 | 29.5 | 46.0 | 64.4 | 84.0 | |
| 1,3-Divinylbenzene | $C_{10}H_{10}$ | 32.7 | 60.0 | 73.8 | 88.7 | 105.5 | 116.0 | 130.0 | 151.4 | 175.2 | 199.5 | −66.9 |
| Docosane | $C_{22}H_{46}$ | 157.8 | 195.4 | 213.0 | 233.5 | 254.5 | 268.3 | 286.0 | 314.2 | 343.5 | 376.0 | 44.5 |
| *n*-Dodecane | $C_{12}H_{26}$ | 47.8 | 75.8 | 90.0 | 104.6 | 121.7 | 132.1 | 146.2 | 167.2 | 191.0 | 216.2 | −9.6 |
| 1-Dodecene | $C_{12}H_{24}$ | 47.2 | 74.0 | 87.8 | 102.4 | 118.6 | 128.5 | 142.3 | 162.2 | 185.5 | 208.0 | −31.5 |
| *n*-Dodecyl alcohol | $C_{12}H_{26}O$ | 91.0 | 120.2 | 134.7 | 150.0 | 167.2 | 177.8 | 192.0 | 213.0 | 235.7 | 259.0 | 24 |
| Dodecylamine | $C_{12}H_{27}N$ | 82.8 | 111.8 | 127.8 | 141.6 | 157.4 | 168.0 | 182.1 | 203.0 | 225.0 | 248.0 | |
| Dodecyltrimethylsilane | $C_{15}H_{34}Si$ | 91.2 | 122.1 | 137.7 | 153.8 | 172.1 | 184.2 | 199.5 | 222.0 | 248.0 | 273.0 | |
| Elaidic acid | $C_{18}H_{34}O_2$ | 171.3 | 206.7 | 223.5 | 242.3 | 260.8 | 273.0 | 288.0 | 312.4 | 337.0 | 362.0 | 51.5 |

**TABLE 2-8 Vapor Pressures of Organic Compounds, up to 1 atm** (*Continued*)

| Compound | | Pressure, mm Hg | | | | | | | | | | Melting point, °C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 5 | 10 | 20 | 40 | 60 | 100 | 200 | 400 | 760 | |
| Name | Formula | Temperature, °C | | | | | | | | | | |
| Epichlorohydrin | $C_3H_5ClO$ | −16.5 | +5.6 | 16.6 | 29.0 | 42.0 | 50.6 | 62.0 | 79.3 | 98.0 | 117.9 | −25.6 |
| 1,2-Epoxy-2-methylpropane | $C_4H_8O$ | −69.0 | −50.0 | −40.3 | −29.5 | −17.3 | −9.7 | +1.2 | 17.5 | 36.0 | 55.5 | |
| Erucic acid | $C_{22}H_{42}O_2$ | 206.7 | 239.7 | 254.5 | 270.6 | 289.1 | 300.2 | 314.4 | 336.5 | 358.8 | 381.5 | 33.5 |
| Estragole (*p*-methoxy allyl benzene) | $C_{10}H_{12}O$ | 52.6 | 80.0 | 93.7 | 108.4 | 124.6 | 135.2 | 148.5 | 168.7 | 192.0 | 215.0 | |
| Ethane | $C_2H_6$ | −159.5 | −148.5 | −142.9 | −136.7 | −129.8 | −125.4 | −119.3 | −110.2 | −99.7 | −88.6 | −183.2 |
| Ethoxydimethylphenylsilane | $C_{10}H_{16}OSi$ | 36.3 | 63.1 | 76.2 | 91.0 | 107.2 | 127.5 | 131.4 | 151.5 | 175.0 | 199.5 | |
| Ethoxytrimethylsilane | $C_5H_{14}OSi$ | −50.9 | −31.0 | −20.7 | −9.8 | +3.7 | 11.5 | 22.1 | 38.1 | 56.3 | 75.7 | |
| Ethoxytriphenylsilane | $C_{20}H_{20}OSi$ | 167.0 | 198.2 | 213.5 | 230.0 | 247.0 | 258.3 | 273.5 | 295.0 | 319.5 | 344.0 | |
| Ethyl acetate | $C_4H_8O_2$ | −43.4 | −23.5 | −13.5 | −3.0 | +9.1 | 16.6 | 27.0 | 42.0 | 59.3 | 77.1 | −82.4 |
| acetoacetate | $C_6H_{10}O_3$ | 28.5 | 54.0 | 67.3 | 81.1 | 96.2 | 106.0 | 118.5 | 138.0 | 158.2 | 180.8 | −45 |
| Ethylacetylene (1-butyne) | $C_4H_6$ | −92.5 | −76.7 | −68.7 | −59.9 | −50.0 | −43.4 | −34.9 | −21.6 | −6.9 | +8.7 | −130 |
| Ethyl acrylate | $C_5H_8O_2$ | −29.5 | −8.7 | +2.0 | 13.0 | 26.0 | 33.5 | 44.5 | 61.5 | 80.0 | 99.5 | −71.2 |
| α-Ethylacrylic acid | $C_5H_8O_2$ | 47.0 | 70.7 | 82.0 | 94.4 | 108.1 | 116.7 | 127.5 | 144.0 | 160.7 | 179.2 | |
| α-Ethylacrylonitrile | $C_5H_7N$ | −29.0 | −6.4 | +5.0 | 17.7 | 31.8 | 40.6 | 53.0 | 71.6 | 92.2 | 114.0 | |
| Ethyl alcohol (ethanol) | $C_2H_6O$ | −31.3 | −12.0 | −2.3 | +8.0 | 19.0 | 26.0 | 34.9 | 48.4 | 63.5 | 78.4 | −112 |
| Ethylamine | $C_2H_7N$ | −82.3 | −66.4 | −58.3 | −48.6 | −39.8 | −33.4 | −25.1 | −12.3 | +2.0 | 16.6 | −80.6 |
| 4-Ethylaniline | $C_8H_{11}N$ | 52.0 | 80.0 | 93.8 | 109.0 | 125.7 | 136.0 | 149.8 | 170.6 | 194.2 | 217.4 | −4 |
| *N*-Ethylaniline | $C_8H_{11}N$ | 38.5 | 66.4 | 80.6 | 96.0 | 113.2 | 123.6 | 137.3 | 156.9 | 180.8 | 204.0 | −63.5 |
| 2-Ethylanisole | $C_9H_{12}O$ | 29.7 | 55.9 | 69.0 | 83.1 | 98.8 | 109.0 | 122.3 | 142.1 | 164.2 | 187.1 | |
| 3-Ethylanisole | $C_9H_{12}O$ | 33.7 | 60.3 | 73.9 | 88.5 | 104.8 | 115.5 | 129.2 | 149.7 | 172.8 | 196.5 | |
| 4-Ethylanisole | $C_9H_{12}O$ | 33.5 | 60.2 | 73.9 | 88.5 | 104.7 | 115.4 | 128.4 | 149.2 | 172.3 | 196.5 | |
| Ethylbenzene | $C_8H_{10}$ | −9.8 | +13.9 | 25.9 | 38.6 | 52.8 | 61.8 | 74.1 | 92.7 | 113.8 | 136.2 | −94.9 |
| Ethyl benzoate | $C_9H_{10}O_2$ | 44.0 | 72.0 | 86.0 | 101.4 | 118.2 | 129.0 | 143.2 | 164.8 | 188.4 | 213.4 | −34.6 |
| benzoylacetate | $C_{11}H_{12}O_3$ | 107.6 | 136.4 | 150.3 | 166.8 | 181.8 | 191.9 | 205.0 | 223.8 | 244.7 | 265.0 | |
| bromide | $C_2H_5Br$ | −74.3 | −56.4 | −47.5 | −37.8 | −26.7 | −19.5 | −10.0 | +4.5 | 21.0 | 38.4 | −117.8 |
| α-bromoisobutyrate | $C_6H_{11}BrO_2$ | 10.6 | 35.8 | 48.0 | 61.8 | 77.0 | 86.7 | 99.8 | 119.7 | 141.2 | 163.6 | |
| *n*-butyrate | $C_6H_{12}O_2$ | −18.4 | +4.0 | 15.3 | 27.8 | 41.5 | 50.1 | 62.0 | 79.8 | 100.0 | 121.0 | −93.3 |
| isobutyrate | $C_6H_{12}O_2$ | −24.3 | −2.4 | +8.4 | 20.6 | 33.8 | 42.3 | 53.5 | 71.0 | 90.0 | 110.0 | −88.2 |
| Ethylcamphoronic anhydride | $C_{11}H_{16}O_5$ | 118.2 | 149.8 | 165.0 | 181.8 | 199.8 | 211.5 | 226.6 | 248.5 | 272.8 | 298.0 | |
| Ethyl isocaproate | $C_8H_{16}O_2$ | 11.0 | 35.8 | 48.0 | 61.7 | 76.3 | 85.8 | 98.4 | 117.8 | 139.2 | 160.4 | |
| carbamate | $C_3H_7NO_2$ | | 65.8 | 77.8 | 91.0 | 105.6 | 114.8 | 126.2 | 144.2 | 164.0 | 184.0 | 49 |
| carbanilate | $C_9H_{11}NO_2$ | 107.8 | 131.8 | 143.7 | 155.5 | 168.8 | 177.3 | 187.9 | 203.8 | 220.0 | 237.0 | 52.5 |
| Ethylcetylamine | $C_{18}H_{39}N$ | 133.2 | 168.2 | 186.0 | 205.5 | 226.5 | 239.8 | 256.8 | 283.3 | 313.0 | 342.0 | |
| Ethyl chloride | $C_2H_5Cl$ | −89.8 | −73.9 | −65.8 | −56.8 | −47.0 | −40.6 | −32.0 | −18.6 | −3.9 | +12.3 | −139 |
| chloroacetate | $C_4H_7ClO_2$ | +1.0 | 25.4 | 37.5 | 50.4 | 65.2 | 74.0 | 86.0 | 103.8 | 123.8 | 144.2 | −26 |
| chloroglyoxylate | $C_4H_5ClO_3$ | −5.1 | +18.0 | 29.9 | 42.0 | 56.0 | 65.2 | 76.6 | 94.5 | 114.7 | 135.0 | |
| α-chloropropionate | $C_5H_9ClO_2$ | +6.6 | 30.2 | 41.9 | 54.3 | 68.2 | 77.3 | 89.3 | 107.2 | 126.2 | 146.5 | |
| *trans*-cinnamate | $C_{11}H_{12}O_2$ | 87.6 | 108.5 | 134.0 | 150.3 | 169.2 | 181.2 | 196.0 | 219.3 | 245.0 | 271.0 | 12 |
| 3-Ethylcumene | $C_{11}H_{16}$ | 28.3 | 55.5 | 68.8 | 83.6 | 99.9 | 110.2 | 124.3 | 145.4 | 168.2 | 193.0 | |
| 4-Ethylcumene | $C_{11}H_{16}$ | 31.5 | 58.4 | 72.0 | 86.7 | 103.3 | 113.8 | 127.2 | 148.3 | 171.8 | 195.8 | |
| Ethyl cyanoacetate | $C_5H_7NO_2$ | 67.8 | 93.5 | 106.0 | 119.8 | 133.8 | 142.1 | 152.8 | 169.8 | 187.8 | 206.0 | |
| Ethylcyclohexane | $C_8H_{16}$ | −14.5 | +9.2 | 20.6 | 33.4 | 47.6 | 56.7 | 69.0 | 87.8 | 109.1 | 131.8 | −111.3 |
| Ethylcyclopentane | $C_7H_{14}$ | −32.2 | −10.8 | −0.1 | +11.7 | 25.0 | 33.4 | 45.0 | 62.4 | 82.3 | 103.4 | −138.6 |
| Ethyl dichloroacetate | $C_4H_6Cl_2O_2$ | 9.6 | 34.0 | 46.3 | 59.5 | 74.0 | 83.6 | 96.1 | 115.2 | 135.9 | 156.5 | |
| *N*,*N*-diethyloxamate | $C_8H_{15}NO_3$ | 76.0 | 106.3 | 121.7 | 137.7 | 154.4 | 166.0 | 180.3 | 202.8 | 226.5 | 252.0 | |
| *N*-Ethyldiphenylamine | $C_{14}H_{15}N$ | 98.3 | 130.2 | 146.0 | 162.8 | 182.0 | 193.7 | 209.8 | 233.0 | 258.8 | 286.0 | |
| Ethylene | $C_2H_4$ | −168.3 | −158.3 | −153.2 | −147.6 | −141.3 | −137.3 | −131.8 | −123.4 | −113.9 | −103.7 | −169 |
| Ethylene-bis-(chloroacetate) | $C_6H_8Cl_2O_4$ | 112.0 | 142.4 | 158.0 | 173.5 | 191.0 | 201.8 | 215.0 | 237.3 | 259.5 | 283.5 | |
| Ethylene chlorohydrin (2-chloroethanol) | $C_2H_5ClO$ | −4.0 | +19.0 | 30.3 | 42.5 | 56.0 | 64.1 | 75.0 | 91.8 | 110.0 | 128.8 | −69 |
| diamine (1,2-ethanediamine) | $C_2H_8N_2$ | −11.0 | +10.5 | 21.5 | 33.0 | 45.8 | 53.8 | 62.5 | 81.0 | 99.0 | 117.2 | 8.5 |
| dibromide (1,2-dibromethane) | $C_2H_4Br_2$ | −27.0 | +4.7 | 18.6 | 32.7 | 48.0 | 57.9 | 70.4 | 89.8 | 110.1 | 131.5 | 10 |
| dichloride (1,2-dichloroethane) | $C_2H_4Cl_2$ | −44.5 | −24.0 | −13.6 | −2.4 | +10.0 | 18.1 | 29.4 | 45.7 | 64.0 | 82.4 | −35.3 |
| glycol (1,2-ethanediol) | $C_2H_6O_2$ | 53.0 | 79.7 | 92.1 | 105.8 | 120.0 | 129.5 | 141.8 | 158.5 | 178.5 | 197.3 | −15.6 |
| glycol diethyl ether (1,2-diethoxyethane) | $C_6H_{14}O_2$ | −33.5 | −10.2 | +1.6 | 14.7 | 29.7 | 39.0 | 51.8 | 71.8 | 94.1 | 119.5 | |
| glycol dimethyl ether (1,2-dimethoxyethane) | $C_4H_{10}O_2$ | −48.0 | −26.2 | −15.3 | −3.0 | +10.7 | 19.7 | 31.8 | 50.0 | 70.8 | 93.0 | |
| glycol monomethyl ether (2-methoxyethanol) | $C_3H_8O_2$ | −13.5 | +10.2 | 22.0 | 34.3 | 47.8 | 56.4 | 68.0 | 85.3 | 104.3 | 124.4 | |
| oxide | $C_2H_4O$ | −89.7 | −73.8 | −65.7 | −56.6 | −46.9 | −40.7 | −32.1 | −19.5 | −4.9 | +10.7 | −111.3 |
| Ethyl α-ethylacetoacetate | $C_8H_{14}O_3$ | 40.5 | 67.3 | 80.2 | 94.6 | 110.3 | 120.6 | 133.8 | 153.2 | 175.6 | 198.0 | |
| fluoride | $C_2H_5F$ | −117.0 | −103.8 | −97.7 | −90.0 | −81.8 | −76.4 | −69.3 | −58.0 | −45.5 | −32.0 | |
| formate | $C_3H_6O_2$ | −60.5 | −42.2 | −33.0 | −22.7 | −11.5 | −4.3 | −5.4 | 20.0 | 37.1 | 54.3 | −79 |
| 2-furoate | $C_7H_8O_3$ | 37.6 | 63.8 | 77.1 | 91.5 | 107.5 | 117.5 | 130.4 | 150.1 | 172.5 | 195.0 | 34 |
| glycolate | $C_4H_8O_3$ | 14.3 | 38.8 | 50.5 | 63.9 | 78.1 | 87.6 | 99.8 | 117.8 | 138.0 | 158.2 | |
| 3-Ethylhexane | $C_8H_{18}$ | −20.0 | +2.1 | 12.8 | 25.0 | 38.5 | 47.1 | 58.9 | 76.7 | 97.0 | 118.5 | |
| 2-Ethylhexyl acrylate | $C_{11}H_{20}O_2$ | 50.0 | 77.7 | 91.8 | 106.3 | 123.7 | 134.0 | 147.9 | 168.2 | 192.2 | 216.0 | |
| Ethylidene chloride (1,1-dichloroethane) | $C_2H_4Cl_2$ | −60.7 | −41.9 | −32.3 | −21.9 | −10.2 | −2.9 | +7.2 | 22.4 | 39.8 | 57.4 | −96.7 |
| fluoride (1,1-difluoroethane) | $C_2H_4F_2$ | −112.5 | −98.4 | −91.7 | −84.1 | −75.8 | −70.4 | −63.2 | −52.0 | −39.5 | −26.5 | −117 |
| Ethyl iodide | $C_2H_5I$ | −54.4 | −34.3 | −24.3 | −13.1 | −0.9 | +7.2 | 18.0 | 34.1 | 52.3 | 72.4 | −105 |
| Ethyl *l*-leucinate | $C_8H_{17}NO_2$ | 27.8 | 57.3 | 72.1 | 88.0 | 106.0 | 117.8 | 131.8 | 149.8 | 167.3 | 184.0 | |
| Ethyl levulinate | $C_7H_{12}O_3$ | 47.3 | 74.0 | 87.3 | 101.8 | 117.7 | 127.6 | 141.3 | 160.2 | 183.0 | 206.2 | |
| Ethyl mercaptan (ethanethiol) | $C_2H_6S$ | −76.7 | −59.1 | −50.2 | −40.7 | −29.8 | −22.4 | −13.0 | +1.5 | 17.7 | 35.0 | −121 |
| Ethyl methylcarbamate | $C_4H_9NO_2$ | 26.5 | 51.0 | 63.2 | 76.1 | 91.0 | 100.0 | 112.0 | 130.0 | 149.8 | 170.0 | |
| Ethyl methyl ether | $C_3H_8O$ | −91.0 | −75.6 | −67.8 | −59.1 | −49.4 | −43.3 | −34.8 | −22.0 | −7.8 | +7.5 | |

**TABLE 2-8 Vapor Pressures of Organic Compounds, up to 1 atm** (*Continued*)

| Compound | | Pressure, mm Hg | | | | | | | | | | Melting point, °C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 5 | 10 | 20 | 40 | 60 | 100 | 200 | 400 | 760 | |
| Name | Formula | Temperature, °C | | | | | | | | | | |
| 1-Ethylnaphthalene | $C_{12}H_{12}$ | 70.0 | 101.4 | 116.8 | 133.8 | 152.0 | 164.1 | 180.0 | 204.6 | 230.8 | 258.1 | −27 |
| Ethyl α-naphthyl ketone (1-propionaphthone) | $C_{13}H_{12}O$ | 124.0 | 155.5 | 171.0 | 188.1 | 206.9 | 218.2 | 233.5 | 255.5 | 280.2 | 306.0 | |
| Ethyl 3-nitrobenzoate | $C_9H_9NO_4$ | 108.1 | 140.2 | 155.0 | 173.6 | 192.6 | 205.0 | 220.3 | 244.6 | 270.6 | 298.0 | 47 |
| 3-Ethylpentane | $C_7H_{16}$ | −37.8 | −17.0 | −6.8 | +4.7 | 17.5 | 25.7 | 36.9 | 53.8 | 73.0 | 93.5 | −118.6 |
| 4-Ethylphenetole | $C_{10}H_{14}O$ | 48.5 | 75.7 | 89.5 | 103.8 | 119.8 | 129.8 | 143.5 | 163.2 | 185.7 | 208.0 | |
| 2-Ethylphenol | $C_8H_{10}O$ | 46.2 | 73.4 | 87.0 | 101.5 | 117.9 | 127.9 | 141.8 | 161.6 | 184.5 | 207.5 | −45 |
| 3-Ethylphenol | $C_8H_{10}O$ | 60.0 | 86.8 | 100.2 | 114.5 | 130.0 | 139.8 | 152.0 | 171.8 | 193.3 | 214.0 | −4 |
| 4-Ethylphenol | $C_8H_{10}O$ | 59.3 | 86.5 | 100.2 | 115.0 | 131.3 | 141.7 | 154.2 | 175.0 | 197.4 | 219.0 | 46.5 |
| Ethyl phenyl ether (phenetole) | $C_8H_{10}O$ | 18.1 | 43.7 | 56.4 | 70.3 | 86.6 | 95.4 | 108.4 | 127.9 | 149.8 | 172.0 | −30.2 |
| Ethyl propionate | $C_5H_{10}O_2$ | −28.0 | −7.2 | +3.4 | 14.3 | 27.2 | 35.1 | 45.2 | 61.7 | 79.8 | 99.1 | −72.6 |
| Ethyl propyl ether | $C_5H_{12}O$ | −64.3 | −45.0 | −35.0 | −24.0 | −12.0 | −4.0 | +6.8 | 23.3 | 41.6 | 61.7 | |
| Ethyl salicylate | $C_9H_{10}O_3$ | 61.2 | 90.0 | 104.2 | 119.3 | 136.7 | 147.6 | 161.5 | 183.7 | 207.0 | 231.5 | 1.3 |
| 3-Ethylstyrene | $C_{10}H_{12}$ | 28.3 | 55.0 | 68.3 | 82.8 | 99.2 | 109.6 | 123.2 | 144.0 | 167.2 | 191.5 | |
| 4-Ethylstyrene | $C_{10}H_{12}$ | 26.0 | 52.7 | 66.3 | 80.8 | 97.3 | 107.6 | 121.5 | 142.0 | 165.0 | 189.0 | |
| Ethylisothiocyanate | $C_3H_5NS$ | 13.2 | +10.6 | 22.8 | 36.1 | 50.8 | 59.8 | 71.9 | 90.0 | 110.1 | 131.0 | −5.9 |
| 2-Ethyltoluene | $C_9H_{12}$ | 9.4 | 34.8 | 47.6 | 61.2 | 76.4 | 86.0 | 99.0 | 119.0 | 141.4 | 165.1 | |
| 3-Ethyltoluene | $C_9H_{12}$ | 7.2 | 32.3 | 44.7 | 58.2 | 73.3 | 82.9 | 95.9 | 115.5 | 137.8 | 161.3 | −95.5 |
| 4-Ethyltoluene | $C_9H_{12}$ | 7.6 | 32.7 | 44.9 | 58.5 | 73.6 | 83.2 | 96.3 | 116.1 | 136.4 | 162.0 | |
| Ethyl trichloroacetate | $C_4H_5Cl_3O_2$ | 20.7 | 45.5 | 57.7 | 70.6 | 85.5 | 94.4 | 107.4 | 125.8 | 146.0 | 167.0 | |
| Ethyltrimethylsilane | $C_5H_{14}Si$ | −60.6 | −41.4 | −31.8 | −21.0 | −9.0 | −1.2 | +9.2 | 25.0 | 42.8 | 62.0 | |
| Ethyltrimethyltin | $C_5H_{14}Sn$ | −30.0 | −7.6 | +3.8 | 16.1 | 30.0 | 38.4 | 50.0 | 67.3 | 87.6 | 108.8 | |
| Ethyl isovalerate | $C_7H_{14}O_2$ | −6.1 | +17.0 | 28.7 | 41.3 | 55.2 | 64.0 | 75.9 | 93.8 | 114.0 | 134.3 | −99.3 |
| 2-Ethyl-1,4-xylene | $C_{10}H_{14}$ | 25.7 | 52.0 | 65.6 | 79.8 | 96.0 | 106.2 | 120.0 | 140.2 | 163.1 | 186.9 | |
| 4-Ethyl-1,3-xylene | $C_{10}H_{14}$ | 26.3 | 53.0 | 66.4 | 80.6 | 97.2 | 107.4 | 121.2 | 141.8 | 164.4 | 188.4 | |
| 5-Ethyl-1,3-xylene | $C_{10}H_{14}$ | 22.1 | 48.8 | 62.1 | 76.5 | 92.6 | 103.0 | 116.5 | 137.4 | 159.6 | 183.7 | |
| Eugenol | $C_{10}H_{12}O_2$ | 78.4 | 108.1 | 123.0 | 138.7 | 155.8 | 167.3 | 182.2 | 204.7 | 228.3 | 253.5 | |
| *iso*-Eugenol | $C_{10}H_{12}O_2$ | 86.3 | 117.0 | 132.4 | 149.0 | 167.0 | 178.2 | 194.0 | 217.2 | 242.3 | 267.5 | −10 |
| Eugenyl acetate | $C_{12}H_{14}O_3$ | 101.6 | 132.3 | 148.0 | 164.2 | 183.0 | 194.0 | 209.7 | 232.5 | 257.4 | 282.0 | 295 |
| Fencholic acid | $C_{10}H_{16}O_2$ | 101.7 | 128.7 | 142.3 | 155.8 | 171.8 | 181.5 | 194.0 | 215.0 | 237.8 | 264.1 | 19 |
| *d*-Fenchone | $C_{10}H_{16}O$ | 28.0 | 54.7 | 68.3 | 83.0 | 99.5 | 109.8 | 123.6 | 144.0 | 166.8 | 191.0 | 5 |
| *dl*-Fenchyl alcohol | $C_{10}H_{18}O$ | 45.8 | 70.3 | 82.1 | 95.6 | 110.8 | 120.2 | 132.3 | 150.0 | 173.2 | 201.0 | 35 |
| Fluorene | $C_{13}H_{10}$ | | 129.3 | 146.0 | 164.2 | 185.2 | 197.8 | 214.7 | 240.3 | 268.6 | 295.0 | 113 |
| Fluorobenzene | $C_6H_5F$ | −43.4 | −22.8 | −12.4 | −1.2 | +11.5 | 19.6 | 30.4 | 47.2 | 65.7 | 84.7 | −42.1 |
| 2-Fluorotoluene | $C_7H_7F$ | −24.2 | −2.2 | +8.9 | 21.4 | 34.7 | 43.7 | 55.3 | 73.0 | 92.8 | 114.0 | −80 |
| 3-Fluorotoluene | $C_7H_7F$ | −22.4 | −0.3 | +11.0 | 23.4 | 37.0 | 45.8 | 57.5 | 75.4 | 95.4 | 116.0 | −110.8 |
| 4-Fluorotoluene | $C_7H_7F$ | −21.8 | +0.3 | 11.8 | 24.0 | 37.8 | 46.5 | 58.1 | 76.0 | 96.1 | 117.0 | |
| Formaldehyde | $CH_2O$ | | | −88.0 | −79.6 | −70.6 | −65.0 | −57.3 | −46.0 | −33.0 | −19.5 | −92 |
| Formamide | $CH_3NO$ | 70.5 | 96.3 | 109.5 | 122.5 | 137.5 | 147.0 | 157.5 | 175.5 | 193.5 | 210.5 | |
| Formic acid | $CH_2O_2$ | −20.0 | −5.0 | +2.1 | 10.3 | 24.0 | 32.4 | 43.8 | 61.4 | 80.3 | 100.6 | 8.2 |
| *trans*-Fumaryl chloride | $C_4H_2Cl_2O_2$ | +15.0 | 38.5 | 51.8 | 65.0 | 79.5 | 89.0 | 101.0 | 120.0 | 140.0 | 160.0 | |
| Furfural (2-furaldehyde) | $C_5H_4O_2$ | 18.5 | 42.6 | 54.8 | 67.8 | 82.1 | 91.5 | 103.4 | 121.8 | 141.8 | 161.8 | |
| Furfuryl alcohol | $C_5H_6O_2$ | 31.8 | 56.0 | 68.0 | 81.0 | 95.7 | 104.0 | 115.9 | 133.1 | 151.8 | 170.0 | |
| Geraniol | $C_{10}H_{18}O$ | 69.2 | 96.8 | 110.0 | 125.6 | 141.8 | 151.5 | 165.3 | 185.6 | 207.8 | 230.0 | |
| Geranyl acetate | $C_{12}H_{20}O_2$ | 73.5 | 102.7 | 117.9 | 133.0 | 150.0 | 160.3 | 175.2 | 196.3 | 219.8 | 243.3 | |
| Geranyl *n*-butyrate | $C_{14}H_{24}O_2$ | 96.8 | 125.2 | 139.0 | 153.8 | 170.1 | 180.2 | 193.8 | 214.0 | 235.0 | 257.4 | |
| Geranyl isobutyrate | $C_{14}H_{24}O_2$ | 90.9 | 119.6 | 133.0 | 147.9 | 164.0 | 174.0 | 187.7 | 207.6 | 228.5 | 251.0 | |
| Geranyl formate | $C_{11}H_{18}O_2$ | 61.8 | 90.3 | 104.3 | 119.8 | 136.2 | 147.2 | 160.7 | 182.6 | 205.8 | 230.0 | |
| Glutaric acid | $C_5H_8O_4$ | 155.5 | 183.8 | 196.0 | 210.5 | 226.3 | 235.5 | 247.0 | 265.0 | 283.5 | 303.0 | 97.5 |
| Glutaric anhydride | $C_5H_6O_3$ | 100.8 | 133.3 | 149.5 | 166.0 | 185.5 | 196.2 | 212.5 | 236.5 | 261.0 | 287.0 | |
| Glutaronitrile | $C_5H_6N_2$ | 91.3 | 123.7 | 140.0 | 156.5 | 176.4 | 189.5 | 205.5 | 230.0 | 257.3 | 286.2 | |
| Glutaryl chloride | $C_5H_6Cl_2O_2$ | 56.1 | 84.0 | 97.8 | 112.3 | 128.3 | 139.1 | 151.8 | 172.4 | 195.3 | 217.0 | |
| Glycerol | $C_3H_8O_3$ | 125.5 | 153.8 | 167.2 | 182.2 | 198.0 | 208.0 | 220.1 | 240.0 | 263.0 | 290.0 | 17.9 |
| Glycerol dichlorohydrin (1,3-dichloro-2-propanol) | $C_3H_6Cl_2O$ | 28.0 | 52.2 | 64.7 | 78.0 | 93.0 | 102.0 | 114.8 | 133.3 | 153.5 | 174.3 | |
| Glycol diacetate | $C_6H_{10}O_4$ | 38.3 | 64.1 | 77.1 | 90.8 | 106.1 | 115.8 | 128.0 | 147.8 | 168.3 | 190.5 | −31 |
| Glycolide (1,4-dioxane-2,6-dione) | $C_4H_4O_4$ | | 103.0 | 116.6 | 132.0 | 148.6 | 158.2 | 173.2 | 194.0 | 217.0 | 240.0 | 97 |
| Guaicol (2-methoxyphenol) | $C_7H_8O_2$ | 52.4 | 79.1 | 92.0 | 106.0 | 121.6 | 131.0 | 144.0 | 162.7 | 184.1 | 205.0 | 28.3 |
| Heneicosane | $C_{21}H_{44}$ | 152.6 | 188.0 | 205.4 | 223.2 | 243.4 | 255.3 | 272.0 | 296.5 | 323.8 | 350.5 | 40.4 |
| Heptacosane | $C_{27}H_{56}$ | 211.7 | 248.6 | 266.8 | 284.6 | 305.7 | 318.3 | 333.5 | 359.4 | 385.0 | 410.6 | 59.5 |
| Heptadecane | $C_{17}H_{36}$ | 115.0 | 145.2 | 160.0 | 177.7 | 195.8 | 207.3 | 223.0 | 247.8 | 274.5 | 303.0 | 22.5 |
| Heptaldehyde (enanthaldehyde) | $C_7H_{14}O$ | 12.0 | 32.7 | 43.0 | 54.0 | 66.3 | 74.0 | 84.0 | 102.0 | 125.5 | 155.0 | −42 |
| *n*-Heptane | $C_7H_{16}$ | −34.0 | −12.7 | −2.1 | +9.5 | 22.3 | 30.6 | 41.8 | 58.7 | 78.0 | 98.4 | −90.6 |
| Heptanoic acid (enanthic acid) | $C_7H_{14}O_2$ | 78.0 | 101.3 | 113.2 | 125.6 | 139.5 | 148.5 | 160.0 | 179.5 | 199.6 | 221.5 | −10 |
| 1-Heptanol | $C_7H_{16}O$ | 42.4 | 64.3 | 74.7 | 85.8 | 99.8 | 108.0 | 119.5 | 136.6 | 155.6 | 175.8 | 34.6 |
| Heptanoyl chloride (enanthyl chloride) | $C_7H_{13}ClO$ | 34.2 | 54.6 | 64.6 | 75.0 | 86.4 | 93.5 | 102.7 | 116.3 | 130.7 | 145.0 | |
| 2-Heptene | $C_7H_{14}$ | −35.8 | −14.1 | −3.5 | +8.3 | 21.5 | 30.0 | 41.3 | 58.6 | 78.1 | 98.5 | |
| Heptylbenzene | $C_{13}H_{20}$ | 64.0 | 94.6 | 110.0 | 126.0 | 144.0 | 154.8 | 170.2 | 193.3 | 217.8 | 244.0 | |
| Heptyl cyanide (enanthonitrile) | $C_7H_{13}N$ | 21.0 | 47.8 | 61.6 | 76.3 | 92.6 | 103.0 | 116.8 | 137.7 | 160.0 | 184.6 | |
| Hexachlorobenzene | $C_6Cl_6$ | 114.4 | 149.3 | 166.4 | 185.7 | 206.0 | 219.0 | 235.5 | 258.5 | 283.5 | 309.4 | 230 |
| Hexachloroethane | $C_2Cl_6$ | 32.7 | 49.8 | 73.5 | 87.6 | 102.3 | 112.0 | 124.2 | 143.1 | 163.8 | 185.6 | 186.6 |
| Hexacosane | $C_{26}H_{54}$ | 204.0 | 240.0 | 257.4 | 275.8 | 295.2 | 307.8 | 323.2 | 348.4 | 374.6 | 399.8 | 56.6 |
| Hexadecane | $C_{16}H_{34}$ | 105.3 | 135.2 | 149.8 | 164.7 | 181.3 | 193.2 | 208.5 | 231.7 | 258.3 | 287.5 | 18.5 |
| 1-Hexadecene | $C_{16}H_{32}$ | 101.6 | 131.7 | 146.2 | 162.0 | 178.8 | 190.8 | 205.3 | 226.8 | 250.0 | 274.0 | 4 |
| *n*-Hexadecyl alcohol (cetyl alcohol) | $C_{16}H_{34}O$ | 122.7 | 158.3 | 177.8 | 197.8 | 219.8 | 234.3 | 251.7 | 280.2 | 312.7 | 344.0 | 49.3 |

**TABLE 2-8 Vapor Pressures of Organic Compounds, up to 1 atm** (*Continued*)

| Compound | | Pressure, mm Hg | | | | | | | | | | Melting point, °C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 5 | 10 | 20 | 40 | 60 | 100 | 200 | 400 | 760 | |
| Name | Formula | Temperature, °C | | | | | | | | | | |
| *n*-Hexadecylamine (cetylamine) | $C_{16}H_{35}N$ | 123.6 | 157.8 | 176.0 | 195.7 | 215.7 | 228.8 | 245.8 | 272.2 | 300.4 | 330.0 | |
| Hexaethylbenzene | $C_{18}H_{30}$ | | 134.3 | 150.3 | 168.0 | 187.7 | 199.7 | 216.0 | 241.7 | 268.5 | 298.3 | 130 |
| *n*-Hexane | $C_6H_{14}$ | −53.9 | −34.5 | −25.0 | −14.1 | −2.3 | +5.4 | 15.8 | 31.6 | 49.6 | 68.7 | −95.3 |
| 1-Hexanol | $C_6H_{14}O$ | 24.4 | 47.2 | 58.2 | 70.3 | 83.7 | 92.0 | 102.8 | 119.6 | 138.0 | 157.0 | −51.6 |
| 2-Hexanol | $C_6H_{14}O$ | 14.6 | 34.8 | 45.0 | 55.9 | 67.9 | 76.0 | 87.3 | 103.7 | 121.8 | 139.9 | |
| 3-Hexanol | $C_6H_{14}O$ | +2.5 | 25.7 | 36.7 | 49.0 | 62.2 | 70.7 | 81.8 | 98.3 | 117.0 | 135.5 | |
| 1-Hexene | $C_6H_{12}$ | −57.5 | −38.0 | −28.1 | −17.2 | −5.0 | +2.8 | 13.0 | 29.0 | 46.8 | 66.0 | −98.5 |
| *n*-Hexyl levulinate | $C_{11}H_{20}O_3$ | 90.0 | 120.0 | 134.7 | 150.2 | 167.8 | 179.0 | 193.6 | 215.7 | 241.0 | 266.8 | |
| *n*-Hexyl phenyl ketone (enanthophenone) | $C_{13}H_{18}O$ | 100.0 | 130.3 | 145.5 | 161.0 | 178.9 | 189.8 | 204.2 | 225.0 | 248.3 | 271.3 | |
| Hydrocinnamic acid | $C_9H_{10}O_2$ | 102.2 | 133.5 | 148.7 | 165.0 | 183.3 | 194.0 | 209.0 | 230.8 | 255.0 | 279.8 | 48.5 |
| Hydrogen cyanide (hydrocyanic acid) | CHN | −71.0 | −55.3 | −47.7 | −39.7 | −30.9 | −25.1 | −17.8 | −5.3 | +10.2 | 25.9 | −13.2 |
| Hydroquinone | $C_6H_6O_2$ | 132.4 | 153.3 | 163.5 | 174.6 | 192.0 | 203.0 | 216.5 | 238.0 | 262.5 | 286.2 | 170.3 |
| 4-Hydroxybenzaldehyde | $C_7H_6O_2$ | 121.2 | 153.2 | 169.7 | 186.8 | 206.0 | 217.5 | 233.5 | 256.8 | 282.6 | 310.0 | 115.5 |
| α-Hydroxyisobutyric acid | $C_4H_8O_3$ | 73.5 | 98.5 | 110.5 | 123.8 | 138.0 | 146.4 | 157.7 | 175.2 | 193.8 | 212.0 | 79 |
| α-Hydroxybutyronitrile | $C_5H_9NO$ | 41.0 | 65.8 | 77.8 | 90.7 | 104.8 | 113.9 | 125.0 | 142.0 | 159.8 | 178.8 | |
| 4-Hydroxy-3-methyl-2-butanone | $C_5H_{10}O_2$ | 44.6 | 69.3 | 81.0 | 94.0 | 108.2 | 117.4 | 129.0 | 146.5 | 165.5 | 185.0 | |
| 4-Hydroxy-4-methyl-2-pentanone | $C_6H_{12}O_2$ | 22.0 | 46.7 | 58.8 | 72.0 | 86.7 | 96.0 | 108.2 | 126.8 | 147.5 | 167.9 | −47 |
| 3-Hydroxypropionitrile | $C_3H_5NO$ | 58.7 | 87.8 | 102.0 | 117.9 | 134.1 | 144.7 | 157.7 | 178.0 | 200.0 | 221.0 | |
| Indene | $C_9H_8$ | 16.4 | 44.3 | 58.5 | 73.9 | 90.7 | 100.8 | 114.7 | 135.6 | 157.8 | 181.6 | −2 |
| Iodobenzene | $C_6H_5I$ | 24.1 | 50.6 | 64.0 | 78.3 | 94.4 | 105.0 | 118.3 | 139.8 | 163.9 | 188.6 | −28.5 |
| Iodononane | $C_9H_{19}I$ | 70.0 | 96.2 | 109.0 | 123.0 | 138.1 | 147.7 | 159.8 | 179.0 | 199.3 | 219.5 | |
| 2-Iodotoluene | $C_7H_7I$ | 37.2 | 65.9 | 79.8 | 95.6 | 112.4 | 123.8 | 138.1 | 160.0 | 185.7 | 211.0 | |
| α-Ionone | $C_{13}H_{20}O$ | 79.5 | 108.8 | 123.0 | 139.0 | 155.6 | 166.3 | 181.2 | 202.5 | 225.2 | 250.0 | |
| Isoprene | $C_5H_8$ | −79.8 | −62.3 | −53.3 | −43.5 | −32.6 | −25.4 | −16.0 | −1.2 | +15.4 | 32.6 | −146.7 |
| Lauraldehyde | $C_{12}H_{24}O$ | 77.7 | 108.4 | 123.7 | 140.2 | 157.8 | 168.7 | 184.5 | 207.8 | 231.8 | 257.0 | 44.5 |
| Lauric acid | $C_{12}H_{24}O_2$ | 121.0 | 150.6 | 166.0 | 183.6 | 201.4 | 212.7 | 227.5 | 249.8 | 273.8 | 299.2 | 48 |
| Levulinaldehyde | $C_5H_8O_2$ | 28.1 | 54.9 | 68.0 | 82.7 | 98.3 | 108.4 | 121.8 | 142.0 | 164.0 | 187.0 | |
| Levulinic acid | $C_5H_8O_3$ | 102.0 | 128.1 | 141.8 | 154.1 | 169.5 | 178.0 | 190.2 | 208.3 | 227.4 | 245.8 | 33.5 |
| *d*-Limonene | $C_{10}H_{16}$ | 14.0 | 40.4 | 53.8 | 68.2 | 84.3 | 94.6 | 108.3 | 128.5 | 151.4 | 175.0 | −96.9 |
| Linalyl acetate | $C_{12}H_{20}O_2$ | 55.4 | 82.5 | 96.0 | 111.4 | 127.7 | 138.1 | 151.8 | 173.3 | 196.2 | 220.0 | |
| Maleic anhydride | $C_4H_2O_3$ | 44.0 | 63.4 | 78.7 | 95.0 | 111.8 | 122.0 | 135.8 | 155.9 | 179.5 | 202.0 | 58 |
| Menthane | $C_{10}H_{20}$ | +9.7 | 35.7 | 48.3 | 62.7 | 78.3 | 88.6 | 102.1 | 122.7 | 146.0 | 169.5 | |
| 1-Menthol | $C_{10}H_{20}O$ | 56.0 | 83.2 | 96.0 | 110.3 | 126.1 | 136.1 | 149.4 | 168.3 | 190.2 | 212.0 | 42.5 |
| Menthyl acetate | $C_{12}H_{22}O_2$ | 57.4 | 85.8 | 100.0 | 115.4 | 132.1 | 143.2 | 156.7 | 178.8 | 202.8 | 227.0 | |
| benzoate | $C_{17}H_{24}O_2$ | 123.2 | 154.2 | 170.0 | 186.3 | 204.3 | 215.8 | 230.4 | 253.2 | 277.1 | 301.0 | 54.5 |
| formate | $C_{11}H_{20}O_2$ | 47.3 | 75.8 | 90.0 | 105.8 | 123.0 | 133.8 | 148.0 | 169.8 | 194.2 | 219.0 | |
| Mesityl oxide | $C_6H_{10}O$ | −8.7 | +14.1 | 26.0 | 37.9 | 51.7 | 60.4 | 72.1 | 90.0 | 109.8 | 130.0 | −59 |
| Methacrylic acid | $C_4H_6O_2$ | 25.5 | 48.5 | 60.0 | 72.7 | 86.4 | 95.3 | 106.6 | 123.9 | 142.5 | 161.0 | 15 |
| Methacrylonitrile | $C_4H_5N$ | −44.5 | −23.3 | −12.5 | −0.6 | +12.8 | 21.5 | 32.8 | 50.0 | 70.3 | 90.3 | |
| Methane | $CH_4$ | −205.9 | −199.0 | −195.5 | −191.8 | −187.7 | −185.1 | −181.4 | −175.5 | −168.8 | −161.5 | −182.5 |
| Methanethiol | $CH_4S$ | −90.7 | −75.3 | −67.5 | −58.8 | −49.2 | −43.1 | −34.8 | −22.1 | −7.9 | +6.8 | −121 |
| Methoxyacetic acid | $C_3H_6O_3$ | 52.5 | 79.3 | 92.0 | 106.5 | 122.0 | 131.8 | 144.5 | 163.5 | 184.2 | 204.0 | |
| *N*-Methylacetanilide | $C_9H_{11}NO$ | | 103.8 | 118.6 | 135.1 | 152.2 | 164.2 | 179.8 | 202.3 | 227.4 | 253.0 | 102 |
| Methyl acetate | $C_3H_6O_2$ | −57.2 | −38.6 | −29.3 | −19.1 | −7.9 | −0.5 | +9.4 | 24.0 | 40.0 | 57.8 | −98.7 |
| acetylene (propyne) | $C_3H_4$ | −111.0 | −97.5 | −90.5 | −82.9 | −74.3 | −68.8 | −61.3 | −49.8 | −37.2 | −23.3 | −102.7 |
| acrylate | $C_4H_6O_2$ | −43.7 | −23.6 | −13.5 | −2.7 | +9.2 | 17.3 | 28.0 | 43.9 | 61.8 | 80.2 | |
| alcohol (methanol) | $CH_4O$ | −44.0 | −25.3 | −16.2 | −6.0 | +5.0 | 12.1 | 21.2 | 34.8 | 49.9 | 64.7 | −97.8 |
| Methylamine | $CH_5N$ | −95.8 | −81.3 | −73.8 | −65.9 | −56.9 | −51.3 | −43.7 | −32.4 | −19.7 | −6.3 | −93.5 |
| *N*-Methylaniline | $C_7H_9N$ | 36.0 | 62.8 | 76.2 | 90.5 | 106.0 | 115.8 | 129.8 | 149.3 | 172.0 | 195.5 | −57 |
| Methyl anthranilate | $C_8H_9NO_2$ | 77.6 | 109.0 | 124.2 | 141.5 | 159.7 | 172.0 | 187.8 | 212.4 | 238.5 | 266.5 | 24 |
| benzoate | $C_8H_8O_2$ | 39.0 | 64.4 | 77.3 | 91.8 | 107.8 | 117.4 | 130.8 | 151.4 | 174.7 | 199.5 | −12.5 |
| 2-Methylbenzothiazole | $C_8H_7NS$ | 70.0 | 97.5 | 111.2 | 125.5 | 141.2 | 150.4 | 163.9 | 183.2 | 204.5 | 225.5 | 15.4 |
| α-Methylbenzyl alcohol | $C_8H_{10}O$ | 49.0 | 75.2 | 88.0 | 102.1 | 117.8 | 127.4 | 140.3 | 159.0 | 180.7 | 204.0 | |
| Methyl bromide | $CH_3Br$ | −96.3 | −80.6 | −72.8 | −64.0 | −54.2 | −48.0 | −39.4 | −26.5 | −11.9 | +3.6 | −93 |
| 2-Methyl-1-butene | $C_5H_{10}$ | −89.1 | −72.8 | −64.3 | −54.8 | −44.1 | −37.3 | −28.0 | −13.8 | +2.5 | 20.2 | −135 |
| 2-Methyl-2-butene | $C_5H_{10}$ | −75.4 | −57.0 | −47.9 | −37.9 | −26.7 | −19.4 | −9.9 | +4.9 | 21.6 | 38.5 | −133 |
| Methyl isobutyl carbinol (2-methyl-4-pentanol) | $C_6H_{14}O$ | −0.3 | +22.1 | 33.3 | 45.4 | 58.2 | 67.0 | 78.0 | 94.9 | 113.5 | 131.7 | |
| *n*-butyl ketone (2-hexanone) | $C_6H_{12}O$ | +7.7 | 28.8 | 38.8 | 50.0 | 62.0 | 69.8 | 79.8 | 94.3 | 111.0 | 127.5 | −56.9 |
| isobutyl ketone (4-methyl-2-pentanone) | $C_6H_{12}O$ | −1.4 | +19.7 | 30.0 | 40.8 | 52.8 | 60.4 | 70.4 | 85.6 | 102.0 | 119.0 | −84.7 |
| *n*-butyrate | $C_5H_{10}O_2$ | −26.8 | −5.5 | +5.0 | 16.7 | 29.6 | 37.4 | 48.0 | 64.3 | 83.1 | 102.3 | |
| isobutyrate | $C_5H_{10}O_2$ | −34.1 | −13.0 | −2.9 | +8.4 | 21.0 | 28.9 | 39.6 | 55.7 | 73.6 | 92.6 | −84.7 |
| caprate | $C_{11}H_{22}O_2$ | 63.7 | 93.5 | 108.0 | 123.0 | 139.0 | 148.6 | 161.5 | 181.6 | 202.9 | 224.0 | −18 |
| caproate | $C_7H_{14}O_2$ | +5.0 | 30.0 | 42.0 | 55.4 | 70.0 | 79.7 | 91.4 | 109.8 | 129.8 | 150 | |
| caprylate | $C_9H_{18}O_2$ | 34.2 | 61.7 | 74.9 | 89.0 | 105.3 | 115.3 | 128.0 | 148.1 | 170.0 | 193.0 | −40 |
| chloride | $CH_3Cl$ | | −99.5 | −92.4 | −84.8 | −76.0 | −70.4 | −63.0 | −51.2 | −38.0 | −24.0 | −97.7 |
| chloroacetate | $C_3H_5ClO_2$ | −2.9 | 19.0 | 30.0 | 41.5 | 54.5 | 63.0 | 73.5 | 90.5 | 109.5 | 130.3 | −31.9 |
| cinnamate | $C_{10}H_{10}O_2$ | 77.4 | 108.1 | 123.0 | 140.0 | 157.9 | 170.0 | 185.8 | 209.6 | 235.0 | 263.0 | 33.4 |
| α-Methylcinnamic acid | $C_{10}H_{10}O_2$ | 125.7 | 155.0 | 169.8 | 185.2 | 201.8 | 212.0 | 224.8 | 245.0 | 266.8 | 288.0 | |
| Methylcyclohexane | $C_7H_{14}$ | −35.9 | −14.0 | −3.2 | +8.7 | 22.0 | 30.5 | 42.1 | 59.6 | 79.6 | 100.9 | −126.4 |
| Methylcyclopentane | $C_6H_{12}$ | −53.7 | −33.8 | −23.7 | −12.8 | −0.6 | +7.2 | 17.9 | 34.0 | 52.3 | 71.8 | −142.4 |
| Methylcyclopropane | $C_4H_8$ | −96.0 | −80.6 | −72.8 | −64.0 | −54.2 | −48.0 | −39.3 | −26.0 | −11.3 | +4.5 | |
| Methyl *n*-decyl ketone (*n*-dodecan-2-one) | $C_{12}H_{24}O$ | 77.1 | 106.0 | 120.4 | 136.0 | 152.4 | 163.8 | 177.5 | 199.0 | 222.5 | 246.5 | |
| dichloroacetate | $C_3H_4Cl_2O_2$ | 3.2 | 26.7 | 38.1 | 50.7 | 64.7 | 73.6 | 85.4 | 103.2 | 122.6 | 143.0 | |
| *N*-Methyldiphenylamine | $C_{13}H_{13}N$ | 103.5 | 134.0 | 149.7 | 165.8 | 184.0 | 195.4 | 210.1 | 232.8 | 257.0 | 282.0 | −7.6 |

**TABLE 2-8 Vapor Pressures of Organic Compounds, up to 1 atm*** (*Continued*)

| Compound | | Pressure, mm Hg | | | | | | | | | | Melting point, °C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 5 | 10 | 20 | 40 | 60 | 100 | 200 | 400 | 760 | |
| Name | Formula | Temperature, °C | | | | | | | | | | |
| Methyl *n*-dodecyl ketone (2-tetradecanone) | $C_{14}H_{28}O$ | 99.3 | 130.0 | 145.5 | 161.3 | 179.8 | 191.4 | 206.0 | 228.2 | 253.3 | 278.0 | |
| Methylene bromide (dibromomethane) | $CH_2Br_2$ | −35.1 | −13.2 | −2.4 | +9.7 | 23.3 | 31.6 | 42.3 | 58.5 | 79.0 | 98.6 | −52.8 |
| chloride (dichloromethane) | $CH_2Cl_2$ | −70.0 | −52.1 | −43.3 | −33.4 | −22.3 | −15.7 | −6.3 | +8.0 | 24.1 | 40.7 | −96.7 |
| Methyl ethyl ketone (2-butanone) | $C_4H_8O$ | −48.3 | −28.0 | −17.7 | −6.5 | +6.0 | 14.0 | 25.0 | 41.6 | 60.0 | 79.6 | −85.9 |
| 2-Methyl-3-ethylpentane | $C_8H_{18}$ | −24.0 | −1.8 | +9.5 | 21.7 | 35.2 | 43.9 | 55.7 | 73.6 | 94.0 | 115.6 | −114.5 |
| 3-Methyl-3-ethylpentane | $C_8H_{18}$ | −23.9 | −1.4 | +9.9 | 22.3 | 36.2 | 45.0 | 57.1 | 75.3 | 96.2 | 118.3 | −90 |
| Methyl fluoride | $CH_3F$ | −147.3 | −137.0 | −131.6 | −125.9 | −119.1 | −115.0 | −109.0 | −99.9 | −89.5 | −78.2 | |
| formate | $C_2H_4O_2$ | −74.2 | −57.0 | −48.6 | −39.2 | −28.7 | −21.9 | −12.9 | +0.8 | 16.0 | 32.0 | −99.8 |
| α-Methylglutaric anhydride | $C_6H_8O_3$ | 93.8 | 125.4 | 141.8 | 157.7 | 177.5 | 189.9 | 205.0 | 229.1 | 255.5 | 282.5 | |
| Methyl glycolate | $C_3H_6O_3$ | +9.6 | 33.7 | 45.3 | 58.1 | 72.3 | 81.8 | 93.7 | 111.8 | 131.7 | 151.5 | |
| 2-Methylheptadecane | $C_{18}H_{38}$ | 119.8 | 152.0 | 168.7 | 186.0 | 204.8 | 216.3 | 231.5 | 254.5 | 279.8 | 306.5 | |
| 2-Methylheptane | $C_8H_{18}$ | −21.0 | +1.3 | 12.3 | 24.4 | 37.9 | 46.6 | 58.3 | 76.0 | 96.2 | 117.6 | −109.5 |
| 3-Methylheptane | $C_8H_{18}$ | −19.8 | +2.6 | 13.3 | 25.4 | 38.9 | 47.6 | 59.4 | 77.1 | 97.4 | 118.9 | −120.8 |
| 4-Methylheptane | $C_8H_{18}$ | −20.4 | +1.5 | 12.4 | 24.5 | 38.0 | 46.6 | 58.3 | 76.1 | 96.3 | 117.7 | −121.1 |
| 2-Methyl-2-heptene | $C_8H_{16}$ | −16.1 | +6.7 | 17.8 | 30.4 | 44.0 | 52.8 | 64.6 | 82.3 | 102.2 | 122.5 | |
| 6-Methyl-3-hepten-2-ol | $C_8H_{16}O$ | 41.6 | 65.0 | 76.7 | 89.3 | 102.7 | 111.5 | 122.6 | 139.5 | 156.6 | 175.5 | |
| 6-Methyl-5-hepten-2-ol | $C_8H_{16}O$ | 41.9 | 66.0 | 77.8 | 90.4 | 104.0 | 112.8 | 123.8 | 140.0 | 156.6 | 174.3 | |
| 2-Methylhexane | $C_7H_{16}$ | −40.4 | −19.5 | −9.1 | +2.3 | 14.9 | 23.0 | 34.1 | 50.8 | 69.8 | 90.0 | −118.2 |
| 3-Methylhexane | $C_7H_{16}$ | −39.0 | −18.1 | −7.8 | +3.6 | 16.4 | 24.5 | 35.6 | 52.4 | 71.6 | 91.9 | |
| Methyl iodide | $CH_3I$ | | −55.0 | −45.8 | −35.6 | −24.2 | −16.9 | −7.0 | +8.0 | 25.3 | 42.4 | −64.4 |
| laurate | $C_{13}H_{26}O_2$ | 87.8 | 117.9 | 133.2 | 149.0 | 166.0 | 176.8 | 190.8 | | | | 5 |
| levulinate | $C_6H_{10}O_3$ | 39.8 | 66.4 | 79.7 | 93.7 | 109.5 | 119.3 | 133.0 | 153.4 | 175.8 | 197.7 | |
| methacrylate | $C_5H_8O_2$ | −30.5 | −10.0 | +1.0 | 11.0 | 25.5 | 34.5 | 47.0 | 63.0 | 82.0 | 101.0 | |
| myristate | $C_{15}H_{30}O_2$ | 115.0 | 145.7 | 160.8 | 177.8 | 195.8 | 207.5 | 222.6 | 245.3 | 269.8 | 295.8 | 18.5 |
| α-naphthyl ketone (1-acetonaphthone) | $C_{12}H_{10}O$ | 115.6 | 146.3 | 161.5 | 178.4 | 196.8 | 208.6 | 223.8 | 246.7 | 270.5 | 295.5 | |
| β-naphthyl ketone (2-acetonaphthone) | $C_{12}H_{10}O$ | 120.2 | 152.3 | 168.5 | 185.7 | 203.8 | 214.7 | 229.8 | 251.6 | 275.8 | 301.0 | 55.5 |
| *n*-nonyl ketone (undecan-2-one) | $C_{11}H_{22}O$ | 68.2 | 95.5 | 108.9 | 123.1 | 139.0 | 148.6 | 161.0 | 181.2 | 202.3 | 224.0 | 15 |
| palmitate | $C_{17}H_{34}O_2$ | 134.3 | 166.8 | 184.3 | 202.0 | | | | | | | 30 |
| *n*-pentadecyl ketone (2-heptdecanone) | $C_{17}H_{34}O$ | 129.6 | 161.6 | 178.0 | 196.4 | 214.3 | 226.7 | 242.0 | 265.8 | 291.7 | 319.5 | |
| 2-Methylpentane | $C_6H_{14}$ | −60.9 | −41.7 | −32.1 | −21.4 | −9.7 | −1.9 | +8.1 | 24.1 | 41.6 | 60.3 | −154 |
| 3-Methylpentane | $C_6H_{14}$ | −59.0 | −39.8 | −30.1 | −19.4 | −7.3 | +0.1 | 10.5 | 26.5 | 44.2 | 63.3 | −118 |
| 2-Methyl-1-pentanol | $C_6H_{14}O$ | 15.4 | 38.0 | 49.6 | 61.6 | 74.7 | 83.4 | 94.2 | 111.3 | 129.8 | 147.9 | |
| 2-Methyl-2-pentanol | $C_6H_{14}O$ | −4.5 | +16.8 | 27.6 | 38.8 | 51.3 | 58.8 | 69.2 | 85.0 | 102.6 | 121.2 | −103 |
| Methyl *n*-pentyl ketone (2-heptanone) | $C_7H_{14}O$ | 19.3 | 43.6 | 55.5 | 67.7 | 81.2 | 89.8 | 100.0 | 116.1 | 133.2 | 150.2 | |
| phenyl ether (anisole) | $C_7H_8O$ | +5.4 | 30.0 | 42.2 | 55.8 | 70.7 | 80.1 | 93.0 | 112.3 | 133.8 | 155.5 | −37.3 |
| 2-Methylpropene | $C_4H_8$ | −105.1 | −96.5 | −81.9 | −73.4 | −63.8 | −57.7 | −49.3 | −36.7 | −22.2 | −6.9 | −140.3 |
| Methyl propionate | $C_4H_8O_2$ | −42.0 | −21.5 | −11.8 | −1.0 | +11.0 | 18.7 | 29.0 | 44.2 | 61.8 | 79.8 | −87.5 |
| 4-Methylpropiophenone | $C_{10}H_{12}O$ | 59.6 | 89.3 | 103.8 | 120.2 | 138.0 | 149.3 | 164.2 | 187.4 | 212.7 | 238.5 | |
| 2-Methylpropionyl bromide | $C_4H_7BrO$ | 13.5 | 38.4 | 50.6 | 64.1 | 79.4 | 88.8 | 101.6 | 120.5 | 141.7 | 163.0 | |
| Methyl propyl ether | $C_4H_{10}O$ | −72.2 | −54.3 | −45.4 | −35.4 | −24.3 | −17.4 | −8.1 | +6.0 | 22.5 | 39.1 | |
| *n*-propyl ketone (2-pentanone) | $C_5H_{10}O$ | −12.0 | +8.0 | 17.9 | 28.5 | 39.8 | 47.3 | 56.8 | 71.0 | 86.8 | 103.3 | −77.8 |
| isopropyl ketone (3-Methyl-2-butanone) | $C_5H_{10}O$ | −19.9 | −1.0 | +8.3 | 18.3 | 29.6 | 36.2 | 45.5 | 59.0 | 73.8 | 88.9 | −92 |
| 2-Methylquinoline | $C_{10}H_9N$ | 75.3 | 104.0 | 119.0 | 134.0 | 150.8 | 161.7 | 176.2 | 197.8 | 211.7 | 246.5 | −1 |
| Methyl salicylate | $C_8H_8O_3$ | 54.0 | 81.6 | 95.3 | 110.0 | 126.2 | 136.7 | 150.0 | 172.6 | 197.5 | 223.2 | −8.3 |
| α-Methyl styrene | $C_9H_{10}$ | 7.4 | 34.0 | 47.1 | 61.8 | 77.8 | 88.3 | 102.2 | 121.8 | 143.0 | 165.4 | −23.2 |
| 4-Methyl styrene | $C_9H_{10}$ | 16.0 | 42.0 | 55.1 | 69.2 | 85.0 | 95.0 | 108.6 | 128.7 | 151.2 | 175.0 | |
| Methyl *n*-tetradecyl ketone (2-hexadecanone) | $C_{16}H_{32}O$ | 109.8 | 151.5 | 167.3 | 184.6 | 203.7 | 215.0 | 230.5 | 254.4 | 279.8 | 307.0 | |
| thiocyanate | $C_2H_3NS$ | −14.0 | +9.8 | 21.6 | 34.5 | 49.0 | 58.1 | 70.4 | 89.8 | 110.8 | 132.9 | −51 |
| isothiocyanate | $C_2H_3NS$ | −34.7 | −8.3 | +5.4 | 20.4 | 38.2 | 47.5 | 59.3 | 77.5 | 97.8 | 119.0 | 35.5 |
| undecyl ketone (2-tridecanone) | $C_{13}H_{26}O$ | 86.8 | 117.0 | 131.8 | 147.8 | 165.7 | 176.6 | 191.5 | 214.0 | 238.3 | 262.5 | 28.5 |
| isovalerate | $C_6H_{12}O_2$ | −19.2 | +2.9 | 14.0 | 26.4 | 39.8 | 48.2 | 59.8 | 77.3 | 96.7 | 116.7 | |
| Monovinylacetylene (butenyne) | $C_4H_4$ | −93.2 | −77.7 | −70.0 | −61.3 | −51.7 | −45.3 | −37.1 | −24.1 | −10.1 | +5.3 | |
| Myrcene | $C_{10}H_{16}$ | 14.5 | 40.0 | 53.2 | 67.0 | 82.6 | 92.6 | 106.0 | 126.0 | 148.3 | 171.5 | |
| Myristaldehyde | $C_{14}H_{28}O$ | 99.0 | 132.0 | 148.3 | 166.2 | 186.0 | 198.3 | 214.5 | 240.4 | 267.9 | 297.8 | 23.5 |
| Myristic acid (tetradecanoic acid) | $C_{14}H_{28}O_2$ | 142.0 | 174.1 | 190.8 | 207.6 | 223.5 | 237.2 | 250.5 | 272.3 | 294.6 | 318.0 | 57.5 |
| Naphthalene | $C_{10}H_8$ | 52.6 | 74.2 | 85.8 | 101.7 | 119.3 | 130.2 | 145.5 | 167.7 | 193.2 | 217.9 | 80.2 |
| 1-Naphthoic acid | $C_{11}H_8O_2$ | 156.0 | 184.0 | 196.8 | 211.2 | 225.0 | 234.5 | 245.8 | 263.5 | 281.4 | 300.0 | 160.5 |
| 2-Naphthoic acid | $C_{11}H_8O_2$ | 160.8 | 189.7 | 202.8 | 216.9 | 231.5 | 241.3 | 252.7 | 270.3 | 289.5 | 308.5 | 184 |
| 1-Naphthol | $C_{10}H_8O$ | 94.0 | 125.5 | 142.0 | 158.0 | 177.8 | 190.0 | 206.0 | 229.6 | 255.8 | 282.5 | 96 |
| 2-Naphthol | $C_{10}H_8O$ | | 128.6 | 145.5 | 161.8 | 181.7 | 193.7 | 209.8 | 234.0 | 260.6 | 288.0 | 122.5 |
| 1-Naphthylamine | $C_{10}H_9N$ | 104.3 | 137.7 | 153.8 | 171.6 | 191.5 | 203.8 | 220.0 | 244.9 | 272.2 | 300.8 | 50 |
| 2-Naphthylamine | $C_{10}H_9N$ | 108.0 | 141.6 | 157.6 | 175.8 | 195.7 | 208.1 | 224.3 | 249.7 | 277.4 | 306.1 | 111.5 |
| Nicotine | $C_{10}H_{14}N_2$ | 61.8 | 91.8 | 107.2 | 123.7 | 142.1 | 154.7 | 169.5 | 193.8 | 219.8 | 247.3 | |
| 2-Nitroaniline | $C_6H_6N_2O_2$ | 104.0 | 135.7 | 150.4 | 167.7 | 186.0 | 197.8 | 213.0 | 236.3 | 260.0 | 284.5 | 71.5 |
| 3-Nitroaniline | $C_6H_6N_2O_2$ | 119.3 | 151.5 | 167.8 | 185.5 | 204.2 | 216.5 | 232.1 | 255.3 | 280.2 | 305.7 | 114 |
| 4-Nitroaniline | $C_6H_6N_2O_2$ | 142.4 | 177.6 | 194.4 | 213.2 | 234.2 | 245.9 | 261.8 | 284.5 | 310.2 | 336.0 | 146.5 |
| 2-Nitrobenzaldehyde | $C_7H_5NO_3$ | 85.8 | 117.7 | 133.4 | 150.0 | 168.8 | 180.7 | 196.2 | 220.0 | 246.8 | 273.5 | 40.9 |
| 3-Nitrobenzaldehyde | $C_7H_5NO_3$ | 96.2 | 127.4 | 142.8 | 159.0 | 177.7 | 189.5 | 204.3 | 227.4 | 252.1 | 278.3 | 58 |
| Nitrobenzene | $C_6H_5NO_2$ | 44.4 | 71.6 | 84.9 | 99.3 | 115.4 | 125.8 | 139.9 | 161.2 | 185.8 | 210.6 | +5.7 |
| Nitroethane | $C_2H_5NO_2$ | −21.0 | +1.5 | 12.5 | 24.8 | 38.0 | 46.5 | 57.8 | 74.8 | 94.0 | 114.0 | −90 |
| Nitroglycerin | $C_3H_5N_3O_9$ | 127 | 167 | 188 | 210 | 235 | 251 | | | | | 11 |
| Nitromethane | $CH_3NO_2$ | −29.0 | −7.9 | +2.8 | 14.1 | 27.5 | 35.5 | 46.6 | 63.5 | 82.0 | 101.2 | −29 |
| 2-Nitrophenol | $C_6H_5NO_3$ | 49.3 | 76.8 | 90.4 | 105.8 | 122.1 | 132.6 | 146.4 | 167.6 | 191.0 | 214.5 | 45 |
| 2-Nitrophenyl acetate | $C_8H_7NO_4$ | 100.0 | 128.0 | 142.0 | 155.8 | 172.8 | 181.7 | 194.1 | 213.0 | 233.5 | 253.0 | |

**TABLE 2-8 Vapor Pressures of Organic Compounds, up to 1 atm** (*Continued*)

| Compound | | Pressure, mm Hg | | | | | | | | | | Melting point, °C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 5 | 10 | 20 | 40 | 60 | 100 | 200 | 400 | 760 | |
| Name | Formula | Temperature, °C | | | | | | | | | | |
| 1-Nitropropane | $C_3H_7NO_2$ | −9.6 | +13.5 | 25.3 | 37.9 | 51.8 | 60.5 | 72.3 | 90.2 | 110.6 | 131.6 | −108 |
| 2-Nitropropane | $C_3H_7NO_2$ | −18.8 | +4.1 | 15.8 | 28.2 | 41.8 | 50.3 | 62.0 | 80.0 | 99.8 | 120.3 | −93 |
| 2-Nitrotoluene | $C_7H_7NO_2$ | 50.0 | 79.1 | 93.8 | 109.6 | 126.3 | 137.6 | 151.5 | 173.7 | 197.7 | 222.3 | −4.1 |
| 3-Nitrotoluene | $C_7H_7NO_2$ | 50.2 | 81.0 | 96.0 | 112.8 | 130.7 | 142.5 | 156.9 | 180.3 | 206.8 | 231.9 | 15.5 |
| 4-Nitrotoluene | $C_7H_7NO_2$ | 53.7 | 85.0 | 100.5 | 117.7 | 136.0 | 147.9 | 163.0 | 186.7 | 212.5 | 238.3 | 51.9 |
| 4-Nitro-1,3-xylene (4-nitro-*m*-xylene) | $C_8H_9NO_2$ | 65.6 | 95.0 | 109.8 | 125.8 | 143.3 | 153.8 | 168.5 | 191.7 | 217.5 | 244.0 | +2 |
| Nonacosane | $C_{29}H_{60}$ | 234.2 | 269.8 | 286.4 | 303.6 | 323.2 | 334.8 | 350.0 | 373.2 | 397.2 | 421.8 | 63.8 |
| Nonadecane | $C_{19}H_{40}$ | 133.2 | 166.3 | 183.5 | 200.8 | 220.0 | 232.8 | 248.0 | 271.8 | 299.8 | 330.0 | 32 |
| *n*-Nonane | $C_9H_{20}$ | +1.4 | 25.8 | 38.0 | 51.2 | 66.0 | 75.5 | 88.1 | 107.5 | 128.2 | 150.8 | −53.7 |
| 1-Nonanol | $C_9H_{20}O$ | 59.5 | 86.1 | 99.7 | 113.8 | 129.0 | 139.0 | 151.3 | 170.5 | 192.1 | 213.5 | −5 |
| 2-Nonanone | $C_9H_{18}O$ | 32.1 | 59.0 | 72.3 | 87.2 | 103.4 | 113.8 | 127.4 | 148.2 | 171.2 | 195.0 | −19 |
| Octacosane | $C_{28}H_{58}$ | 226.5 | 260.3 | 277.4 | 295.4 | 314.2 | 326.8 | 341.8 | 364.8 | 388.9 | 412.5 | 61.6 |
| Octadecane | $C_{18}H_{38}$ | 119.6 | 152.1 | 169.6 | 187.5 | 207.4 | 219.7 | 236.0 | 260.6 | 288.0 | 317.0 | 28 |
| *n*-Octane | $C_8H_{18}$ | −14.0 | +8.3 | 19.2 | 31.5 | 45.1 | 53.8 | 65.7 | 83.6 | 104.0 | 125.6 | −56.8 |
| *n*-Octanol (1-octanol) | $C_8H_{18}O$ | 54.0 | 76.5 | 88.3 | 101.0 | 115.2 | 123.8 | 135.2 | 152.0 | 173.8 | 195.2 | −15.4 |
| 2-Octanone | $C_8H_{16}O$ | 23.6 | 48.4 | 60.9 | 74.3 | 89.8 | 99.0 | 111.7 | 130.4 | 151.0 | 172.9 | −16 |
| *n*-Octyl acrylate | $C_{11}H_{20}O_2$ | 58.5 | 87.7 | 102.0 | 117.8 | 135.6 | 145.6 | 159.1 | 180.2 | 204.0 | 227.0 | |
| iodide (1-Iodooctane) | $C_8H_{17}I$ | 45.8 | 74.8 | 90.0 | 105.9 | 123.8 | 135.4 | 150.0 | 173.3 | 199.3 | 225.5 | −45.9 |
| Oleic acid | $C_{18}H_{34}O_2$ | 176.5 | 208.5 | 223.0 | 240.0 | 257.2 | 269.8 | 286.0 | 309.8 | 334.7 | 360.0 | 14 |
| Palmitaldehyde | $C_{16}H_{32}O$ | 121.6 | 154.6 | 171.8 | 190.0 | 210.0 | 222.6 | 239.5 | 264.1 | 292.3 | 321.0 | 34 |
| Palmitic acid | $C_{16}H_{32}O_2$ | 153.6 | 188.1 | 205.8 | 223.8 | 244.4 | 256.0 | 271.5 | 298.7 | 326.0 | 353.8 | 64.0 |
| Palmitonitrile | $C_{16}H_{31}N$ | 134.3 | 168.3 | 185.8 | 204.2 | 223.8 | 236.6 | 251.5 | 277.1 | 304.5 | 332.0 | 31 |
| Pelargonic acid | $C_9H_{18}O_2$ | 108.2 | 126.0 | 137.4 | 149.8 | 163.7 | 172.3 | 184.4 | 203.1 | 227.5 | 253.5 | 12.5 |
| Pentachlorobenzene | $C_6HCl_5$ | 98.6 | 129.7 | 144.3 | 160.0 | 178.5 | 190.1 | 205.5 | 227.0 | 251.6 | 276.0 | 85.5 |
| Pentachloroethane | $C_2HCl_5$ | +1.0 | 27.2 | 39.8 | 53.9 | 69.9 | 80.0 | 93.5 | 114.0 | 137.2 | 160.5 | −22 |
| Pentachloroethylbenzene | $C_8H_5Cl_5$ | 96.2 | 130.0 | 148.0 | 166.0 | 186.2 | 199.0 | 216.0 | 241.8 | 269.3 | 299.0 | |
| Pentachlorophenol | $C_6HCl_5O$ | | | | 192.2 | 211.2 | 223.4 | 239.6 | 261.8 | 285.0 | 309.3 | 188.5 |
| Pentacosane | $C_{25}H_{52}$ | 194.2 | 230.0 | 248.2 | 266.1 | 285.6 | 298.4 | 314.0 | 339.0 | 365.4 | 390.3 | 53.3 |
| Pentadecane | $C_{15}H_{32}$ | 91.6 | 121.0 | 135.4 | 150.2 | 167.7 | 178.4 | 194.0 | 216.1 | 242.8 | 270.5 | 10 |
| 1,3-Pentadiene | $C_5H_8$ | −71.8 | −53.8 | −45.0 | −34.8 | −23.4 | −16.5 | −6.7 | +8.0 | 24.7 | 42.1 | |
| 1,4-Pentadiene | $C_5H_8$ | −83.5 | −66.2 | −57.1 | −47.7 | −37.0 | −30.0 | −20.6 | −6.7 | +8.3 | 26.1 | |
| Pentaethylbenzene | $C_{16}H_{26}$ | 86.0 | 120.0 | 135.8 | 152.4 | 171.9 | 184.2 | 200.0 | 224.1 | 250.2 | 277.0 | |
| Pentaethylchlorobenzene | $C_{16}H_{25}Cl$ | 90.0 | 123.8 | 140.7 | 158.1 | 178.2 | 191.0 | 208.0 | 230.3 | 257.2 | 285.0 | |
| *n*-Pentane | $C_5H_{12}$ | −76.6 | −62.5 | −50.1 | −40.2 | −29.2 | −22.2 | −12.6 | +1.9 | 18.5 | 36.1 | −129.7 |
| iso-Pentane (2-methylbutane) | $C_5H_{12}$ | −82.9 | −65.8 | −57.0 | −47.3 | −36.5 | −29.6 | −20.2 | −5.9 | +10.5 | 27.8 | −159.7 |
| neo-Pentane (2,2-dimethylpropane) | $C_5H_{12}$ | −102.0 | −85.4 | −76.7 | −67.2 | −56.1 | −49.0 | −39.1 | −23.7 | −7.1 | +9.5 | −16.6 |
| 2,3,4-Pentanetriol | $C_5H_{12}O_3$ | 155.0 | 189.3 | 204.5 | 220.5 | 239.6 | 249.8 | 263.5 | 284.5 | 307.0 | 327.2 | |
| 1-Pentene | $C_5H_{10}$ | −80.4 | −63.3 | −54.5 | −46.0 | −34.1 | −27.1 | −17.7 | −3.4 | +12.8 | 30.1 | |
| α-Phellandrene | $C_{10}H_{16}$ | 20.0 | 45.7 | 58.0 | 72.1 | 87.8 | 97.6 | 110.6 | 130.6 | 152.0 | 175.0 | |
| Phenanthrene | $C_{14}H_{10}$ | 118.2 | 154.3 | 173.0 | 193.7 | 215.8 | 229.9 | 249.0 | 277.1 | 308.0 | 340.2 | 99.5 |
| Phenethyl alcohol (phenyl cellosolve) | $C_8H_{10}O_2$ | 58.2 | 85.9 | 100.0 | 114.8 | 130.5 | 141.2 | 154.0 | 175.0 | 197.5 | 219.5 | |
| 2-Phenetidine | $C_8H_{11}NO$ | 67.0 | 94.7 | 108.6 | 123.7 | 139.9 | 149.8 | 163.5 | 184.0 | 207.0 | 228.0 | |
| Phenol | $C_6H_6O$ | 40.1 | 62.5 | 73.8 | 86.0 | 100.1 | 108.4 | 121.4 | 139.0 | 160.0 | 181.9 | 40.6 |
| 2-Phenoxyethanol | $C_8H_{10}O_2$ | 78.0 | 106.6 | 121.2 | 136.0 | 152.2 | 163.2 | 176.5 | 197.6 | 221.0 | 245.3 | 11.6 |
| 2-Phenoxyethyl acetate | $C_{10}H_{12}O_3$ | 82.6 | 113.5 | 128.0 | 144.5 | 162.3 | 174.0 | 189.2 | 211.3 | 235.0 | 259.7 | −6.7 |
| Phenyl acetate | $C_8H_8O_2$ | 38.2 | 64.8 | 78.0 | 92.3 | 108.1 | 118.1 | 131.6 | 151.2 | 173.5 | 195.9 | |
| Phenylacetic acid | $C_8H_8O_2$ | 97.0 | 127.0 | 141.3 | 156.0 | 173.6 | 184.5 | 198.2 | 219.5 | 243.0 | 265.5 | 76.5 |
| Phenylacetonitrile | $C_8H_7N$ | 60.0 | 89.0 | 103.5 | 119.4 | 136.3 | 147.7 | 161.8 | 184.2 | 208.5 | 233.5 | −23.8 |
| Phenylacetyl chloride | $C_8H_7ClO$ | 48.0 | 75.3 | 89.0 | 103.6 | 119.8 | 129.8 | 143.5 | 163.8 | 186.0 | 210.0 | |
| Phenyl benzoate | $C_{13}H_{10}O_2$ | 106.8 | 141.5 | 157.8 | 177.0 | 197.6 | 210.8 | 227.8 | 254.0 | 283.5 | 314.0 | 70.5 |
| 4-Phenyl-3-buten-2-one | $C_{10}H_{10}O$ | 81.7 | 112.2 | 127.4 | 143.8 | 161.3 | 172.6 | 187.8 | 211.0 | 235.4 | 261.0 | 41.5 |
| Phenyl isocyanate | $C_7H_5NO$ | 10.6 | 36.0 | 48.5 | 62.5 | 77.7 | 87.7 | 100.6 | 120.8 | 142.7 | 165.6 | |
| isocyanide | $C_7H_5N$ | 12.0 | 37.0 | 49.7 | 63.4 | 78.3 | 88.0 | 101.0 | 120.8 | 142.3 | 165.0 | |
| Phenylcyclohexane | $C_{12}H_{16}$ | 67.5 | 96.5 | 111.3 | 126.4 | 144.0 | 154.2 | 169.3 | 191.3 | 214.6 | 240.0 | +7.5 |
| Phenyl dichlorophosphate | $C_6H_5Cl_2O_2P$ | 66.7 | 95.9 | 110.0 | 125.9 | 143.4 | 153.6 | 168.0 | 189.8 | 213.0 | 239.5 | |
| *m*-Phenylene diamine | | | | | | | | | | | | |
| (1,3-phenylenediamine) | $C_6H_8N_2$ | 99.8 | 131.2 | 147.0 | 163.8 | 182.5 | 194.0 | 209.9 | 233.0 | 259.0 | 285.5 | 62.8 |
| Phenylglyoxal | $C_8H_6O_2$ | | 75.0 | 87.8 | 100.7 | 115.5 | 124.2 | 136.2 | 153.8 | 173.5 | 193.5 | 73 |
| Phenylhydrazine | $C_6H_8N_2$ | 71.8 | 101.6 | 115.8 | 131.5 | 148.2 | 158.7 | 173.5 | 195.4 | 218.2 | 243.5 | 19.5 |
| *N*-Phenyliminodiethanol | $C_{10}H_{15}NO_2$ | 145.0 | 179.2 | 195.8 | 213.4 | 233.0 | 245.3 | 260.6 | 284.5 | 311.3 | 337.8 | |
| 1-Phenyl-1,3-pentanedione | $C_{11}H_{12}O_2$ | 98.0 | 128.5 | 144.0 | 159.9 | 178.0 | 189.8 | 204.5 | 226.7 | 251.2 | 276.5 | |
| 2-Phenylphenol | $C_{12}H_{10}O$ | 100.0 | 131.6 | 146.2 | 163.3 | 180.3 | 192.2 | 205.9 | 227.9 | 251.8 | 275.0 | 56.5 |
| 4-Phenylphenol | $C_{12}H_{10}O$ | | | 176.2 | 193.8 | 213.0 | 225.3 | 240.9 | 263.2 | 285.5 | 308.0 | 164.5 |
| 3-Phenyl-1-propanol | $C_9H_{12}O$ | 74.7 | 102.4 | 116.0 | 131.2 | 147.4 | 156.8 | 170.3 | 191.2 | 212.8 | 235.0 | |
| Phenyl isothiocyanate | $C_7H_5NS$ | 47.2 | 75.6 | 89.8 | 115.5 | 122.5 | 133.3 | 147.7 | 169.6 | 194.0 | 218.5 | −21.0 |
| Phorone | $C_9H_{14}O$ | 42.0 | 68.3 | 81.5 | 95.6 | 111.3 | 121.4 | 134.0 | 153.5 | 175.3 | 197.2 | 28 |
| iso-Phorone | $C_9H_{14}O$ | 38.0 | 66.7 | 81.2 | 96.8 | 114.5 | 125.6 | 140.6 | 163.3 | 188.7 | 215.2 | |
| Phosgene (carbonyl chloride) | $CCl_2O$ | −92.9 | −77.0 | −69.3 | −60.3 | −50.3 | −44.0 | −35.6 | −22.3 | −7.6 | +8.3 | −104 |
| Phthalic anhydride | $C_8H_4O_3$ | 96.5 | 121.3 | 134.0 | 151.7 | 172.0 | 185.3 | 202.3 | 228.0 | 256.8 | 284.5 | 130.8 |
| Phthalide | $C_8H_6O_2$ | 95.5 | 127.7 | 144.0 | 161.3 | 181.0 | 193.5 | 210.0 | 234.5 | 261.8 | 290.0 | 73 |
| Phthaloyl chloride | $C_8H_4Cl_2O_2$ | 86.3 | 118.3 | 134.2 | 151.0 | 170.0 | 182.2 | 197.8 | 222.0 | 248.3 | 275.8 | 88.5 |
| 2-Picoline | $C_6H_7N$ | −11.1 | +12.6 | 24.4 | 37.4 | 51.2 | 59.9 | 71.4 | 89.0 | 108.4 | 128.8 | −70 |
| Pimelic acid | $C_7H_{12}O_4$ | 163.4 | 196.2 | 212.0 | 229.3 | 247.0 | 258.2 | 272.0 | 294.5 | 318.5 | 342.1 | 103 |
| α-Pinene | $C_{10}H_{16}$ | −1.0 | +24.6 | 37.3 | 51.4 | 66.8 | 76.8 | 90.1 | 110.2 | 132.3 | 155.0 | −55 |
| β-Pinene | $C_{10}H_{16}$ | +4.2 | 30.0 | 42.3 | 58.1 | 71.5 | 81.2 | 94.0 | 114.1 | 136.1 | 158.3 | |

**TABLE 2-8 Vapor Pressures of Organic Compounds, up to 1 atm** (*Continued*)

| Compound | | Pressure, mm Hg | | | | | | | | | | Melting point, °C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 5 | 10 | 20 | 40 | 60 | 100 | 200 | 400 | 760 | |
| Name | Formula | Temperature, °C | | | | | | | | | | |
| Piperidine | $C_5H_{11}N$ | | −7.0 | +3.9 | 15.8 | 29.2 | 37.7 | 49.0 | 66.2 | 85.7 | 106.0 | −9 |
| Piperonal | $C_8H_6O_3$ | 87.0 | 117.4 | 132.0 | 148.0 | 165.7 | 177.0 | 191.7 | 214.3 | 238.5 | 263.0 | 37 |
| Propane | $C_3H_8$ | −128.9 | −115.4 | −108.5 | −100.9 | −92.4 | −87.0 | −79.6 | −68.4 | −55.6 | −42.1 | −187.1 |
| Propenylbenzene | $C_9H_{10}$ | 17.5 | 43.8 | 57.0 | 71.5 | 87.7 | 97.8 | 111.7 | 132.0 | 154.7 | 179.0 | −30.1 |
| Propionamide | $C_3H_7NO$ | 65.0 | 91.0 | 105.0 | 119.0 | 134.8 | 144.3 | 156.0 | 174.2 | 194.0 | 213.0 | 79 |
| Propionic acid | $C_3H_6O_2$ | 4.6 | 28.0 | 39.7 | 52.0 | 65.8 | 74.1 | 85.8 | 102.5 | 122.0 | 141.1 | −22 |
| anhydride | $C_6H_{10}O_3$ | 20.6 | 45.3 | 57.7 | 70.4 | 85.6 | 94.5 | 107.2 | 127.8 | 146.0 | 167.0 | −45 |
| Propionitrile | $C_3H_5N$ | −35.0 | −13.6 | −3.0 | +8.8 | 22.0 | 30.1 | 41.4 | 58.2 | 77.7 | 97.1 | −91.9 |
| Propiophenone | $C_9H_{10}O$ | 50.0 | 77.9 | 92.2 | 107.6 | 124.3 | 135.0 | 149.3 | 170.2 | 194.2 | 218.0 | 21 |
| *n*-Propyl acetate | $C_5H_{10}O_2$ | −26.7 | −5.4 | +5.0 | 16.0 | 28.8 | 37.0 | 47.8 | 64.0 | 82.0 | 101.8 | −92.5 |
| iso-Propyl acetate | $C_5H_{10}O_2$ | −38.3 | −17.4 | −7.2 | +4.2 | 17.0 | 25.1 | 35.7 | 51.7 | 69.8 | 89.0 | |
| *n*-Propyl alcohol (1-propanol) | $C_3H_8O$ | −15.0 | +5.0 | 14.7 | 25.3 | 36.4 | 43.5 | 52.8 | 66.8 | 82.0 | 97.8 | −127 |
| iso-Propyl alcohol (2-propanol) | $C_3H_8O$ | −26.1 | −7.0 | +2.4 | 12.7 | 23.8 | 30.5 | 39.5 | 53.0 | 67.8 | 82.5 | −85.8 |
| *n*-Propylamine | $C_3H_9N$ | −64.4 | −46.3 | −37.2 | −27.1 | −16.0 | −9.0 | +0.5 | 15.0 | 31.5 | 48.5 | −83 |
| Propylbenzene | $C_9H_{12}$ | 6.3 | 31.3 | 43.4 | 56.8 | 71.6 | 81.1 | 94.0 | 113.5 | 135.7 | 159.2 | −99.5 |
| Propyl benzoate | $C_{10}H_{12}O_2$ | 54.6 | 83.8 | 98.0 | 114.3 | 131.8 | 143.3 | 157.4 | 180.1 | 205.2 | 231.0 | −51.6 |
| *n*-Propyl bromide (1-bromopropane) | $C_3H_7Br$ | −53.0 | −33.4 | −23.3 | −12.4 | −0.3 | +7.5 | 18.0 | 34.0 | 52.0 | 71.0 | −109.9 |
| iso-Propyl bromide (2-bromopropane) | $C_3H_7Br$ | −61.8 | −42.5 | −32.8 | −22.0 | −10.1 | −2.5 | +8.0 | 23.8 | 41.5 | 60.0 | −89.0 |
| *n*-Propyl n-butyrate | $C_7H_{14}O_2$ | −1.6 | +22.1 | 34.0 | 47.0 | 61.5 | 70.3 | 82.6 | 101.0 | 121.7 | 142.7 | −95.2 |
| isobutyrate | $C_7H_{14}O_2$ | −6.2 | +16.8 | 28.3 | 40.6 | 54.3 | 63.0 | 73.9 | 91.8 | 112.0 | 133.9 | |
| iso-Propyl isobutyrate | $C_7H_{14}O_2$ | −16.3 | +5.8 | 17.0 | 29.0 | 42.4 | 51.4 | 62.3 | 80.2 | 100.0 | 120.5 | |
| Propyl carbamate | $C_4H_9NO_2$ | 52.4 | 77.6 | 90.0 | 103.2 | 117.7 | 126.5 | 138.3 | 155.8 | 175.8 | 195.0 | |
| *n*-Propyl chloride (1-chloropropane) | $C_3H_7Cl$ | −68.3 | −50.0 | −41.0 | −31.0 | −19.5 | −12.1 | −2.5 | +12.2 | 29.4 | 46.4 | −122.8 |
| iso-Propyl chloride (2-chloropropane) | $C_3H_7Cl$ | −78.8 | −61.1 | −52.0 | −42.0 | −31.0 | −23.5 | −13.7 | +1.3 | 18.1 | 36.5 | −117 |
| iso-Propyl chloroacetate | $C_5H_9ClO_2$ | +3.8 | 28.1 | 40.2 | 53.9 | 68.7 | 78.0 | 90.3 | 108.8 | 128.0 | 148.6 | |
| Propyl chloroglyoxylate | $C_5H_7ClO_3$ | 9.7 | 32.3 | 43.5 | 55.6 | 68.8 | 77.2 | 88.0 | 104.7 | 123.0 | 150.0 | |
| Propylene | $C_3H_6$ | −131.9 | −120.7 | −112.1 | −104.7 | −96.5 | −91.3 | −84.1 | −73.3 | −60.9 | −47.7 | −185 |
| Propylene glycol (1,2-Propanediol) | $C_3H_8O_2$ | 45.5 | 70.8 | 83.2 | 96.4 | 111.2 | 119.9 | 132.0 | 149.7 | 168.1 | 188.2 | |
| Propylene oxide | $C_3H_6O$ | −75.0 | −57.8 | −49.0 | −39.3 | −28.4 | −21.3 | −12.0 | +2.1 | 17.8 | 34.5 | −112.1 |
| *n*-Propyl formate | $C_4H_8O_2$ | −43.0 | −22.7 | −12.6 | −1.7 | +10.8 | 18.8 | 29.5 | 45.3 | 62.6 | 81.3 | −92.9 |
| iso-Propyl formate | $C_4H_8O_2$ | −52.0 | −32.7 | −22.7 | −12.1 | −0.2 | +7.5 | 17.8 | 33.6 | 50.5 | 68.3 | |
| 4,4′-iso-Propylidenebisphenol | $C_{15}H_{16}O_2$ | 193.0 | 224.2 | 240.8 | 255.5 | 273.0 | 282.9 | 297.0 | 317.5 | 339.0 | 360.5 | |
| *n*-Propyl iodide (1-iodopropane) | $C_3H_7I$ | −36.0 | −13.5 | −2.4 | +10.0 | 23.6 | 32.1 | 43.8 | 61.8 | 81.8 | 102.5 | −98.8 |
| iso-Propyl iodide (2-iodopropane) | $C_3H_7I$ | −43.3 | −22.1 | −11.7 | 0.0 | +13.2 | 21.6 | 32.8 | 50.0 | 69.5 | 89.5 | −90 |
| *n*-Propyl levulinate | $C_8H_{14}O_3$ | 59.7 | 86.3 | 99.9 | 114.0 | 130.1 | 140.6 | 154.0 | 175.6 | 198.0 | 221.2 | |
| iso-Propyl levulinate | $C_8H_{14}O_3$ | 48.0 | 74.5 | 88.0 | 102.4 | 118.1 | 127.8 | 141.8 | 161.6 | 185.2 | 208.2 | |
| Propyl mercaptan (1-propanethiol) | $C_3H_8S$ | −56.0 | −36.3 | −26.3 | −15.4 | −3.2 | +4.6 | 15.3 | 31.5 | 49.2 | 67.4 | −112 |
| 2-iso-Propylnaphthalene | $C_{13}H_{14}$ | 76.0 | 107.9 | 123.4 | 140.3 | 159.0 | 171.4 | 187.6 | 211.8 | 238.5 | 266.0 | |
| iso-Propyl β-naphthyl ketone | | | | | | | | | | | | |
| (2-isobutyronaphthone) | $C_{14}H_{14}O$ | 133.2 | 165.4 | 181.0 | 197.7 | 215.6 | 227.0 | 242.3 | 264.0 | 288.2 | 313.0 | |
| 2-iso-Propylphenol | $C_9H_{12}O$ | 56.6 | 83.8 | 97.0 | 111.7 | 127.5 | 137.7 | 150.3 | 170.1 | 192.6 | 214.5 | 15.5 |
| 3-iso-Propylphenol | $C_9H_{12}O$ | 62.0 | 90.3 | 104.1 | 119.8 | 136.2 | 146.6 | 160.2 | 182.0 | 205.0 | 228.0 | 26 |
| 4-iso-Propylphenol | $C_9H_{12}O$ | 67.0 | 94.7 | 108.0 | 123.4 | 139.8 | 149.7 | 163.3 | 184.0 | 206.1 | 228.2 | 61 |
| Propyl propionate | $C_6H_{12}O_2$ | −14.2 | +8.0 | 19.4 | 31.6 | 45.0 | 53.8 | 65.2 | 82.7 | 102.0 | 122.4 | −76 |
| 4-iso-Propylstyrene | $C_{11}H_{14}$ | 34.7 | 62.3 | 76.0 | 91.2 | 108.0 | 118.4 | 132.8 | 153.9 | 178.0 | 202.5 | |
| Propyl isovalerate | $C_8H_{16}O_2$ | +8.0 | 32.8 | 45.1 | 58.0 | 72.8 | 82.3 | 95.0 | 113.9 | 135.0 | 155.9 | |
| Pulegone | $C_{10}H_{16}O$ | 58.3 | 82.5 | 94.0 | 106.8 | 121.7 | 130.2 | 143.1 | 162.5 | 189.8 | 221.0 | |
| Pyridine | $C_5H_5N$ | −18.9 | +2.5 | 13.2 | 24.8 | 38.0 | 46.8 | 57.8 | 75.0 | 95.6 | 115.4 | −42 |
| Pyrocatechol | $C_6H_6O_2$ | | 104.0 | 118.3 | 134.0 | 150.6 | 161.7 | 176.0 | 197.7 | 221.5 | 245.5 | 105 |
| Pyrocaltechol diacetate | | | | | | | | | | | | |
| (1,2-phenylene diacetate) | $C_{10}H_{10}O_4$ | 98.0 | 129.8 | 145.7 | 161.8 | 179.8 | 191.6 | 206.5 | 228.7 | 253.3 | 278.0 | |
| Pyrogallol | $C_6H_6O_3$ | | 151.7 | 167.7 | 185.3 | 204.2 | 216.3 | 232.0 | 255.3 | 281.5 | 309.0 | 133 |
| Pyrotartaric anhydride | $C_5H_6O_3$ | 69.7 | 99.7 | 114.2 | 130.0 | 147.8 | 158.6 | 173.8 | 196.1 | 221.0 | 247.4 | |
| Pyruvic acid | $C_3H_4O_3$ | 21.4 | 45.8 | 57.9 | 70.8 | 85.3 | 94.1 | 106.5 | 124.7 | 144.7 | 165.0 | 13.6 |
| Quinoline | $C_9H_7N$ | 59.7 | 89.6 | 103.8 | 119.8 | 136.7 | 148.1 | 163.2 | 186.2 | 212.3 | 237.7 | −15 |
| iso-Quinoline | $C_9H_7N$ | 63.5 | 92.7 | 107.8 | 123.7 | 141.6 | 152.0 | 167.6 | 190.0 | 214.5 | 240.5 | 24.6 |
| Resorcinol | $C_6H_6O_2$ | 108.4 | 138.0 | 152.1 | 168.0 | 185.3 | 195.8 | 209.8 | 230.8 | 253.4 | 276.5 | 110.7 |
| Safrole | $C_{10}H_{10}O_2$ | 63.8 | 93.0 | 107.6 | 123.0 | 140.1 | 150.3 | 165.1 | 186.2 | 210.0 | 233.0 | 11.2 |
| Salicylaldehyde | $C_7H_6O_2$ | 33.0 | 60.1 | 73.8 | 88.7 | 105.2 | 115.7 | 129.4 | 150.0 | 173.7 | 196.5 | −7 |
| Salicylic acid | $C_7H_6O_3$ | 113.7 | 136.0 | 146.2 | 156.8 | 172.2 | 182.0 | 193.4 | 210.0 | 230.5 | 256.0 | 159 |
| Sebacic acid | $C_{10}H_{18}O_4$ | 183.0 | 215.7 | 232.0 | 250.0 | 268.2 | 279.8 | 294.5 | 313.2 | 332.8 | 352.3 | 134.5 |
| Selenophene | $C_4H_4Se$ | −39.0 | −16.0 | −4.0 | +9.1 | 24.1 | 33.8 | 47.0 | 66.7 | 89.8 | 114.3 | |
| Skatole | $C_9H_9N$ | 95.0 | 124.2 | 139.6 | 154.3 | 171.9 | 183.6 | 197.4 | 218.8 | 242.5 | 266.2 | 95 |
| Stearaldehyde | $C_{18}H_{36}O$ | 140.0 | 174.6 | 192.1 | 210.6 | 230.8 | 244.2 | 260.0 | 285.0 | 313.8 | 342.5 | 63.5 |
| Stearic acid | $C_{18}H_{36}O_2$ | 173.7 | 209.0 | 225.0 | 243.4 | 263.3 | 275.5 | 291.0 | 316.5 | 343.0 | 370.0 | 69.3 |
| Stearyl alcohol (1-octadecanol) | $C_{18}H_{36}O$ | 150.3 | 185.6 | 202.0 | 220.0 | 240.4 | 252.7 | 269.4 | 293.5 | 320.3 | 349.5 | 58.5 |
| Styrene | $C_8H_8$ | −7.0 | +18.0 | 30.8 | 44.6 | 59.8 | 69.5 | 82.0 | 101.3 | 122.5 | 145.2 | −30.6 |
| Styrene dibromide [(1,2-dibromoethyl) | | | | | | | | | | | | |
| benzene] | $C_8H_8Br_2$ | 86.0 | 115.6 | 129.8 | 145.2 | 161.8 | 172.2 | 186.3 | 207.8 | 230.0 | 254.0 | |
| Suberic acid | $C_8H_{14}O_4$ | 172.8 | 205.5 | 219.5 | 238.2 | 254.6 | 265.4 | 279.8 | 300.5 | 322.8 | 345.5 | 142 |
| Succinic anhydride | $C_4H_4O_3$ | 92.0 | 115.0 | 128.2 | 145.3 | 163.0 | 174.0 | 189.0 | 212.0 | 237.0 | 261.0 | 119.6 |
| Succinimide | $C_4H_5NO_2$ | 115.0 | 143.2 | 157.0 | 174.0 | 192.0 | 203.0 | 217.4 | 240.0 | 263.5 | 287.5 | 125.5 |
| Succinyl chloride | $C_4H_4Cl_2O_2$ | 39.0 | 65.0 | 78.0 | 91.8 | 107.5 | 117.2 | 130.0 | 149.3 | 170.0 | 192.5 | 17 |
| α-Terpineol | $C_{10}H_{18}O$ | 52.8 | 80.4 | 94.3 | 109.8 | 126.0 | 136.3 | 150.1 | 171.2 | 194.3 | 217.5 | 35 |
| Terpenoline | $C_{10}H_{16}$ | 32.3 | 58.0 | 70.6 | 84.8 | 100.0 | 109.8 | 122.7 | 142.0 | 163.5 | 185.0 | |

**TABLE 2-8 Vapor Pressures of Organic Compounds, up to 1 atm** (*Continued*)

| Compound | | Pressure, mm Hg | | | | | | | | | | Melting point, °C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 5 | 10 | 20 | 40 | 60 | 100 | 200 | 400 | 760 | |
| Name | Formula | Temperature, °C | | | | | | | | | | |
| 1,1,1,2-Tetrabromoethane | $C_2H_2Br_4$ | 58.0 | 83.3 | 95.7 | 108.5 | 123.2 | 132.0 | 144.0 | 161.5 | 181.0 | 200.0 | |
| 1,1,2,2-Tetrabromoethane | $C_2H_2Br_4$ | 65.0 | 95.5 | 110.0 | 126.0 | 144.0 | 155.1 | 170.0 | 192.5 | 217.5 | 243.5 | |
| Tetraisobutylene | $C_{16}H_{32}$ | 63.8 | 93.7 | 108.5 | 124.5 | 142.2 | 152.6 | 167.5 | 190.0 | 214.6 | 240.0 | |
| Tetracosane | $C_{24}H_{50}$ | 183.8 | 219.6 | 237.6 | 255.3 | 276.3 | 288.4 | 305.2 | 330.5 | 358.0 | 386.4 | 51.1 |
| 1,2,3,4-Tetrachlorobenzene | $C_6H_2Cl_4$ | 68.5 | 99.6 | 114.7 | 131.2 | 149.2 | 160.0 | 175.7 | 198.0 | 225.5 | 254.0 | 46.5 |
| 1,2,3,5-Tetrachlorobenzene | $C_6H_2Cl_4$ | 58.2 | 89.0 | 104.1 | 121.6 | 140.0 | 152.0 | 168.0 | 193.7 | 220.0 | 246.0 | 54.5 |
| 1,2,4,5-Tetrachlorobenzene | $C_6H_2Cl_4$ | | | | | 146.0 | 157.7 | 173.5 | 196.0 | 220.5 | 245.0 | 139 |
| 1,1,2,2-Tetrachloro-1,2-difluoroethane | $C_2Cl_4F_2$ | −37.5 | −16.0 | −5.0 | +6.7 | 19.8 | 28.1 | 38.6 | 55.0 | 73.1 | 92.0 | 26.5 |
| 1,1,1,2-Tetrachloroethane | $C_2H_2Cl_4$ | −16.3 | +7.4 | 19.3 | 32.1 | 46.7 | 56.0 | 68.0 | 87.2 | 108.2 | 130.5 | −68.7 |
| 1,1,2,2-Tetrachloroethane | $C_2H_2Cl_4$ | −3.8 | +20.7 | 33.0 | 46.2 | 60.8 | 70.0 | 83.2 | 102.2 | 124.0 | 145.9 | −36 |
| 1,2,3,5-Tetrachloro-4-ethylbenzene | $C_8H_6Cl_4$ | 77.0 | 110.0 | 126.0 | 143.7 | 162.1 | 175.0 | 191.6 | 215.3 | 243.0 | 270.0 | |
| Tetrachloroethylene | $C_2Cl_4$ | −20.6 | +2.4 | 13.8 | 26.3 | 40.1 | 49.2 | 61.3 | 79.8 | 100.0 | 120.8 | −19.0 |
| 2,3,4,6-Tetrachlorophenol | $C_6H_2Cl_4O$ | 100.0 | 130.3 | 145.3 | 161.0 | 179.1 | 190.0 | 205.2 | 227.2 | 250.4 | 275.0 | 69.5 |
| 3,4,5,6-Tetrachloro-1,2-xylene | $C_8H_6Cl_4$ | 94.4 | 125.0 | 140.3 | 156.0 | 174.2 | 185.8 | 200.5 | 223.0 | 248.3 | 273.5 | |
| Tetradecane | $C_{14}H_{30}$ | 76.4 | 106.0 | 120.7 | 135.6 | 152.7 | 164.0 | 178.5 | 201.8 | 226.8 | 252.5 | 5.5 |
| Tetradecylamine | $C_{14}H_{31}N$ | 102.6 | 135.8 | 152.0 | 170.0 | 189.0 | 200.2 | 215.7 | 239.8 | 264.6 | 291.2 | |
| Tetradecyltrimethylsilane | $C_{17}H_{38}Si$ | 120.0 | 150.7 | 166.2 | 183.5 | 201.5 | 213.3 | 227.8 | 250.0 | 275.0 | 300.0 | |
| Tetraethoxysilane | $C_8H_{20}O_4Si$ | 16.0 | 40.3 | 52.6 | 65.8 | 81.1 | 90.7 | 103.6 | 123.5 | 146.2 | 168.5 | |
| 1,2,3,4-Tetraethylbenzene | $C_{14}H_{22}$ | 65.7 | 96.2 | 111.6 | 127.7 | 145.8 | 156.7 | 172.4 | 196.0 | 221.4 | 248.0 | 11.6 |
| Tetraethylene glycol | $C_8H_{18}O_5$ | 153.9 | 183.7 | 197.1 | 212.3 | 228.0 | 237.8 | 250.0 | 268.4 | 288.0 | 307.8 | |
| Tetraethylene glycol chlorohydrin | $C_8H_{17}ClO_4$ | 110.1 | 141.8 | 156.1 | 172.6 | 190.0 | 200.5 | 214.7 | 236.5 | 258.2 | 281.5 | |
| Tetraethyllead | $C_8H_{20}Pb$ | 38.4 | 63.6 | 74.8 | 88.0 | 102.4 | 111.7 | 123.8 | 142.0 | 161.8 | 183.0 | −136 |
| Tetraethylsilane | $C_8H_{20}Si$ | −1.0 | +23.9 | 36.3 | 50.0 | 65.3 | 74.8 | 88.0 | 108.0 | 130.2 | 153.0 | |
| Tetralin | $C_{10}H_{12}$ | 38.0 | 65.3 | 79.0 | 93.8 | 110.4 | 121.3 | 135.3 | 157.2 | 181.8 | 207.2 | −31.0 |
| 1,2,3,4-Tetramethylbenzene | $C_{10}H_{14}$ | 42.6 | 68.7 | 81.8 | 95.8 | 111.5 | 121.8 | 135.7 | 155.7 | 180.0 | 204.4 | −6.2 |
| 1,2,3,5-Tetramethylbenzene | $C_{10}H_{14}$ | 40.6 | 65.8 | 77.8 | 91.0 | 105.8 | 115.4 | 128.3 | 149.9 | 173.7 | 197.9 | −24.0 |
| 1,2,4,5-Tetramethylbenzene | $C_{10}H_{14}$ | 45.0 | 65.0 | 74.6 | 88.0 | 104.2 | 114.8 | 128.1 | 149.5 | 172.1 | 195.9 | 79.5 |
| 2,2,3,3-Tetramethylbutane | $C_8H_{18}$ | −17.4 | +3.2 | 13.5 | 24.6 | 36.8 | 44.5 | 54.8 | 70.2 | 87.4 | 106.3 | −102.2 |
| Tetramethylene dibromide (1,4-dibromobutane) | $C_4H_8Br_2$ | 32.0 | 58.8 | 72.4 | 87.6 | 104.0 | 115.1 | 128.7 | 149.8 | 173.8 | 197.5 | −20 |
| Tetramethyllead | $C_4H_{12}Pb$ | −29.0 | −6.8 | +4.4 | 16.6 | 30.3 | 39.2 | 50.8 | 68.8 | 89.0 | 110.0 | −27.5 |
| Tetramethyltin | $C_4H_{12}Sn$ | −51.3 | −31.0 | −20.6 | −9.3 | +3.5 | 11.7 | 22.8 | 39.8 | 58.5 | 78.0 | |
| Tetrapropylene glycol monoisopropyl ether | $C_{15}H_{32}O_5$ | 116.6 | 147.8 | 163.0 | 179.8 | 197.7 | 209.0 | 223.3 | 245.0 | 268.3 | 292.7 | |
| Thioacetic acid (mercaptoacetic acid) | $C_2H_4O_2S$ | 60.0 | 87.7 | 101.5 | 115.8 | 131.8 | 142.0 | 154.0 | | | | −16.5 |
| Thiodiglycol (2,2′-thiodiethanol) | $C_4H_{10}O_2S$ | 42.0 | 96.0 | 128.0 | 165.0 | 210.0 | 240.5 | 285 | | | | |
| Thiophene | $C_4H_4S$ | −40.7 | −20.8 | −10.9 | 0.0 | +12.5 | 20.1 | 30.5 | 46.5 | 64.7 | 84.4 | −38.3 |
| Thiophenol (benzenethiol) | $C_6H_6S$ | 18.6 | 43.7 | 56.0 | 69.7 | 84.2 | 93.9 | 106.6 | 125.8 | 146.7 | 168.0 | |
| α-Thujone | $C_{10}H_{16}O$ | 38.3 | 65.7 | 79.3 | 93.7 | 110.0 | 120.2 | 134.0 | 154.2 | 177.8 | 201.0 | |
| Thymol | $C_{10}H_{14}O$ | 64.3 | 92.8 | 107.4 | 122.6 | 139.8 | 149.8 | 164.1 | 185.5 | 209.2 | 231.8 | 51.5 |
| Tiglaldehyde | $C_5H_8O$ | −25.0 | −1.6 | +10.0 | 23.2 | 37.0 | 45.8 | 57.7 | 75.4 | 95.5 | 116.4 | |
| Tiglic acid | $C_5H_8O_2$ | 52.0 | 77.8 | 90.2 | 103.8 | 119.0 | 127.8 | 140.5 | 158.0 | 179.2 | 198.5 | 64.5 |
| Tiglonitrile | $C_5H_7N$ | −25.5 | −2.4 | +9.2 | 22.1 | 36.7 | 46.0 | 58.2 | 77.8 | 99.7 | 122.0 | |
| Toluene | $C_7H_8$ | −26.7 | −4.4 | +6.4 | 18.4 | 31.8 | 40.3 | 51.9 | 69.5 | 89.5 | 110.6 | −95.0 |
| Toluene-2,4-diamine | $C_7H_{10}N_2$ | 106.5 | 137.2 | 151.7 | 167.9 | 185.7 | 196.2 | 211.5 | 232.8 | 256.0 | 280.0 | 99 |
| 2-Toluic nitrile (2-tolunitrile) | $C_8H_7N$ | 36.7 | 64.0 | 77.9 | 93.0 | 110.0 | 120.8 | 135.0 | 156.0 | 180.0 | 205.2 | −13 |
| 4-Toluic nitrile (4-tolunitrile) | $C_8H_7N$ | 42.5 | 71.3 | 85.8 | 101.7 | 109.5 | 130.0 | 145.2 | 167.3 | 193.0 | 217.6 | 29.5 |
| 2-Toluidine | $C_7H_9N$ | 44.0 | 69.3 | 81.4 | 95.1 | 110.0 | 119.8 | 133.0 | 153.0 | 176.2 | 199.7 | −16.3 |
| 3-Toluidine | $C_7H_9N$ | 41.0 | 68.0 | 82.0 | 96.7 | 113.5 | 123.8 | 136.7 | 157.6 | 180.6 | 203.3 | −31.5 |
| 4-Toluidine | $C_7H_9N$ | 42.0 | 68.2 | 81.8 | 95.8 | 111.5 | 121.5 | 133.7 | 154.0 | 176.9 | 200.4 | 44.5 |
| 2-Tolyl isocyanide | $C_8H_7N$ | 25.2 | 51.0 | 64.0 | 78.2 | 94.0 | 104.0 | 117.7 | 137.8 | 159.9 | 183.5 | |
| 4-Tolylhydrazine | $C_7H_{10}N_2$ | 82.4 | 110.0 | 123.8 | 138.6 | 154.1 | 165.0 | 178.0 | 198.0 | 219.5 | 242.0 | 65.5 |
| Tribromoacetaldehyde | $C_2HBr_3O$ | 18.5 | 45.0 | 58.0 | 72.1 | 87.8 | 97.5 | 110.2 | 130.0 | 151.6 | 174.0 | |
| 1,1,2-Tribromobutane | $C_4H_7Br_3$ | 45.0 | 73.5 | 87.8 | 103.2 | 120.2 | 131.6 | 146.0 | 167.8 | 192.0 | 216.2 | |
| 1,2,2-Tribromobutane | $C_4H_7Br_3$ | 41.0 | 69.0 | 83.2 | 98.6 | 116.0 | 127.0 | 141.8 | 163.5 | 188.0 | 213.8 | |
| 2,2,3-Tribromobutane | $C_4H_7Br_3$ | 38.2 | 66.0 | 79.8 | 94.6 | 111.8 | 122.2 | 136.3 | 157.8 | 182.2 | 206.5 | |
| 1,1,2-Tribromoethane | $C_2H_3Br_3$ | 32.6 | 58.0 | 70.6 | 84.2 | 100.0 | 110.0 | 123.5 | 143.5 | 165.4 | 188.4 | −26 |
| 1,2,3-Tribromopropane | $C_3H_5Br_3$ | 47.5 | 75.8 | 90.0 | 105.8 | 122.8 | 134.0 | 148.0 | 170.0 | 195.0 | 220.0 | 16.5 |
| Triisobutylamine | $C_{12}H_{27}N$ | 32.3 | 57.4 | 69.8 | 83.0 | 97.8 | 107.3 | 119.7 | 138.0 | 157.8 | 179.0 | −22 |
| Triisobutylene | $C_{12}H_{24}$ | 18.0 | 44.0 | 56.5 | 70.0 | 86.7 | 96.7 | 110.0 | 130.2 | 153.0 | 179.0 | |
| 2,4,6-Tritertbutylphenol | $C_{18}H_{30}O$ | 95.2 | 126.1 | 142.0 | 158.0 | 177.4 | 188.0 | 203.0 | 226.2 | 250.6 | 276.3 | |
| Trichloroacetic acid | $C_2HCl_3O_2$ | 51.0 | 76.0 | 88.2 | 101.8 | 116.3 | 125.9 | 137.8 | 155.4 | 175.2 | 195.6 | 57 |
| Trichloroacetic anhydride | $C_4Cl_6O_3$ | 56.2 | 85.3 | 99.6 | 114.3 | 131.2 | 141.8 | 155.2 | 176.2 | 199.8 | 223.0 | |
| Trichloroacetyl bromide | $C_2BrCl_3O$ | −7.4 | +16.7 | 29.3 | 42.1 | 57.2 | 66.7 | 79.5 | 98.4 | 120.2 | 143.0 | |
| 2,4,6-Trichloroaniline | $C_6H_4Cl_3N$ | 134.0 | 157.8 | 170.0 | 182.6 | 195.8 | 204.5 | 214.6 | 229.8 | 246.4 | 262.0 | 78 |
| 1,2,3-Trichlorobenzene | $C_6H_3Cl_3$ | 40.0 | 70.0 | 85.6 | 101.8 | 119.8 | 131.5 | 146.0 | 168.2 | 193.5 | 218.5 | 52.5 |
| 1,2,4-Trichlorobenzene | $C_6H_3Cl_3$ | 38.4 | 67.3 | 81.7 | 97.2 | 114.8 | 125.7 | 140.0 | 162.0 | 187.7 | 213.0 | 17 |
| 1,3,5-Trichlorobenzene | $C_6H_3Cl_3$ | | 63.8 | 78.0 | 93.7 | 110.8 | 121.8 | 136.0 | 157.7 | 183.0 | 208.4 | 63.5 |
| 1,2,3-Trichlorobutane | $C_4H_7Cl_3$ | +0.5 | 27.2 | 40.0 | 55.0 | 71.5 | 82.0 | 96.2 | 118.0 | 143.0 | 169.0 | |
| 1,1,1-Trichloroethane | $C_2H_3Cl_3$ | −52.0 | −32.0 | −21.9 | −10.8 | +1.6 | 9.5 | 20.0 | 36.2 | 54.6 | 74.1 | −30.6 |
| 1,1,2-Trichloroethane | $C_2H_3Cl_3$ | −24.0 | −2.0 | +8.3 | 21.6 | 35.2 | 44.0 | 55.7 | 73.3 | 93.0 | 113.9 | −36.7 |
| Trichloroethylene | $C_2HCl_3$ | −43.8 | −22.8 | −12.4 | −1.0 | +11.9 | 20.0 | 31.4 | 48.0 | 67.0 | 86.7 | −73 |
| Trichlorofluoromethane | $CCl_3F$ | −84.3 | −67.6 | −59.0 | −49.7 | −39.0 | −32.3 | −23.0 | −9.1 | +6.8 | 23.7 | |
| 2,4,5-Trichlorophenol | $C_6H_3Cl_3O$ | 72.0 | 102.1 | 117.3 | 134.0 | 151.5 | 162.5 | 178.0 | 201.5 | 226.5 | 251.8 | 62 |
| 2,4,6-Trichlorophenol | $C_6H_3Cl_3O$ | 76.5 | 105.9 | 120.2 | 135.8 | 152.2 | 163.5 | 177.8 | 199.0 | 222.5 | 246.0 | 68.5 |

**TABLE 2-8 Vapor Pressures of Organic Compounds, up to 1 atm** (*Concluded*)

| Compound | | Pressure, mm Hg | | | | | | | | | | Melting point, °C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 5 | 10 | 20 | 40 | 60 | 100 | 200 | 400 | 760 | |
| Name | Formula | Temperature, °C | | | | | | | | | | |
| Tri-2-chlorophenylthiophosphate | $C_{18}H_{12}Cl_3O_3PS$ | 188.2 | 217.2 | 231.2 | 246.7 | 261.7 | 271.5 | 283.8 | 302.8 | 322.0 | 341.3 | |
| 1,1,1-Trichloropropane | $C_3H_5Cl_3$ | −28.8 | −7.0 | +4.2 | 16.2 | 29.9 | 38.3 | 50.0 | 67.7 | 87.5 | 108.2 | −77.7 |
| 1,2,3-Trichloropropane | $C_3H_5Cl_3$ | +9.0 | 33.7 | 46.0 | 59.3 | 74.0 | 83.6 | 96.1 | 115.6 | 137.0 | 158.0 | −14.7 |
| 1,1,2-Trichloro-1,2,2-trifluoroethane | $C_2Cl_3F_3$ | −68.0 | −49.4 | −40.3 | −30.0 | −18.5 | −11.2 | −1.7 | +13.5 | 30.2 | 47.6 | −35 |
| Tricosane | $C_{23}H_{48}$ | 170.0 | 206.3 | 223.0 | 242.0 | 261.3 | 273.8 | 289.8 | 313.5 | 339.8 | 366.5 | 47.7 |
| Tridecane | $C_{13}H_{28}$ | 59.4 | 98.3 | 104.0 | 120.2 | 137.7 | 148.2 | 162.5 | 185.0 | 209.4 | 234.0 | −6.2 |
| Tridecanoic acid | $C_{13}H_{26}O_2$ | 137.8 | 166.3 | 181.0 | 195.8 | 212.4 | 222.0 | 236.0 | 255.2 | 276.5 | 299.0 | 41 |
| Triethoxymethylsilane | $C_7H_{18}O_3Si$ | −1.5 | +22.8 | 34.6 | 47.2 | 61.7 | 70.4 | 82.7 | 101.0 | 121.8 | 143.5 | |
| Triethoxyphenylsilane | $C_{12}H_{20}O_3Si$ | 71.0 | 98.8 | 112.6 | 127.2 | 143.5 | 153.2 | 167.5 | 188.0 | 210.5 | 233.5 | |
| 1,2,4-Triethylbenzene | $C_{12}H_{18}$ | 46.0 | 74.2 | 88.5 | 104.0 | 121.7 | 132.2 | 146.8 | 168.3 | 193.7 | 218.0 | |
| 1,3,4-Triethylbenzene | $C_{12}H_{18}$ | 47.9 | 76.0 | 90.2 | 105.8 | 122.6 | 133.4 | 147.7 | 168.3 | 193.2 | 217.5 | |
| Triethylborine | $C_6H_{15}B$ | | | −148.0 | −140.6 | −131.4 | −125.2 | −116.0 | −101.0 | −81.0 | −56.2 | |
| Triethyl camphoronate | $C_{15}H_{26}O_6$ | | 150.2 | 166.0 | 183.6 | 201.8 | 213.5 | 228.6 | 250.8 | 276.0 | 301.0 | 135 |
| citrate | $C_{12}H_{20}O_7$ | 107.0 | 138.7 | 144.0 | 171.1 | 190.4 | 202.5 | 217.8 | 242.2 | 267.5 | 294.0 | |
| Triethyleneglycol | $C_6H_{14}O_4$ | 114.0 | 144.0 | 158.1 | 174.0 | 191.3 | 201.5 | 214.6 | 235.2 | 256.6 | 278.3 | |
| Triethylheptylsilane | $C_{13}H_{30}Si$ | 70.0 | 99.8 | 114.6 | 130.3 | 148.0 | 158.2 | 174.0 | 196.0 | 221.0 | 247.0 | |
| Triethyloctylsilane | $C_{14}H_{32}Si$ | 73.7 | 104.8 | 120.6 | 137.7 | 155.7 | 168.0 | 184.3 | 208.0 | 235.0 | 262.0 | |
| Triethyl orthoformate | $C_7H_{16}O_3$ | +5.5 | 29.2 | 40.5 | 53.4 | 67.5 | 76.0 | 88.0 | 106.0 | 125.7 | 146.0 | |
| phosphate | $C_6H_{15}O_4P$ | 39.6 | 67.8 | 82.1 | 97.8 | 115.7 | 126.3 | 141.6 | 163.7 | 187.0 | 211.0 | |
| Triethylthallium | $C_6H_{15}Tl$ | +9.3 | 37.6 | 51.7 | 67.7 | 85.4 | 95.7 | 112.1 | 136.0 | 163.5 | 192.1 | −63.0 |
| Trifluorophenylsilane | $C_6H_5F_3Si$ | −31.0 | −9.7 | +0.8 | 12.3 | 25.4 | 33.2 | 44.2 | 60.1 | 78.7 | 98.3 | |
| Trimethallyl phosphate | $C_{12}H_{21}PO_4$ | 93.7 | 131.0 | 149.8 | 169.8 | 192.0 | 207.0 | 225.7 | 255.0 | 288.5 | 324.0 | |
| 2,3,5-Trimethylacetophenone | $C_{11}H_{14}O$ | 79.0 | 108.0 | 122.3 | 137.5 | 154.2 | 165.7 | 179.7 | 201.3 | 224.3 | 247.5 | |
| Trimethylamine | $C_3H_9N$ | −97.1 | −81.7 | −73.8 | −65.0 | −55.2 | −48.8 | −40.3 | −27.0 | −12.5 | +2.9 | −117.1 |
| 2,4,5-Trimethylaniline | $C_9H_{13}N$ | 68.4 | 95.9 | 109.0 | 123.7 | 139.8 | 149.5 | 162.0 | 182.3 | 203.7 | 234.5 | 67 |
| 1,2,3-Trimethylbenzene | $C_9H_{12}$ | 16.8 | 42.9 | 55.9 | 69.9 | 85.4 | 95.3 | 108.8 | 129.0 | 152.0 | 176.1 | −25.5 |
| 1,2,4-Trimethylbenzene | $C_9H_{12}$ | 13.6 | 38.3 | 50.7 | 64.5 | 79.8 | 89.5 | 102.8 | 122.7 | 145.4 | 169.2 | −44.1 |
| 1,3,5-Trimethylbenzene | $C_9H_{12}$ | 9.6 | 34.7 | 47.4 | 61.0 | 76.1 | 85.8 | 98.9 | 118.6 | 141.0 | 164.7 | −44.8 |
| 2,2,3-Trimethylbutane | $C_7H_{16}$ | | | −18.8 | −7.5 | +5.2 | 13.3 | 24.4 | 41.2 | 60.4 | 80.9 | −25.0 |
| Trimethyl citrate | $C_9H_{14}O_7$ | 106.2 | 146.2 | 160.4 | 177.2 | 194.2 | 205.5 | 219.6 | 241.3 | 264.2 | 287.0 | 78.5 |
| Trimethyleneglycol (1,3-propanediol) | $C_3H_8O_2$ | 59.4 | 87.2 | 100.6 | 115.5 | 131.0 | 141.1 | 153.4 | 172.8 | 193.8 | 214.2 | |
| 1,2,4-Trimethyl-5-ethylbenzene | $C_{11}H_{16}$ | 43.7 | 71.2 | 84.6 | 99.7 | 106.0 | 126.3 | 140.3 | 160.3 | 184.5 | 208.1 | |
| 1,3,5-Trimethyl-2-ethylbenzene | $C_{11}H_{16}$ | 38.8 | 67.0 | 80.5 | 96.0 | 113.2 | 123.8 | 137.9 | 158.4 | 183.5 | 208.0 | |
| 2,2,3-Trimethylpentane | $C_8H_{18}$ | −29.0 | −7.1 | +3.9 | 16.0 | 29.5 | 38.1 | 49.9 | 67.8 | 88.2 | 109.8 | −112.3 |
| 2,2,4-Trimethylpentane | $C_8H_{18}$ | −36.5 | −15.0 | −4.3 | +7.5 | 20.7 | 29.1 | 40.7 | 58.1 | 78.0 | 99.2 | −107.3 |
| 2,3,3-Trimethylpentane | $C_8H_{18}$ | −25.8 | −3.9 | +6.9 | 19.2 | 33.0 | 41.8 | 53.8 | 72.0 | 92.7 | 114.8 | −101.5 |
| 2,3,4-Trimethylpentane | $C_8H_{18}$ | −26.3 | −4.1 | +7.1 | 19.3 | 32.9 | 41.6 | 53.4 | 71.3 | 91.8 | 113.5 | −109.2 |
| 2,2,4-Trimethyl-3-pentanone | $C_8H_{16}O$ | 14.7 | 36.0 | 46.4 | 57.6 | 69.8 | 77.3 | 87.6 | 102.2 | 118.4 | 135.0 | |
| Trimethyl phosphate | $C_3H_9O_4P$ | 26.0 | 53.7 | 67.8 | 83.0 | 100.0 | 110.0 | 124.0 | 145.0 | 167.8 | 192.7 | |
| 2,4,5-Trimethylstyrene | $C_{11}H_{14}$ | 48.1 | 77.0 | 91.6 | 107.1 | 124.2 | 135.5 | 149.8 | 171.8 | 196.1 | 221.2 | |
| 2,4,6-Trimethylstyrene | $C_{11}H_{14}$ | 37.5 | 65.7 | 79.7 | 94.8 | 111.8 | 122.3 | 136.8 | 157.8 | 182.3 | 207.0 | |
| Trimethylsuccinic anhydride | $C_7H_{10}O_3$ | 53.5 | 82.6 | 97.4 | 113.8 | 131.0 | 142.2 | 156.5 | 179.8 | 205.5 | 231.0 | |
| Triphenylmethane | $C_{19}H_{16}$ | 169.7 | 188.4 | 197.0 | 206.8 | 215.5 | 221.2 | 228.4 | 239.7 | 249.8 | 259.2 | 93.4 |
| Triphenylphosphate | $C_{18}H_{15}O_4P$ | 193.5 | 230.4 | 249.8 | 269.7 | 290.3 | 305.2 | 322.5 | 349.8 | 379.2 | 413.5 | 49.4 |
| Tripropyleneglycol | $C_9H_{20}O_4$ | 96.0 | 125.7 | 140.5 | 155.8 | 173.7 | 184.6 | 199.0 | 220.2 | 244.3 | 267.2 | |
| Tripropyleneglycol monobutyl ether | $C_{13}H_{28}O_4$ | 101.5 | 131.6 | 147.0 | 161.8 | 179.8 | 190.2 | 204.4 | 224.4 | 247.0 | 269.5 | |
| Tripropyleneglycol monoisopropyl ether | $C_{12}H_{26}O_4$ | 82.4 | 112.4 | 127.3 | 143.7 | 161.4 | 173.2 | 187.8 | 209.7 | 232.8 | 256.6 | |
| Tritolyl phosphate | $C_{21}H_{21}O_4P$ | 154.6 | 184.2 | 198.0 | 213.2 | 229.7 | 239.8 | 252.2 | 271.8 | 292.7 | 313.0 | |
| Undecane | $C_{11}H_{24}$ | 32.7 | 59.7 | 73.9 | 85.6 | 104.4 | 115.2 | 128.1 | 149.3 | 171.9 | 195.8 | −25.6 |
| Undecanoic acid | $C_{11}H_{22}O_2$ | 101.4 | 133.1 | 149.0 | 166.0 | 185.6 | 197.2 | 212.5 | 237.8 | 262.8 | 290.0 | 29.5 |
| 10-Undecenoic acid | $C_{11}H_{20}O_2$ | 114.0 | 142.8 | 156.3 | 172.0 | 188.7 | 199.5 | 213.5 | 232.8 | 254.0 | 275.0 | 24.5 |
| Undecan-2-ol | $C_{11}H_{24}O$ | 71.1 | 99.0 | 112.8 | 127.5 | 143.7 | 153.7 | 167.2 | 187.7 | 209.8 | 232.0 | |
| *n*-Valeric acid | $C_5H_{10}O_2$ | 42.2 | 67.7 | 79.8 | 93.1 | 107.8 | 116.6 | 128.3 | 146.0 | 165.0 | 184.4 | −34.5 |
| iso-Valeric acid | $C_5H_{10}O_2$ | 34.5 | 59.6 | 71.3 | 84.0 | 98.0 | 107.3 | 118.9 | 136.2 | 155.2 | 175.1 | −37.6 |
| γ-Valerolactone | $C_5H_8O_2$ | 37.5 | 65.8 | 79.8 | 95.2 | 101.9 | 122.4 | 136.5 | 157.7 | 182.3 | 207.5 | |
| Valeronitrile | $C_5H_9N$ | −6.0 | +18.1 | 30.0 | 43.3 | 57.8 | 66.9 | 78.6 | 97.7 | 118.7 | 140.8 | |
| Vanillin | $C_8H_8O_3$ | 107.0 | 138.4 | 154.0 | 170.5 | 188.7 | 199.8 | 214.5 | 237.3 | 260.0 | 285.0 | 81.5 |
| Vinyl acetate | $C_4H_6O_2$ | −48.0 | −28.0 | −18.0 | −7.0 | +5.3 | 13.0 | 23.3 | 38.4 | 55.5 | 72.5 | |
| 2-Vinylanisole | $C_9H_{10}O$ | 41.9 | 68.0 | 81.0 | 94.7 | 110.0 | 119.8 | 132.3 | 151.0 | 172.1 | 194.0 | |
| 3-Vinylanisole | $C_9H_{10}O$ | 43.4 | 69.9 | 83.0 | 97.2 | 112.5 | 122.3 | 135.3 | 154.0 | 175.8 | 197.5 | |
| 4-Vinylanisole | $C_9H_{10}O$ | 45.2 | 72.0 | 85.7 | 100.0 | 116.0 | 126.1 | 139.7 | 159.0 | 182.0 | 204.5 | |
| Vinyl chloride (1-chloroethylene) | $C_2H_3Cl$ | −105.6 | −90.8 | −83.7 | −75.7 | −66.8 | −61.1 | −53.2 | −41.3 | −28.0 | −13.8 | −153.7 |
| cyanide (acrylonitrile) | $C_3H_3N$ | −51.0 | −30.7 | −20.3 | −9.0 | +3.8 | 11.8 | 22.8 | 38.7 | 58.3 | 78.5 | −82 |
| fluoride (1-fluoroethylene) | $C_2H_3F$ | −149.3 | −138.0 | −132.2 | −125.4 | −118.0 | −113.0 | −106.2 | −95.4 | −84.0 | −72.2 | −160.5 |
| Vinylidene chloride (1,1-dichloroethene) | $C_2H_2Cl_2$ | −77.2 | −60.0 | −51.2 | −41.7 | −31.1 | −24.0 | −15.0 | −1.0 | +14.8 | 31.7 | −122.5 |
| 4-Vinylphenetole | $C_{10}H_{12}O$ | 64.0 | 91.7 | 105.6 | 120.3 | 136.3 | 146.4 | 159.8 | 180.0 | 202.8 | 225.0 | |
| 2-Xenyl dichlorophosphate | $C_{12}H_9Cl_2PO$ | 138.2 | 171.1 | 187.0 | 205.0 | 223.8 | 236.0 | 251.5 | 275.3 | 301.5 | 328.5 | |
| 2,4-Xyaldehyde | $C_9H_{10}O$ | 59.0 | 85.9 | 99.0 | 114.0 | 129.7 | 139.8 | 152.2 | 172.3 | 194.1 | 215.5 | 75 |
| 2-Xylene (2-xylene) | $C_8H_{10}$ | −3.8 | +20.2 | 32.1 | 45.1 | 59.5 | 68.8 | 81.3 | 100.2 | 121.7 | 144.4 | −25.2 |
| 3-Xylene (3-xylene) | $C_8H_{10}$ | −6.9 | +16.8 | 28.3 | 41.1 | 55.3 | 64.4 | 76.8 | 95.5 | 116.7 | 139.1 | −47.9 |
| 4-Xylene (4-xylene) | $C_8H_{10}$ | −8.1 | +15.5 | 27.3 | 40.1 | 54.4 | 63.5 | 75.9 | 94.6 | 115.9 | 138.3 | +13.3 |
| 2,4-Xylidine | $C_8H_{11}N$ | 52.6 | 79.8 | 93.0 | 107.6 | 123.8 | 133.7 | 146.8 | 166.4 | 188.3 | 211.5 | |
| 2,6-Xylidine | $C_8H_{11}N$ | 44.0 | 72.6 | 87.0 | 102.7 | 120.2 | 131.5 | 146.0 | 168.0 | 193.7 | 217.9 | |

# VAPOR PRESSURES OF SOLUTIONS

## UNITS CONVERSIONS

For this subsection, the following units conversions are applicable:

$$°F = \tfrac{9}{5}°C + 32.$$

To convert millimeters of mercury to pounds-force per square inch, multiply by 0.01934.

To convert cubic feet to cubic meters, multiply by 0.02832.

To convert bars to pounds-force per square inch, multiply by 14.504.

To convert bars to kilopascals, multiply by $1 \times 10^2$.

### TABLE 2-9 Partial Pressures of Water over Aqueous Solutions of HCl*

$\log_{10} p\text{mm} = A - B/T$, ($T$ in $K$), which, however, agrees only approximately with the table. The table is more nearly correct.

Partial pressure of $H_2O$, mmHg, °C

| % HCl | $A$ | $B$ | 0° | 5° | 10° | 15° | 20° | 25° | 30° | 35° | 40° | 45° | 50° | 60° | 70° | 80° | 90° | 100° | 110° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 8.99156 | 2282 | 4.18 | 6.04 | 8.45 | 11.7 | 15.9 | 21.8 | 29.1 | 39.4 | 50.6 | 66.2 | 86.0 | 139 | 220 | 333 | 492 | 715 | |
| 10 | 8.99864 | 2295 | 3.84 | 5.52 | 7.70 | 10.7 | 14.6 | 20.0 | 26.8 | 35.5 | 47.0 | 61.5 | 80.0 | 130 | 204 | 310 | 463 | 677 | 960 |
| 14 | 8.97075 | 2300 | 3.39 | 4.91 | 6.95 | 9.65 | 13.1 | 18.0 | 24.1 | 31.9 | 42.1 | 55.3 | 72.0 | 116 | 185 | 273 | 425 | 625 | 892 |
| 18 | 8.98014 | 2323 | 2.87 | 4.21 | 5.92 | 8.26 | 11.3 | 15.4 | 20.6 | 27.5 | 36.4 | 47.9 | 62.5 | 102 | 162 | 248 | 374 | 550 | 783 |
| 20 | 8.97877 | 2334 | 2.62 | 3.83 | 5.40 | 7.50 | 10.3 | 14.1 | 19.0 | 25.1 | 33.3 | 43.6 | 57.0 | 93.5 | 150 | 230 | 345 | 510 | 729 |
| 22 | 9.02708 | 2363 | 2.33 | 3.40 | 4.82 | 6.75 | 9.30 | 12.6 | 17.1 | 22.8 | 30.2 | 39.8 | 52.0 | 85.6 | 138 | 211 | 317 | 467 | 670 |
| 24 | 8.96022 | 2356 | 2.05 | 3.04 | 4.31 | 6.03 | 8.30 | 11.4 | 15.4 | 20.4 | 27.1 | 35.7 | 46.7 | 77.0 | 124 | 194 | 290 | 426 | 611 |
| 26 | 9.01511 | 2390 | 1.76 | 2.60 | 3.71 | 5.21 | 7.21 | 9.95 | 13.5 | 18.0 | 24.0 | 31.7 | 41.5 | 69.0 | 112 | 173 | 261 | 387 | 555 |
| 28 | 8.97611 | 2395 | 1.50 | 2.24 | 3.21 | 4.54 | 6.32 | 8.75 | 11.8 | 15.8 | 21.1 | 27.9 | 36.5 | 60.7 | 99.0 | 154 | 234 | 349 | 499 |
| 30 | 9.00117 | 2422 | 1.26 | 1.90 | 2.73 | 3.88 | 5.41 | 7.52 | 10.2 | 13.7 | 18.4 | 24.3 | 32.0 | 53.5 | 87.5 | 136 | 207 | 310 | 444 |
| 32 | 9.03317 | 2453 | 1.04 | 1.57 | 2.27 | 3.25 | 4.55 | 6.37 | 8.70 | 11.7 | 15.7 | 21.0 | 27.7 | 46.5 | 76.5 | 120 | 184 | 275 | 396 |
| 34 | 9.07143 | 2487 | 0.85 | 1.29 | 1.87 | 2.70 | 3.81 | 5.35 | 7.32 | 9.95 | 13.5 | 18.1 | 24.0 | 40.5 | 66.5 | 104 | 161 | 243 | 355 |
| 36 | 9.11815 | 2526 | 0.68 | 1.03 | 1.50 | 2.19 | 3.10 | 4.41 | 6.08 | 8.33 | 11.4 | 15.4 | 20.4 | 34.8 | 57.0 | 90.0 | 140 | 212 | 311 |
| 38 | 9.20783 | 2579 | 0.53 | 0.81 | 1.20 | 1.75 | 2.51 | 3.60 | 5.03 | 6.92 | 9.52 | 13.0 | 17.4 | 29.6 | 49.1 | 77.5 | 120 | 182 | 266 |
| 40 | 9.33923 | 2647 | 0.41 | 0.63 | 0.94 | 1.37 | 2.00 | 2.88 | 4.09 | 5.68 | 7.85 | 10.7 | 14.5 | 25.0 | 42.1 | 67.3 | 105 | 158 | 230 |
| 42 | 9.44953 | 2709 | 0.31 | 0.48 | 0.72 | 1.06 | 1.56 | 2.30 | 3.28 | 4.60 | 6.45 | 8.90 | 12.1 | 21.2 | 35.8 | 57.2 | 89.2 | 135 | 195 |

*Accuracy, ca. 2 percent for solutions of 15 to 30 percent HCl between 0 and 100°; for solutions of > 30 percent HCl the accuracy is ca. 5 percent at the lower temperatures and ca. 15 percent at the higher temperatures. Below 15 percent HCl, the accuracy is ca. 5 percent at the lower temperatures and higher strengths to ca. 15 to 20 percent at the lower strengths and perhaps 15 to 20 percent at the higher temperatures and lower strengths.

### TABLE 2-10 Partial Pressures of HCl over Aqueous Solutions of HCl*

$\log_{10} p\text{mm} = A - B/T$, ($T$ in $K$), which, however, agrees only approximately with the table. The table is more nearly correct. mmHg, °C

| % HCl | $A$ | $B$ | 0° | 5° | 10° | 15° | 20° | 25° | 30° | 35° | 40° | 45° | 50° | 60° | 70° | 80° | 90° | 100° | 110° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 11.8037 | 4736 | | | 0.0000117 | 0.000023 | 0.000044 | 0.000084 | 0.000151 | 0.000275 | 0.00047 | 0.00083 | 0.00140 | 0.00380 | 0.0100 | 0.0245 | 0.058 | 0.132 | 0.280 |
| 4 | 11.6400 | 4471 | 0.000018 | 0.000036 | .000069 | .000131 | .00024 | .00044 | .00077 | .00134 | .0023 | .00385 | .0064 | .0165 | .0405 | .095 | .21 | .46 | .93 |
| 6 | 11.2144 | 4202 | .000066 | .000125 | .000234 | .000425 | .00076 | .00131 | .00225 | .0038 | .0062 | .0102 | .0163 | .040 | .094 | .206 | .44 | .92 | 1.78 |
| 8 | 11.0406 | 4042 | .000118 | .000323 | .000583 | .00104 | .00178 | .0031 | .00515 | .0085 | .0136 | .022 | .0344 | .081 | .183 | .39 | .82 | 1.64 | 3.10 |
| 10 | 10.9311 | 3908 | .00042 | .00075 | .00134 | .00232 | .00395 | .0067 | .0111 | .0178 | .0282 | .045 | .069 | .157 | .35 | .73 | 1.48 | 2.9 | 5.4 |
| 12 | 10.7900 | 3765 | .00099 | .00175 | .00305 | .0052 | .0088 | .0145 | .0234 | .037 | .058 | .091 | .136 | .305 | .66 | 1.34 | 2.65 | 5.1 | 9.3 |
| 14 | 10.6954 | 3636 | .0024 | .00415 | .0071 | .0118 | .0196 | .0316 | .050 | .078 | .121 | .185 | .275 | .60 | 1.25 | 2.50 | 4.8 | 9.0 | 16.0 |
| 16 | 10.6261 | 3516 | .0056 | .0095 | .016 | .0265 | .0428 | .0685 | .106 | .163 | .247 | .375 | .55 | 1.17 | 2.40 | 4.66 | 8.8 | 16.1 | 28 |
| 18 | 10.4957 | 3376 | .0135 | .0225 | .037 | .060 | .095 | .148 | .228 | .345 | .515 | .77 | 1.11 | 2.3 | 4.55 | 8.6 | 15.7 | 28 | 48 |
| 20 | 10.3833 | 3245 | .0316 | .052 | .084 | .132 | .205 | .32 | .48 | .72 | 1.06 | 1.55 | 2.21 | 4.4 | 8.5 | 15.6 | 28.1 | 49 | 83 |
| 22 | 10.3172 | 3125 | .0734 | .119 | .187 | .294 | .45 | .68 | 1.02 | 1.50 | 2.18 | 3.14 | 4.42 | 8.6 | 16.3 | 29.3 | 52 | 90 | 146 |
| 24 | 10.2185 | 2995 | .175 | .277 | .43 | .66 | 1.00 | 1.49 | 2.17 | 3.14 | 4.5 | 6.4 | 8.9 | 16.9 | 31.0 | 54.5 | 94 | 157 | 253 |
| 26 | 10.1303 | 2870 | .41 | .64 | .98 | 1.47 | 2.17 | 3.20 | 4.56 | 6.50 | 9.2 | 12.7 | 17.5 | 32.5 | 58.5 | 100 | 169 | 276 | 436 |
| 28 | 10.0115 | 2732 | 1.0 | 1.52 | 2.27 | 3.36 | 4.90 | 7.05 | 9.90 | 13.8 | 19.1 | 26.4 | 35.7 | 64 | 112 | 188 | 309 | 493 | 760 |
| 30 | 9.8763 | 2593 | 2.4 | 3.57 | 5.23 | 7.60 | 10.6 | 15.1 | 21.0 | 28.6 | 39.4 | 53 | 71 | 124 | 208 | 340 | 542 | 845 | |
| 32 | 9.7523 | 2457 | 5.7 | 8.3 | 11.8 | 16.8 | 23.5 | 32.5 | 44.5 | 60.0 | 81 | 107 | 141 | 238 | 390 | 623 | 970 | | |
| 34 | 9.6061 | 2316 | 13.1 | 18.8 | 26.4 | 36.8 | 50.5 | 68.5 | 92 | 122 | 161 | 211 | 273 | 450 | 720 | | | | |
| 36 | 9.5262 | 2229 | 29.0 | 41.0 | 56.4 | 78 | 105.5 | 142 | 188 | 246 | 322 | 416 | 535 | 860 | | | | | |
| 38 | 9.4670 | 2094 | 63.0 | 87.0 | 117 | 158 | 210 | 277 | 360 | 465 | 598 | 758 | 955 | | | | | | |
| 40 | 9.2156 | 1939 | 130 | 176 | 233 | 307 | 399 | 515 | 627 | 830 | | | | | | | | | |
| 42 | 8.9925 | 1800 | 253 | 332 | 430 | 560 | 709 | 900 | | | | | | | | | | | |
| 44 | 8.8621 | 1681 | 510 | 655 | 840 | | | | | | | | | | | | | | |
| 46 | | | 940 | | | | | | | | | | | | | | | | |

*Accuracy, ca. 2 percent for solutions of 15 to 30 percent HCl between 0 and 100°; for solutions of > 30 percent HCl the accuracy is ca. 5 percent at the lower temperatures and ca. 15 percent at the higher temperatures. Below 15 percent HCl, the accuracy is ca. 5 percent at the lower temperatures and higher strengths to ca. 15 to 20 percent at the lower strengths and perhaps 15 to 20 percent at the higher temperatures and lower strengths.

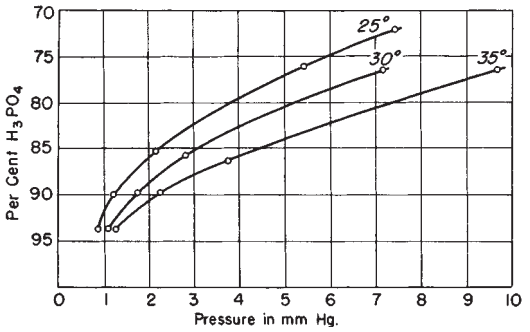


**FIG. 2-1** Vapor pressures of $H_3PO_4$ aqueous: partial pressure of $H_2O$ vapor. (*Courtesy of Victor Chemical Works, Stauffer Chemical Company; measurements by W. H. Woodstock.*)

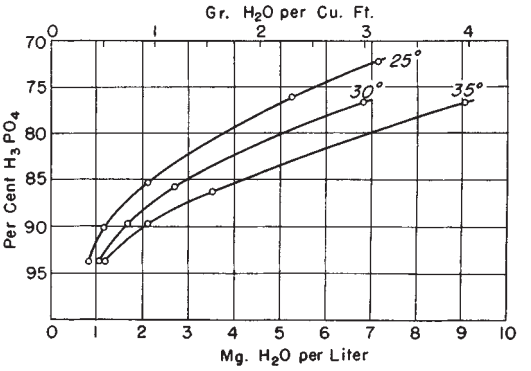


**FIG. 2-2** Vapor pressures of $H_3PO_4$ aqueous: weight of $H_2O$ in saturated air. (*Courtesy of Victor Chemical Works, Stauffer Chemical Company; measurements by W. H. Woodstock.*)

**TABLE 2-11 Partial Pressures of $H_2O$ and $SO_2$ over Aqueous Solutions of Sulfur Dioxide***

Partial pressures of $H_2O$ and $SO_2$, mmHg, °C

| g $SO_2$/ 100 g $H_2O$ | Temperature, ∞C | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 90 | 120 |
| 0.01 | 0.02 | 0.04 | 0.07 | 0.12 | 0.19 | 0.29 | 0.43 | 1.21 | 2.82 |
| 0.05 | 0.38 | 0.66 | 1.07 | 1.68 | 2.53 | 3.69 | 5.24 | 12.9 | 27.0 |
| 0.10 | 1.15 | 1.91 | 3.03 | 4.62 | 6.80 | 9.71 | 13.5 | 31.7 | 63.9 |
| 0.15 | 2.10 | 3.44 | 5.37 | 8.07 | 11.7 | 16.5 | 22.7 | 52.2 | 104 |
| 0.20 | 3.17 | 5.13 | 7.93 | 11.8 | 17.0 | 23.8 | 32.6 | 73.7 | 145 |
| 0.25 | 4.34 | 6.93 | 10.6 | 15.7 | 22.5 | 31.4 | 42.8 | 95.8 | 186 |
| 0.30 | 5.57 | 8.84 | 13.5 | 19.8 | 28.2 | 39.2 | 53.3 | 118 | 229 |
| 0.40 | 8.17 | 12.8 | 19.4 | 28.3 | 40.1 | 55.3 | 74.7 | 164 | 316 |
| 0.50 | 10.9 | 17.0 | 25.6 | 37.1 | 52.3 | 72.0 | 96.8 | 211 | 404 |
| 1.00 | 25.8 | 39.5 | 58.4 | 83.7 | 117 | 159 | 212 | 454 | 856 |
| 2.00 | 58.6 | 88.5 | 129 | 183 | 253 | 342 | 453 | 955 | |
| 3.00 | 93.2 | 139 | 202 | 285 | 393 | 530 | 700 | | |
| 4.00 | 129 | 192 | 277 | 389 | 535 | 720 | | | |
| 5.00 | 165 | 245 | 353 | 496 | 679 | | | | |
| 6.00 | 202 | 299 | 430 | 602 | 824 | | | | |
| 8.00 | 275 | 407 | 585 | 818 | | | | | |
| 10.00 | 351 | 517 | 741 | | | | | | |
| 15.00 | 542 | 796 | | | | | | | |
| 20.00 | 735 | | | | | | | | |

*Extracted with permission from *J. Chem Eng. Data* **8,** 1963: 333–336. Copyright 1963 American Chemical Society.

**TABLE 2-12 Water Partial Pressure, bar, over Aqueous Sulfuric Acid Solutions***

| °C | Weight percent, $H_2SO_4$ | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10.0 | 20.0 | 30.0 | 40.0 | 50.0 | 60.0 | 70.0 | 75.0 | 80.0 | 85.0 |
| 0 | .582E–02 | .534E–02 | .448E–02 | .326E–02 | .193E–02 | .836E–03 | .207E–03 | .747E–04 | .197E–04 | .343E–05 |
| 10 | .117E–01 | .107E–01 | .909E–02 | .670E–02 | .405E–02 | .180E–02 | .467E–03 | .175E–03 | .490E–04 | .952E–05 |
| 20 | .223E–01 | .205E–01 | .174E–01 | .130E–01 | .802E–02 | .367E–02 | .995E–03 | .388E–03 | .115E–04 | .245E–04 |
| 30 | .404E–01 | .373E–01 | .319E–01 | .241E–01 | .151E–01 | .710E–02 | .201E–02 | .811E–03 | .253E–03 | .589E–04 |
| 40 | .703E–01 | .649E–01 | .558E–01 | .427E–01 | .272E–01 | .131E–01 | .387E–02 | .162E–02 | .531E–03 | .133E–03 |
| 50 | .117 | .109 | .939E–01 | .725E–01 | .470E–01 | .232E–01 | .715E–02 | .309E–02 | .106E–02 | .286E–03 |
| 60 | .189 | .175 | .152 | .119 | .782E–01 | .395E–01 | .127E–01 | .565E–02 | .204E–02 | .584E–03 |
| 70 | .296 | .275 | .239 | .188 | .126 | .651E–01 | .217E–01 | .997E–02 | .376E–02 | .114E–02 |
| 80 | .449 | .417 | .365 | .290 | .196 | .104 | .360E–01 | .170E–01 | .668E–02 | .213E–02 |
| 90 | .664 | .617 | .542 | .434 | .298 | .161 | .578E–01 | .281E–01 | .115E–01 | .383E–02 |
| 100 | .957 | .891 | .786 | .634 | .441 | .244 | .905E–01 | .452E–01 | .192E–01 | .666E–02 |
| 110 | 1.349 | 1.258 | 1.113 | .904 | .638 | .360 | .138 | .708E–01 | .312E–01 | .112E–01 |
| 120 | 1.863 | 1.740 | 1.544 | 1.264 | .903 | .519 | .206 | .108 | .493E–01 | .183E–01 |
| 130 | 2.524 | 2.361 | 2.101 | 1.732 | 1.253 | .734 | .301 | .162 | .760E–01 | .291E–01 |
| 140 | 3.361 | 3.149 | 2.810 | 2.333 | 1.708 | 1.020 | .481 | .236 | .115 | .451E–01 |
| 150 | 4.404 | 4.132 | 3.697 | 3.090 | 2.289 | 1.392 | .605 | .339 | .170 | .682E–01 |
| 160 | 5.685 | 5.342 | 4.793 | 4.031 | 3.021 | 1.870 | .837 | .478 | .246 | .101 |
| 170 | 7.236 | 6.810 | 6.127 | 5.185 | 3.930 | 2.475 | 1.138 | .662 | .350 | .147 |
| 180 | 9.093 | 8.571 | 7.731 | 6.584 | 5.045 | 3.233 | 1.525 | .902 | .489 | .208 |
| 190 | 11.289 | 10.658 | 9.640 | 8.259 | 6.397 | 4.169 | 2.017 | 1.212 | .673 | .291 |
| 200 | 13.861 | 13.107 | 11.887 | 10.245 | 8.020 | 5.312 | 2.632 | 1.606 | .913 | .401 |
| 210 | 16.841 | 15.951 | 14.505 | 12.576 | 9.948 | 6.696 | 3.395 | 2.101 | 1.220 | .542 |
| 220 | 20.264 | 19.225 | 17.529 | 15.287 | 12.217 | 8.354 | 4.331 | 2.714 | 1.609 | .724 |
| 230 | 24.160 | 22.960 | 20.992 | 18.414 | 14.864 | 10.322 | 5.466 | 3.467 | 2.096 | .952 |
| 240 | 28.561 | 27.188 | 24.927 | 21.992 | 17.929 | 12.641 | 6.831 | 4.381 | 2.699 | 1.237 |
| 250 | 33.494 | 31.939 | 29.364 | 26.056 | 21.452 | 15.351 | 8.458 | 5.480 | 3.435 | 1.587 |
| 260 | 38.984 | 37.240 | 34.334 | 30.642 | 25.472 | 18.496 | 10.382 | 6.788 | 4.326 | 2.012 |
| 270 | 45.055 | 43.116 | 39.865 | 35.784 | 30.030 | 22.121 | 12.640 | 8.333 | 5.395 | 2.525 |
| 280 | 51.726 | 49.590 | 45.984 | 41.514 | 35.168 | 26.274 | 15.269 | 10.142 | 6.663 | 3.136 |
| 290 | 59.015 | 56.681 | 52.715 | 47.865 | 40.926 | 31.003 | 18.311 | 12.242 | 8.155 | 3.857 |
| 300 | 66.934 | 64.407 | 60.081 | 54.868 | 47.346 | 36.360 | 21.808 | 14.665 | 9.897 | 4.701 |
| 310 | 75.495 | 72.781 | 68.100 | 62.553 | 54.470 | 42.395 | 25.804 | 17.438 | 11.912 | 5.680 |
| 320 | 84.705 | 81.816 | 76.792 | 70.947 | 62.337 | 49.164 | 30.343 | 20.591 | 14.227 | 6.806 |
| 330 | 94.567 | 91.518 | 86.172 | 80.077 | 70.988 | 56.721 | 35.473 | 24.153 | 16.867 | 8.093 |
| 340 | 105.083 | 101.894 | 96.252 | 89.969 | 80.463 | 65.123 | 41.240 | 28.154 | 19.855 | 9.551 |
| 350 | 116.251 | 112.946 | 107.043 | 100.646 | 90.802 | 74.426 | 47.692 | 32.622 | 23.217 | 11.193 |

*Vermeulen, Dong, Robinson, Nguyen, and Gmitro, AIChE meeting, Anaheim, Calif., 1982; and private communication from Prof. Theodore Vermeulen, Chemical Engineering Dept., University of California, Berkeley.

**TABLE 2-12 Water Partial Pressure, bar, over Aqueous Sulfuric Acid Solutions** (*Concluded*)

Weight percent, $H_2SO_4$

| °C | 90.0 | 92.0 | 94.0 | 96.0 | 97.0 | 98.0 | 98.5 | 99.0 | 99.5 | 100.0 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | .518E–06 | .242E–06 | .107E–06 | .401E–07 | .218E–07 | .980E–08 | .569E–08 | .268E–08 | .775E–09 | .196E–09 |
| 10 | .159E–05 | .762E–06 | .344E–06 | .130E–06 | .713E–07 | .323E–07 | .188E–07 | .888E–08 | .258E–08 | .655E–09 |
| 20 | .448E–05 | .220E–05 | .101E–05 | .390E–06 | .215E–06 | .978E–07 | .572E–07 | .271E–07 | .789E–08 | .201E–08 |
| 30 | .117E–04 | .587E–05 | .275E–05 | .108E–05 | .598E–06 | .275E–06 | .161E–06 | .766E–07 | .224E–07 | .575E–08 |
| 40 | .285E–04 | .146E–04 | .696E–05 | .278E–05 | .155E–05 | .720E–06 | .424E–06 | .202E–06 | .595E–07 | .153E–07 |
| 50 | .652E–04 | .341E–04 | .166E–04 | .672E–05 | .379E–05 | .177E–05 | .105E–05 | .503E–06 | .149E–06 | .384E–07 |
| 60 | .141E–03 | .754E–04 | .372E–04 | .154E–04 | .875E–05 | .413E–05 | .245E–05 | .118E–05 | .350E–06 | .910E–07 |
| 70 | .290E–03 | .158E–03 | .795E–04 | .334E–04 | .192E–04 | .912E–05 | .544E–05 | .263E–05 | .784E–06 | .205E–06 |
| 80 | .569E–03 | .316E–03 | .162E–03 | .691E–04 | .400E–04 | .192E–04 | .115E–04 | .559E–05 | .168E–05 | .439E–06 |
| 90 | .107E–02 | .606E–03 | .315E–03 | .137E–03 | .801E–04 | .388E–04 | .234E–04 | .114E–04 | .343E–05 | .903E–06 |
| 100 | .194E–02 | .112E–02 | .590E–03 | .261E–03 | .154E–03 | .752E–04 | .455E–04 | .223E–04 | .674E–05 | .178E–05 |
| 110 | .338E–02 | .198E–02 | .107E–02 | .479E–03 | .285E–03 | .141E–03 | .855E–04 | .420E–04 | .128E–04 | .339E–05 |
| 120 | .571E–02 | .341E–02 | .186E–02 | .851E–03 | .511E–03 | .254E–03 | .155E–03 | .766E–04 | .233E–04 | .623E–05 |
| 130 | .938E–02 | .569E–02 | .315E–02 | .146E–02 | .886E–03 | .445E–03 | .278E–03 | .135E–03 | .414E–04 | .111E–04 |
| 140 | .150E–01 | .923E–02 | .519E–02 | .245E–02 | .149E–02 | .757E–03 | .467E–03 | .232E–03 | .711E–04 | .191E–04 |
| 150 | .233E–01 | .146E–01 | .832E–02 | .399E–02 | .245E–02 | .125E–02 | .776E–03 | .387E–03 | .119E–03 | .321E–04 |
| 160 | .354E–01 | .225E–01 | .130E–01 | .633E–02 | .393E–02 | .202E–02 | .126E–02 | .629E–03 | .194E–03 | .526E–04 |
| 170 | .526E–01 | .340E–01 | .199E–01 | .983E–02 | .614E–02 | .319E–02 | .199E–02 | .999E–03 | .309E–03 | .840E–04 |
| 180 | .766E–01 | .502E–01 | .298E–01 | .149E–01 | .941E–02 | .492E–02 | .309E–02 | .155E–02 | .482E–03 | .131E–03 |
| 190 | .110 | .729E–01 | .438E–01 | .222E–01 | .141E–01 | .744E–02 | .469E–02 | .236E–02 | .735E–03 | .201E–03 |
| 200 | .154 | .104 | .631E–01 | .325E–01 | .208E–01 | .110E–01 | .698E–02 | .352E–02 | .110E–02 | .300E–03 |
| 210 | .213 | .146 | .894E–01 | .467E–01 | .300E–01 | .161E–01 | .102E–01 | .516E–02 | .161E–02 | .442E–03 |
| 220 | .290 | .201 | .125 | .660E–01 | .427E–01 | .230E–01 | .147E–01 | .743E–02 | .232E–02 | .638E–03 |
| 230 | .389 | .273 | .171 | .918E–01 | .598E–01 | .325E–01 | .208E–01 | .105E–01 | .329E–02 | .906E–03 |
| 240 | .514 | .366 | .232 | .126 | .825E–01 | .451E–01 | .290E–01 | .147E–01 | .460E–02 | .127E–02 |
| 250 | .673 | .485 | .310 | .170 | .112 | .618E–01 | .398E–01 | .202E–01 | .633E–02 | .174E–02 |
| 260 | .870 | .635 | .409 | .227 | .151 | .835E–01 | .540E–01 | .274E–01 | .858E–02 | .237E–02 |
| 270 | 1.112 | .822 | .534 | .300 | .200 | .111 | .723E–01 | .366E–01 | .115E–01 | .317E–02 |
| 280 | 1.407 | 1.052 | .689 | .391 | .263 | .147 | .957E–01 | .485E–01 | .152E–01 | .420E–02 |
| 290 | 1.763 | 1.335 | .880 | .505 | .341 | .192 | .125 | .634E–01 | .199E–01 | .548E–02 |
| 300 | 2.190 | 1.676 | 1.112 | .646 | .437 | .248 | .162 | .820E–01 | .257E–01 | .708E–02 |
| 310 | 2.696 | 2.088 | 1.394 | .817 | .556 | .316 | .208 | .105 | .328E–01 | .905E–02 |
| 320 | 3.292 | 2.578 | 1.732 | 1.025 | .701 | .400 | .264 | .133 | .415E–01 | .114E–01 |
| 330 | 3.990 | 3.159 | 2.133 | 1.274 | .875 | .502 | .331 | .167 | .520E–01 | .143E–01 |
| 340 | 4.801 | 3.843 | 2.608 | 1.571 | 1.083 | .624 | .413 | .208 | .646E–01 | .178E–01 |
| 350 | 5.738 | 4.641 | 3.164 | 1.922 | 1.331 | .770 | .511 | .256 | .795E–01 | .218E–01 |

**TABLE 2-13 Sulfur Trioxide Partial Pressure, bar, over Aqueous Sulfuric Acid Solutions***

| | Weight percent, $H_2SO_4$ | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| °C | 10.0 | 20.0 | 30.0 | 40.0 | 50.0 | 60.0 | 70.0 | 75.0 | 80.0 | 85.0 |
| 0 | .644E–29 | .103E–27 | .205E–26 | .688E–25 | .368E–23 | .341E–21 | .784E–19 | .174E–17 | .531E–16 | .229E–14 |
| 10 | .149E–27 | .223E–26 | .395E–25 | .113E–23 | .522E–22 | .415E–20 | .796E–18 | .158E–16 | .417E–15 | .141E–13 |
| 20 | .278E–26 | .394E–25 | .626E–24 | .156E–22 | .621E–21 | .426E–19 | .685E–17 | .121E–15 | .280E–14 | .767E–13 |
| 30 | .426E–25 | .577E–24 | .832E–23 | .181E–21 | .630E–20 | .376E–18 | .509E–16 | .808E–15 | .164E–13 | .371E–12 |
| 40 | .549E–24 | .714E–23 | .941E–22 | .181E–20 | .555E–19 | .288E–17 | .331E–15 | .473E–14 | .851E–13 | .162E–11 |
| 50 | .602E–23 | .757E–22 | .921E–21 | .158E–19 | .429E–18 | .195E–16 | .191E–14 | .246E–13 | .395E–12 | .643E–11 |
| 60 | .573E–22 | .699E–21 | .789E–20 | .122E–18 | .294E–17 | .118E–15 | .985E–14 | .116E–12 | .165E–11 | .234E–10 |
| 70 | .477E–21 | .567E–20 | .599E–19 | .843E–18 | .181E–16 | .643E–15 | .461E–13 | .492E–12 | .634E–11 | .791E–10 |
| 80 | .352E–20 | .410E–19 | .408E–18 | .524E–17 | .101E–15 | .319E–14 | .197E–12 | .192E–11 | .223E–10 | .249E–09 |
| 90 | .233E–19 | .266E–18 | .250E–17 | .296E–16 | .516E–15 | .145E–13 | .775E–12 | .693E–11 | .731E–10 | .734E–09 |
| 100 | .139E–18 | .157E–17 | .140E–16 | .153E–15 | .242E–14 | .606E–13 | .283E–11 | .232E–10 | .223E–09 | .204E–08 |
| 110 | .756E–18 | .844E–17 | .719E–16 | .730E–15 | .105E–13 | .236E–12 | .961E–11 | .729E–10 | .641E–09 | .538E–08 |
| 120 | .377E–17 | .418E–16 | .340E–15 | .323E–14 | .424E–13 | .858E–12 | .307E–10 | .215E–09 | .174E–08 | .135E–07 |
| 130 | .174E–16 | .191E–15 | .150E–14 | .133E–13 | .160E–12 | .293E–11 | .922E–10 | .601E–09 | .446E–08 | .324E–07 |
| 140 | .743E–16 | .815E–15 | .615E–14 | .517E–13 | .569E–12 | .943E–11 | .262E–09 | .159E–08 | .109E–07 | .745E–07 |
| 150 | .297E–15 | .325E–14 | .237E–13 | .188E–12 | .191E–11 | .287E–10 | .710E–09 | .403E–08 | .256E–07 | .165E–06 |
| 160 | .111E–14 | .122E–13 | .862E–13 | .649E–12 | .608E–11 | .833E–10 | .183E–08 | .974E–08 | .575E–07 | .351E–06 |
| 170 | .393E–14 | .430E–13 | .296E–12 | .212E–11 | .184E–10 | .231E–09 | .453E–08 | .226E–07 | .125E–06 | .725E–06 |
| 180 | .131E–13 | .144E–12 | .967E–12 | .622E–11 | .532E–10 | .610E–09 | .107E–07 | .505E–07 | .260E–06 | .145E–05 |
| 190 | .415E–13 | .458E–12 | .301E–11 | .197E–10 | .147E–09 | .155E–08 | .246E–07 | .109E–06 | .527E–06 | .282E–05 |
| 200 | .125E–12 | .139E–11 | .893E–11 | .561E–10 | .391E–09 | .379E–08 | .542E–07 | .228E–06 | .103E–05 | .534E–05 |
| 210 | .362E–12 | .404E–11 | .254E–10 | .154E–09 | .100E–08 | .894E–08 | .116E–06 | .462E–06 | .198E–05 | .986E–05 |
| 220 | .100E–11 | .112E–10 | .695E–10 | .405E–09 | .246E–08 | .204E–07 | .240E–06 | .911E–06 | .368E–05 | .178E–04 |
| 230 | .265E–11 | .301E–10 | .183E–09 | .103E–08 | .587E–08 | .450E–07 | .482E–06 | .175E–05 | .668E–05 | .314E–04 |
| 240 | .678E–11 | .777E–10 | .465E–09 | .253E–08 | .135E–07 | .965E–07 | .944E–06 | .328E–05 | .119E–04 | .543E–04 |
| 250 | .167E–10 | .193E–09 | .114E–08 | .602E–08 | .303E–07 | .201E–06 | .180E–05 | .600E–05 | .206E–04 | .923E–04 |
| 260 | .399E–10 | .466E–09 | .272E–08 | .139E–07 | .660E–07 | .408E–06 | .336E–05 | .108E–04 | .352E–04 | .154E–03 |
| 270 | .920E–10 | .109E–08 | .628E–08 | .312E–07 | .140E–06 | .807E–06 | .612E–05 | .189E–04 | .590E–04 | .253E–03 |
| 280 | .206E–09 | .247E–08 | .141E–07 | .683E–07 | .288E–06 | .156E–05 | .109E–04 | .326E–04 | .973E–04 | .408E–03 |
| 290 | .449E–09 | .545E–08 | .308E–07 | .145E–06 | .580E–06 | .295E–05 | .191E–04 | .553E–04 | .158E–03 | .649E–03 |
| 300 | .953E–09 | .117E–07 | .657E–07 | .302E–06 | .114E–05 | .546E–05 | .329E–04 | .921E–04 | .253E–03 | .102E–02 |
| 310 | .197E–08 | .245E–07 | .136E–06 | .614E–06 | .220E–05 | .990E–05 | .556E–04 | .151E–03 | .398E–03 | .158E–02 |
| 320 | .397E–08 | .502E–07 | .277E–06 | .122E–05 | .414E–05 | .176E–04 | .923E–04 | .245E–03 | .621E–03 | .242E–02 |
| 330 | .782E–08 | .100E–06 | .551E–06 | .237E–05 | .766E–05 | .308E–04 | .151E–03 | .391E–03 | .956E–03 | .367E–02 |
| 340 | .151E–07 | .196E–06 | .107E–05 | .452E–05 | .139E–04 | .529E–04 | .243E–03 | .617E–03 | .145E–02 | .550E–02 |
| 350 | .285E–07 | .376E–06 | .204E–05 | .846E–05 | .246E–04 | .893E–04 | .387E–03 | .963E–03 | .219E–02 | .815E–02 |

*Vermeulen, Dong, Robinson, Nguyen, and Gmitro, AIChE meeting, Anaheim, Calif., 1982; and private communication from Prof. Theodore Vermeulen, Chemical Engineering Dept., University of California, Berkeley.

**TABLE 2-13 Sulfur Trioxide Partial Pressure, bar, over Aqueous Sulfuric Acid Solutions** (*Concluded*)

Weight percent, $H_2SO_4$

| °C | 90.0 | 92.0 | 94.0 | 96.0 | 97.0 | 98.0 | 98.5 | 99.0 | 99.5 | 100.0 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | .671E–13 | .216E–12 | .677E–12 | .240E–11 | .500E–11 | .124E–10 | .224E–10 | .502E–10 | .182E–09 | .755E–09 |
| 10 | .345E–12 | .107E–11 | .326E–11 | .114E–10 | .234E–10 | .578E–10 | .104E–09 | .232E–09 | .839E–09 | .347E–08 |
| 20 | .159E–11 | .475E–11 | .141E–10 | .482E–10 | .986E–10 | .241E–09 | .433E–09 | .961E–09 | .346E–08 | .142E–07 |
| 30 | .664E–11 | .192E–10 | .557E–10 | .186E–09 | .376E–09 | .911E–09 | .163E–08 | .360E–08 | .129E–07 | .528E–07 |
| 40 | .254E–10 | .709E–10 | .201E–09 | .655E–09 | .131E–08 | .315E–08 | .562E–08 | .123E–07 | .440E–07 | .179E–06 |
| 50 | .897E–10 | .242E–09 | .669E–09 | .214E–08 | .424E–08 | .101E–07 | .179E–07 | .391E–07 | .139E–06 | .560E–06 |
| 60 | .294E–09 | .771E–09 | .207E–08 | .647E–08 | .127E–07 | .299E–07 | .528E–07 | .115E–06 | .405E–06 | .163E–05 |
| 70 | .904E–09 | .230E–08 | .602E–08 | .184E–07 | .357E–07 | .833E–07 | .146E–06 | .316E–06 | .111E–05 | .444E–05 |
| 80 | .261E–08 | .643E–08 | .165E–07 | .492E–07 | .946E–07 | .218E–06 | .381E–06 | .820E–06 | .286E–05 | .114E–04 |
| 90 | .712E–08 | .171E–07 | .426E–07 | .124E–06 | .237E–06 | .541E–06 | .940E–06 | .201E–05 | .698E–05 | .276E–04 |
| 100 | .184E–07 | .430E–07 | .105E–06 | .300E–06 | .565E–06 | .127E–05 | .220E–05 | .470E–05 | .162E–04 | .638E–04 |
| 110 | .456E–07 | .103E–06 | .247E–06 | .689E–06 | .128E–05 | .287E–05 | .494E–05 | .105E–04 | .359E–04 | .141E–03 |
| 120 | .108E–06 | .238E–06 | .555E–06 | .152E–05 | .280E–05 | .619E–05 | .106E–04 | .224E–04 | .764E–04 | .298E–03 |
| 130 | .244E–06 | .526E–06 | .120E–05 | .321E–05 | .586E–05 | .128E–04 | .219E–04 | .459E–04 | .156E–03 | .606E–03 |
| 140 | .533E–06 | .112E–05 | .250E–05 | .656E–05 | .118E–04 | .257E–04 | .435E–04 | .910E–04 | .308E–03 | .119E–02 |
| 150 | .112E–05 | .230E–05 | .504E–05 | .129E–04 | .231E–04 | .497E–04 | .837E–04 | .174E–03 | .588E–03 | .226E–02 |
| 160 | .229E–05 | .459E–05 | .983E–05 | .247E–04 | .438E–04 | .932E–04 | .156E–03 | .324E–03 | .109E–02 | .416E–02 |
| 170 | .453E–05 | .886E–05 | .186E–04 | .459E–04 | .806E–04 | .170E–03 | .283E–03 | .586E–03 | .196E–02 | .746E–02 |
| 180 | .870E–05 | .166E–04 | .343E–04 | .829E–04 | .144E–03 | .301E–03 | .499E–03 | .103E–02 | .343E–02 | .130E–01 |
| 190 | .163E–04 | .304E–04 | .615E–04 | .146E–03 | .252E–03 | .520E–03 | .859E–03 | .177E–02 | .587E–02 | .222E–01 |
| 200 | .297E–04 | .543E–04 | .108E–03 | .251E–03 | .429E–03 | .878E–03 | .144E–02 | .296E–02 | .981E–02 | .370E–01 |
| 210 | .528E–04 | .946E–04 | .185E–03 | .422E–03 | .714E–03 | .145E–02 | .237E–02 | .486E–02 | .161E–01 | .603E–01 |
| 220 | .919E–04 | .161E–03 | .309E–03 | .694E–03 | .117E–02 | .235E–02 | .383E–02 | .781E–02 | .258E–01 | .965E–01 |
| 230 | .157E–03 | .269E–03 | .508E–03 | .112E–02 | .187E–02 | .373E–02 | .605E–02 | .123E–01 | .405E–01 | .152 |
| 240 | .261E–03 | .441E–03 | .819E–03 | .178E–02 | .293E–02 | .582E–02 | .939E–02 | .191E–01 | .627E–01 | .234 |
| 250 | .428E–03 | .708E–03 | .130E–02 | .276E–02 | .453E–02 | .891E–02 | .143E–01 | .291E–01 | .955E–01 | .356 |
| 260 | .690E–03 | .112E–02 | .202E–02 | .423E–02 | .688E–02 | .134E–01 | .215E–01 | .437E–01 | .143 | .532 |
| 270 | .109E–02 | .174E–02 | .309E–02 | .638E–02 | .103E–01 | .200E–01 | .319E–01 | .646E–01 | .212 | .786 |
| 280 | .170E–02 | .266E–02 | .466E–02 | .948E–02 | .152E–01 | .293E–01 | .465E–01 | .943E–01 | .309 | 1.144 |
| 290 | .261E–02 | .401E–02 | .694E–02 | .139E–01 | .221E–01 | .423E–01 | .670E–01 | .136 | .444 | 1.646 |
| 300 | .395E–02 | .595E–02 | .102E–01 | .201E–01 | .318E–01 | .604E–01 | .953E–01 | .193 | .632 | 2.339 |
| 310 | .589E–02 | .873E–02 | .148E–01 | .287E–01 | .451E–01 | .852E–01 | .134 | .272 | .889 | 3.289 |
| 320 | .868E–02 | .126E–01 | .211E–01 | .405E–01 | .632E–01 | .119 | .186 | .378 | 1.236 | 4.575 |
| 330 | .126E–01 | .181E–01 | .299E–01 | .565E–01 | .877E–01 | .164 | .256 | .520 | 1.703 | 6.303 |
| 340 | .181E–01 | .255E–01 | .418E–01 | .780E–01 | .120 | .224 | .348 | .708 | 2.323 | 8.603 |
| 350 | .258E–01 | .357E–01 | .578E–01 | .107 | .164 | .303 | .470 | .956 | 3.142 | 11.640 |

**TABLE 2-14 Sulfuric Acid Partial Pressure, bar, over Aqueous Sulfuric Acid***

| | Weight Percent, $H_2SO_4$ | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| °C | 10.0 | 20.0 | 30.0 | 40.0 | 50.0 | 60.0 | 70.0 | 75.0 | 80.0 | 85.0 |
| 0 | .576E–21 | .843E–20 | .141E–18 | .344E–17 | .109E–15 | .438E–14 | .249E–12 | .200E–11 | .161E–10 | .121E–09 |
| 10 | .634E–20 | .874E–19 | .131E–17 | .276E–16 | .769E–15 | .273E–13 | .135E–11 | .101E–10 | .743E–10 | .490E–09 |
| 20 | .588E–19 | .769E–18 | .104E–16 | .193E–15 | .474E–14 | .149E–12 | .649E–11 | .447E–10 | .305E–09 | .179E–08 |
| 30 | .468E–18 | .584E–17 | .721E–16 | .119E–14 | .259E–13 | .725E–12 | .278E–10 | .178E–09 | .113E–08 | .594E–08 |
| 40 | .324E–17 | .389E–16 | .441E–15 | .649E–14 | .127E–12 | .317E–11 | .108E–09 | .643E–09 | .379E–08 | .181E–07 |
| 50 | .197E–16 | .229E–15 | .241E–14 | .320E–13 | .562E–12 | .126E–10 | .380E–09 | .212E–08 | .117E–07 | .513E–07 |
| 60 | .107E–15 | .121E–14 | .119E–13 | .144E–12 | .228E–11 | .462E–10 | .124E–08 | .646E–08 | .334E–07 | .135E–06 |
| 70 | .526E–15 | .581E–14 | .535E–13 | .592E–12 | .851E–11 | .156E–09 | .373E–08 | .183E–07 | .888E–07 | .336E–06 |
| 80 | .235E–14 | .254E–13 | .221E–12 | .225E–11 | .295E–10 | .492E–09 | .105E–07 | .485E–07 | .222E–06 | .786E–06 |
| 90 | .960E–14 | .102E–12 | .844E–12 | .798E–11 | .956E–10 | .145E–08 | .279E–07 | .121E–06 | .522E–06 | .175E–05 |
| 100 | .353E–13 | .381E–12 | .300E–11 | .264E–10 | .291E–09 | .402E–08 | .698E–07 | .287E–06 | .117E–05 | .371E–05 |
| 110 | .127E–12 | .132E–11 | .997E–11 | .824E–10 | .835E–09 | .106E–07 | .166E–06 | .644E–06 | .249E–05 | .752E–05 |
| 120 | .418E–12 | .432E–11 | .312E–10 | .243E–09 | .227E–08 | .264E–07 | .375E–06 | .138E–05 | .508E–05 | .147E–04 |
| 130 | .129E–11 | .132E–10 | .924E–10 | .678E–09 | .589E–08 | .631E–07 | .814E–06 | .285E–05 | .995E–05 | .277E–04 |
| 140 | .375E–11 | .385E–10 | .259E–09 | .181E–08 | .146E–07 | .144E–06 | .169E–05 | .565E–05 | .188E–04 | .503E–04 |
| 150 | .103E–10 | .106E–09 | .694E–09 | .460E–08 | .346E–07 | .316E–06 | .340E–05 | .108E–04 | .343E–04 | .889E–04 |
| 160 | .272E–10 | .279E–09 | .178E–08 | .112E–07 | .789E–07 | .670E–06 | .659E–05 | .200E–04 | .608E–04 | .152E–03 |
| 170 | .682E–10 | .702E–09 | .436E–08 | .264E–07 | .174E–06 | .137E–05 | .124E–04 | .359E–04 | .104E–03 | .255E–03 |
| 180 | .164E–09 | .170E–08 | .103E–07 | .599E–07 | .369E–06 | .271E–05 | .225E–04 | .627E–04 | .175E–03 | .416E–03 |
| 190 | .378E–09 | .394E–08 | .234E–07 | .131E–06 | .760E–06 | .521E–05 | .400E–04 | .107E–03 | .286E–03 | .663E–03 |
| 200 | .842E–09 | .883E–08 | .514E–07 | .278E–06 | .152E–05 | .975E–05 | .691E–04 | .177E–03 | .457E–03 | .104E–02 |
| 210 | .181E–08 | .191E–07 | .109E–06 | .573E–06 | .295E–05 | .178E–04 | .117E–03 | .288E–03 | .715E–03 | .159E–02 |
| 220 | .376E–08 | .401E–07 | .226E–06 | .115E–05 | .559E–05 | .316E–04 | .193E–03 | .459E–03 | .110E–02 | .239E–02 |
| 230 | .758E–08 | .817E–07 | .455E–06 | .224E–05 | .103E–04 | .549E–04 | .311E–03 | .717E–03 | .166E–02 | .354E–02 |
| 240 | .148E–07 | .162E–06 | .889E–06 | .427E–05 | .186E–04 | .935E–04 | .494E–03 | .110E–02 | .245E–02 | .515E–02 |
| 250 | .283E–07 | .312E–06 | .170E–05 | .793E–05 | .329E–04 | .156E–03 | .770E–03 | .166E–02 | .358E–02 | .740E–02 |
| 260 | .526E–07 | .588E–06 | .316E–05 | .144E–04 | .569E–04 | .255E–03 | .118E–02 | .247E–02 | .516E–02 | .105E–01 |
| 270 | .954E–07 | .108E–05 | .577E–05 | .257E–04 | .965E–04 | .411E–03 | .178E–02 | .362E–02 | .733E–02 | .147E–01 |
| 280 | .169E–06 | .194E–05 | .103E–04 | .450E–04 | .161E–03 | .650E–03 | .265E–02 | .524E–02 | .103E–01 | .203E–01 |
| 290 | .294E–06 | .342E–05 | .180E–04 | .771E–04 | .263E–03 | .101E–02 | .389E–02 | .750E–02 | .143E–01 | .278E–01 |
| 300 | .500E–06 | .591E–05 | .309E–04 | .130E–03 | .424E–03 | .156E–02 | .563E–02 | .106E–01 | .196E–01 | .376E–01 |
| 310 | .834E–06 | .100E–04 | .522E–04 | .215E–03 | .672E–03 | .236E–02 | .805E–02 | .148E–01 | .266E–01 | .504E–01 |
| 320 | .137E–05 | .167E–04 | .865E–04 | .352E–03 | .105E–02 | .352E–02 | .114E–01 | .205E–01 | .359E–01 | .670E–01 |
| 330 | .220E–05 | .273E–04 | .141E–03 | .565E–03 | .162E–02 | .519E–02 | .159E–01 | .281E–01 | .480E–01 | .883E–01 |
| 340 | .349E–05 | .440E–04 | .227E–03 | .895E–03 | .246E–02 | .757E–02 | .221E–01 | .382E–01 | .636E–01 | .116 |
| 350 | .544E–05 | .698E–04 | .360E–03 | .140E–02 | .369E–02 | .109E–01 | .303E–01 | .516E–01 | .836E–01 | .150 |

| | Weight percent, $H_2SO_4$ | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| °C | 90.0 | 92.0 | 94.0 | 96.0 | 97.0 | 98.0 | 98.5 | 99.0 | 99.5 | 100.0 |
| 0 | .534E–09 | .803E–09 | .112E–08 | .148E–08 | .167E–08 | .187E–08 | .196E–08 | .206E–08 | .217E–08 | .228E–08 |
| 10 | .200E–08 | .296E–08 | .409E–08 | .540E–08 | .609E–08 | .679E–08 | .714E–08 | .750E–08 | .788E–08 | .827E–08 |
| 20 | .677E–08 | .993E–08 | .136E–07 | .179E–07 | .201E–07 | .224E–07 | .236E–07 | .247E–07 | .260E–07 | .273E–07 |
| 30 | .211E–07 | .306E–07 | .415E–07 | .543E–07 | .611E–07 | .680E–07 | .714E–07 | .749E–07 | .786E–07 | .824E–07 |
| 40 | .607E–07 | .870E–07 | .117E–06 | .153E–06 | .171E–06 | .191E–06 | .200E–06 | .210E–06 | .220E–06 | .230E–06 |
| 50 | .163E–06 | .231E–06 | .309E–06 | .400E–06 | .449E–06 | .498E–06 | .523E–06 | .548E–06 | .574E–06 | .600E–06 |
| 60 | .411E–06 | .575E–06 | .765E–06 | .985E–06 | .110E–05 | .122E–05 | .128E–05 | .134E–05 | .140E–05 | .147E–05 |
| 70 | .976E–06 | .135E–05 | .179E–05 | .229E–05 | .256E–05 | .283E–05 | .297E–05 | .310E–05 | .325E–05 | .339E–05 |
| 80 | .220E–05 | .302E–05 | .396E–05 | .504E–05 | .562E–05 | .622E–05 | .652E–05 | .681E–05 | .712E–05 | .743E–05 |
| 90 | .473E–05 | .642E–05 | .835E–05 | .106E–04 | .118E–04 | .130E–04 | .136E–04 | .143E–04 | .149E–04 | .155E–04 |
| 100 | .973E–05 | .131E–04 | .169E–04 | .213E–04 | .237E–04 | .261E–04 | .274E–04 | .285E–04 | .298E–04 | .310E–04 |
| 110 | .192E–04 | .256E–04 | .328E–04 | .412E–04 | .457E–04 | .503E–04 | .527E–04 | .549E–04 | .572E–04 | .595E–04 |
| 120 | .366E–04 | .482E–04 | .614E–04 | .767E–04 | .849E–04 | .935E–04 | .977E–04 | .102E–03 | .106E–03 | .110E–03 |
| 130 | .672E–04 | .879E–04 | .111E–03 | .138E–03 | .153E–03 | .168E–03 | .175E–03 | .182E–03 | .190E–03 | .197E–03 |
| 140 | .120E–03 | .155E–03 | .195E–03 | .241E–03 | .266E–03 | .292E–03 | .304E–03 | .316E–03 | .329E–03 | .341E–03 |
| 150 | .207E–03 | .266E–03 | .332E–03 | .408E–03 | .449E–03 | .493E–03 | .514E–03 | .534E–03 | .554E–03 | .574E–03 |
| 160 | .348E–03 | .444E–03 | .550E–03 | .673E–03 | .740E–03 | .810E–03 | .844E–03 | .876E–03 | .909E–03 | .941E–03 |
| 170 | .572E–03 | .723E–03 | .889E–03 | .108E–02 | .119E–02 | .130E–02 | .135E–02 | .140E–02 | .145E–02 | .150E–02 |
| 180 | .917E–03 | .115E–02 | .140E–02 | .170E–02 | .186E–02 | .204E–02 | .212E–02 | .220E–02 | .227E–02 | .235E–02 |
| 190 | .144E–02 | .179E–02 | .217E–02 | .262E–02 | .286E–02 | .312E–02 | .325E–02 | .336E–02 | .348E–02 | .359E–02 |
| 200 | .221E–02 | .273E–02 | .329E–02 | .395E–02 | .431E–02 | .470E–02 | .488E–02 | .505E–02 | .522E–02 | .538E–02 |
| 210 | .333E–02 | .408E–02 | .490E–02 | .585E–02 | .637E–02 | .693E–02 | .720E–02 | .744E–02 | .768E–02 | .791E–02 |
| 220 | .494E–02 | .601E–02 | .715E–02 | .850E–02 | .924E–02 | .100E–01 | .104E–01 | .108E–01 | .111E–01 | .114E–01 |
| 230 | .719E–02 | .869E–02 | .103E–01 | .122E–01 | .132E–01 | .143E–01 | .149E–01 | .153E–01 | .158E–01 | .162E–01 |
| 240 | .103E–01 | .124E–01 | .146E–01 | .171E–01 | .186E–01 | .201E–01 | .209E–01 | .215E–01 | .221E–01 | .227E–01 |
| 250 | .146E–01 | .174E–01 | .203E–01 | .238E–01 | .257E–01 | .278E–01 | .289E–01 | .297E–01 | .305E–01 | .314E–01 |
| 260 | .203E–01 | .240E–01 | .279E–01 | .326E–01 | .352E–01 | .380E–01 | .394E–01 | .405E–01 | .416E–01 | .427E–01 |
| 270 | .279E–01 | .329E–01 | .380E–01 | .441E–01 | .475E–01 | .513E–01 | .531E–01 | .545E–01 | .560E–01 | .574E–01 |
| 280 | .380E–01 | .444E–01 | .510E–01 | .589E–01 | .633E–01 | .683E–01 | .706E–01 | .725E–01 | .744E–01 | .762E–01 |
| 290 | .510E–01 | .592E–01 | .676E–01 | .778E–01 | .835E–01 | .900E–01 | .930E–01 | .954E–01 | .978E–01 | .100 |
| 300 | .678E–01 | .782E–01 | .888E–01 | .102 | .109 | .117 | .121 | .124 | .127 | .130 |
| 310 | .892E–01 | .102 | .115 | .132 | .141 | .151 | .156 | .160 | .164 | .167 |
| 320 | .116 | .132 | .149 | .169 | .180 | .193 | .199 | .204 | .209 | .213 |
| 330 | .150 | .170 | .190 | .214 | .228 | .245 | .252 | .258 | .263 | .269 |
| 340 | .192 | .216 | .240 | .270 | .287 | .307 | .317 | .328 | .330 | .386 |
| 350 | .243 | .272 | .301 | .337 | .358 | .383 | .394 | .402 | .410 | .417 |

*Vermeulen, Dong, Robinson, Nguyen, and Gmitro, AIChE meeting, Anaheim, CA, 1982; and private communication from Prof. Theodore Vermeulen, Chemical Engineering Dept., University of California, Berkeley.

**TABLE 2-15 Total Pressure, bar, of Aqueous Sulfuric Acid Solutions***

| | Weight percent, $H_2SO_4$ | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| °C | 10.0 | 20.0 | 30.0 | 40.0 | 50.0 | 60.0 | 70.0 | 75.0 | 80.0 | 85.0 |
| 0 | .582E–02 | .534E–02 | .448E–02 | .326E–02 | .193E–02 | .836E–03 | .207E–03 | .747E–04 | .197E–04 | .343E–05 |
| 10 | .117E–01 | .107E–01 | .909E–02 | .670E–02 | .405E–02 | .180E–02 | .467E–03 | .175E–03 | .490E–04 | .952E–05 |
| 20 | .223E–01 | .205E–01 | .174E–01 | .130E–01 | .802E–02 | .367E–02 | .995E–03 | .388E–03 | .115E–03 | .245E–04 |
| 30 | .404E–01 | .373E–01 | .319E–01 | .241E–01 | .151E–01 | .710E–02 | .201E–02 | .811E–03 | .253E–03 | .589E–04 |
| 40 | .703E–01 | .649E–01 | .558E–01 | .427E–01 | .272E–01 | .131E–01 | .387E–02 | .162E–02 | .531E–03 | .134E–03 |
| 50 | .117 | .109 | .939E–01 | .725E–01 | .470E–01 | .232E–01 | .715E–02 | .309E–02 | .106E–02 | .286E–03 |
| 60 | .189 | .175 | .152 | .119 | .782E–01 | .395E–01 | .127E–01 | .565E–02 | .204E–02 | .584E–03 |
| 70 | .296 | .275 | .239 | .188 | .126 | .651E–01 | .217E–01 | .997E–01 | .376E–02 | .114E–02 |
| 80 | .449 | .417 | .365 | .290 | .196 | .104 | .360E–01 | .170E–01 | .668E–02 | .213E–02 |
| 90 | .664 | .617 | .542 | .434 | .298 | .161 | .578E–01 | .281E–01 | .115E–01 | .383E–02 |
| 100 | .957 | .891 | .786 | .634 | .441 | .244 | .905E–01 | .452E–01 | .192E–01 | .666E–02 |
| 110 | 1.349 | 1.258 | 1.113 | .904 | .638 | .360 | .138 | .708E–01 | .312E–01 | .112E–01 |
| 120 | 1.863 | 1.740 | 1.544 | 1.264 | .903 | .519 | .206 | .108 | .493E–01 | .183E–01 |
| 130 | 2.524 | 2.361 | 2.101 | 1.732 | 1.253 | .734 | .301 | .162 | .760E–01 | .291E–01 |
| 140 | 3.361 | 3.149 | 2.810 | 2.333 | 1.708 | 1.020 | .431 | .236 | .115 | .451E–01 |
| 150 | 4.404 | 4.132 | 3.697 | 3.090 | 2.289 | 1.392 | .605 | .339 | .170 | .683E–01 |
| 160 | 5.685 | 5.342 | 4.793 | 4.031 | 3.021 | 1.870 | .837 | .478 | .246 | .101 |
| 170 | 7.236 | 6.810 | 6.127 | 5.185 | 3.930 | 2.475 | 1.138 | .662 | .350 | .147 |
| 180 | 9.093 | 8.571 | 7.731 | 6.584 | 5.045 | 3.233 | 1.525 | .902 | .489 | .209 |
| 190 | 11.289 | 10.658 | 9.640 | 8.259 | 6.397 | 4.169 | 2.017 | 1.212 | .673 | .292 |
| 200 | 13.861 | 13.107 | 11.887 | 10.245 | 8.020 | 5.312 | 2.633 | 1.606 | .913 | .402 |
| 210 | 16.841 | 15.951 | 14.505 | 12.576 | 9.948 | 6.696 | 3.396 | 2.101 | 1.221 | .544 |
| 220 | 20.264 | 19.225 | 17.529 | 15.287 | 12.217 | 8.354 | 4.331 | 2.715 | 1.610 | .726 |
| 230 | 24.160 | 22.960 | 20.992 | 18.414 | 14.864 | 10.322 | 5.466 | 3.468 | 2.098 | .956 |
| 240 | 28.561 | 27.188 | 24.927 | 21.992 | 17.929 | 12.641 | 6.832 | 4.382 | 2.701 | 1.242 |
| 250 | 33.494 | 31.939 | 29.364 | 26.056 | 21.452 | 15.351 | 8.459 | 5.481 | 3.439 | 1.594 |
| 260 | 38.984 | 37.240 | 34.334 | 30.642 | 25.472 | 18.496 | 10.384 | 6.791 | 4.332 | 2.023 |
| 270 | 45.055 | 43.116 | 39.865 | 35.784 | 30.030 | 22.122 | 12.642 | 8.337 | 5.402 | 2.540 |
| 280 | 51.726 | 49.590 | 45.984 | 41.514 | 35.168 | 26.275 | 15.272 | 10.147 | 6.673 | 3.157 |
| 290 | 59.015 | 56.681 | 52.715 | 47.866 | 40.926 | 31.004 | 18.315 | 12.250 | 8.170 | 3.886 |
| 300 | 66.934 | 64.407 | 60.081 | 54.869 | 47.347 | 36.361 | 21.814 | 14.675 | 9.916 | 4.740 |
| 310 | 75.495 | 72.781 | 68.101 | 62.553 | 54.470 | 42.398 | 25.812 | 17.453 | 11.939 | 5.732 |
| 320 | 84.705 | 81.816 | 76.792 | 70.947 | 62.338 | 49.168 | 30.355 | 20.611 | 14.264 | 6.876 |
| 330 | 94.567 | 91.518 | 86.172 | 80.078 | 70.990 | 56.727 | 35.489 | 24.182 | 16.916 | 8.185 |
| 340 | 105.083 | 101.894 | 96.252 | 89.970 | 80.466 | 65.130 | 41.262 | 28.193 | 19.920 | 9.672 |
| 350 | 116.251 | 112.947 | 107.043 | 100.647 | 90.806 | 74.437 | 47.723 | 32.674 | 23.303 | 11.351 |

| | Weight percent, $H_2SO_4$ | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| °C | 90.0 | 92.0 | 94.0 | 96.0 | 97.0 | 98.0 | 98.5 | 99.0 | 99.5 | 100.0 |
| 0 | .518E–06 | .243E–06 | .109E–06 | .416E–07 | .235E–07 | .117E–07 | .768E–08 | .479E–08 | .313E–08 | .323E–08 |
| 10 | .159E–05 | .765E–06 | .348E–06 | .136E–06 | .774E–07 | .391E–07 | .261E–07 | .166E–07 | .113E–07 | .124E–07 |
| 20 | .449E–05 | .221E–05 | .102E–05 | .407E–06 | .235E–06 | .121E–06 | .812E–07 | .528E–07 | .373E–07 | .435E–07 |
| 30 | .117E–04 | .590E–05 | .279E–05 | .113E–05 | .659E–06 | .344E–06 | .234E–06 | .155E–06 | .114E–06 | .141E–06 |
| 40 | .385E–04 | .147E–04 | .708E–05 | .293E–05 | .173E–05 | .914E–06 | .630E–06 | .425E–06 | .323E–06 | .425E–06 |
| 50 | .653E–04 | .344E–04 | .169E–04 | .712E–05 | .425E–05 | .228E–05 | .159E–05 | .109E–05 | .861E–06 | .120E–05 |
| 60 | .141E–03 | .759E–04 | .380E–04 | .164E–04 | .987E–05 | .538E–05 | .379E–05 | .264E–05 | .216E–05 | .319E–05 |
| 70 | .291E–03 | .159E–03 | .813E–04 | .357E–04 | .218E–04 | .120E–04 | .856E–05 | .605E–05 | .514E–05 | .804E–05 |
| 80 | .571E–03 | .319E–03 | .166E–03 | .742E–04 | .458E–04 | .257E–04 | .184E–04 | .132E–04 | .117E–04 | .193E–04 |
| 90 | .107E–02 | .612E–03 | .324E–03 | .148E–03 | .921E–04 | .524E–04 | .390E–04 | .277E–04 | .253E–04 | .441E–04 |
| 100 | .195E–02 | .113E–02 | .607E–03 | .283E–03 | .178E–03 | .103E–03 | .751E–04 | .555E–04 | .527E–04 | .966E–04 |
| 110 | .340E–02 | .201E–02 | .110E–02 | .521E–03 | .332E–03 | .194E–03 | .143E–03 | .107E–03 | .106E–03 | .204E–03 |
| 120 | .575E–02 | .346E–02 | .192E–02 | .929E–03 | .598E–03 | .354E–03 | .263E–03 | .201E–03 | .206E–03 | .414E–03 |
| 130 | .944E–02 | .578E–02 | .327E–02 | .161E–02 | .104E–02 | .626E–03 | .470E–03 | .363E–03 | .387E–03 | .314E–03 |
| 140 | .151E–01 | .939E–02 | .539E–02 | .270E–02 | .177E–02 | .107E–02 | .815E–03 | .639E–03 | .708E–03 | .155E–02 |
| 150 | .235E–01 | .149E–01 | .866E–02 | .441E–02 | .293E–02 | .180E–02 | .137E–02 | .109E–02 | .126E–02 | .287E–02 |
| 160 | .357E–01 | .230E–01 | .136E–01 | .703E–02 | .471E–02 | .293E–02 | .226E–02 | .183E–02 | .219E–02 | .516E–02 |
| 170 | .532E–01 | .347E–01 | .208E–01 | .110E–01 | .741E–02 | .466E–02 | .363E–02 | .299E–02 | .372E–02 | .905E–02 |
| 180 | .775E–01 | .514E–01 | .312E–01 | .167E–01 | .114E–01 | .726E–02 | .571E–02 | .478E–02 | .619E–02 | .155E–01 |
| 190 | .111 | .747E–01 | .460E–01 | .250E–01 | .172E–01 | .111E–01 | .880E–02 | .749E–02 | .101E–01 | .260E–01 |
| 200 | .156 | .107 | .665E–01 | .367E–01 | .255E–01 | .166E–01 | .133E–01 | .115E–01 | .161E–01 | .427E–01 |
| 210 | .216 | .150 | .944E–01 | .530E–01 | .371E–01 | .245E–01 | .198E–01 | .175E–01 | .253E–01 | .687E–01 |
| 220 | .295 | .207 | .132 | .752E–01 | .531E–01 | .354E–01 | .289E–01 | .260E–01 | .392E–01 | .109 |
| 230 | .396 | .282 | .182 | .105 | .749E–01 | .505E–01 | .417E–01 | .382E–01 | .596E–01 | .169 |
| 240 | .525 | .379 | .247 | .145 | .104 | .710E–01 | .592E–01 | .553E–01 | .895E–01 | .258 |
| 250 | .688 | .503 | .331 | .197 | .143 | .985E–01 | .830E–01 | .790E–01 | .132 | .389 |
| 260 | .881 | .660 | .439 | .264 | .193 | .135 | .115 | .112 | .193 | .577 |
| 270 | 1.141 | .856 | .575 | .351 | .258 | .153 | .157 | .156 | .279 | .846 |
| 280 | 1.447 | 1.099 | .744 | .460 | .341 | .245 | .213 | .215 | .398 | 1.225 |
| 290 | 1.817 | 1.398 | .954 | .597 | .446 | .324 | .285 | .295 | .562 | 1.751 |
| 300 | 2.261 | 1.761 | 1.211 | .767 | .578 | .425 | .379 | .399 | .785 | 2.476 |
| 310 | 2.791 | 2.199 | 1.524 | .977 | .742 | .553 | .498 | .536 | 1.085 | 3.465 |
| 320 | 3.417 | 2.723 | 1.901 | 1.234 | .944 | .713 | .649 | .714 | 1.486 | 4.800 |
| 330 | 4.153 | 3.347 | 2.353 | 1.545 | 1.191 | .911 | .840 | .944 | 2.018 | 6.586 |
| 340 | 5.011 | 4.084 | 2.889 | 1.919 | 1.491 | 1.156 | 1.078 | 1.239 | 2.718 | 8.957 |
| 350 | 6.006 | 4.949 | 3.523 | 2.366 | 1.852 | 1.456 | 1.374 | 1.614 | 3.631 | 12.079 |

*Vermeulen, Dong, Robinson, Nguyen, and Gmitro, AIChE meeting, Anaheim, Calif., 1982; and private communication from Prof. Theodore Vermeulen, Chemical Engineering Dept., University of California, Berkeley.

**TABLE 2-16 Partial Pressures of $HNO_3$ and $H_2O$ over Aqueous Solutions of $HNO_3$**

mmHg

Percentages are weight % $HNO_3$ in solution.

| | 20% | | 25% | | 30% | | 35% | | 40% | | 45% | | 50% | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| °C | $HNO_3$ | $H_2O$ | $HNO_3$ | $H_2O$ | $HNO_3$ | $H_2O$ | $HNO_3$ | $H_2O$ | $HNO_3$ | $H_2O$ | $HNO_3$ | $H_2O$ | $HNO_3$ | $H_2O$ |
| 0 | | 4.1 | | 3.8 | | 3.6 | | 3.3 | | 3.0 | | 2.6 | | 2.1 |
| 5 | | 5.7 | | 5.4 | | 5.0 | | 4.6 | | 4.2 | | 3.6 | | 3.0 |
| 10 | | 8.0 | | 7.6 | | 7.1 | | 6.5 | | 5.8 | | 5.0 | 0.12 | 4.2 |
| 15 | | 10.9 | | 10.3 | | 9.7 | | 8.9 | | 8.0 | 0.10 | 6.9 | .18 | 5.8 |
| 20 | | 15.2 | | 14.2 | | 13.2 | | 12.0 | | 10.8 | .15 | 9.4 | .27 | 7.9 |
| 25 | | 20.6 | | 19.2 | | 17.8 | | 16.2 | 0.12 | 14.6 | .23 | 12.7 | .39 | 10.7 |
| 30 | | 27.6 | | 25.7 | | 23.8 | 0.09 | 21.7 | .17 | 19.5 | .33 | 16.9 | .56 | 14.4 |
| 35 | | 36.5 | | 33.8 | | 31.1 | .13 | 28.3 | .25 | 25.5 | .48 | 22.3 | .80 | 19.0 |
| 40 | | 47.5 | | 44 | 0.11 | 41 | .20 | 37.7 | .36 | 33.5 | .68 | 29.3 | 1.13 | 25.0 |
| 45 | | 62 | 0.09 | 57.5 | .17 | 53 | .28 | 48 | .52 | 43 | .96 | 38.0 | 1.57 | 32.5 |
| 50 | | 80 | .13 | 75 | .25 | 69 | .42 | 63 | .75 | 56 | 1.35 | 49.5 | 2.18 | 42.5 |
| 55 | 0.09 | 100 | .18 | 94 | .35 | 87 | .59 | 79 | 1.04 | 71 | 1.83 | 62.5 | 2.95 | 54 |
| 60 | .13 | 128 | .28 | 121 | .51 | 113 | .85 | 102 | 1.48 | 90 | 2.54 | 80 | 4.05 | 70 |
| 65 | .19 | 162 | .40 | 151 | .71 | 140 | 1.18 | 127 | 2.05 | 114 | 3.47 | 100 | 5.46 | 88 |
| 70 | .27 | 200 | .54 | 187 | 1.00 | 174 | 1.63 | 159 | 2.80 | 143 | 4.65 | 126 | 7.25 | 110 |
| 75 | .38 | 250 | .77 | 234 | 1.38 | 217 | 2.26 | 198 | 3.80 | 178 | 6.20 | 158 | 9.6 | 138 |
| 80 | .53 | 307 | 1.05 | 287 | 1.87 | 267 | 3.07 | 243 | 5.10 | 218 | 8.15 | 195 | 12.5 | 170 |
| 85 | .74 | 378 | 1.44 | 352 | 2.53 | 325 | 4.15 | 297 | 6.83 | 268 | 10.7 | 240 | 16.3 | 211 |
| 90 | 1.01 | 458 | 1.95 | 426 | 3.38 | 393 | 5.50 | 359 | 9.0 | 325 | 13.7 | 292 | 20.9 | 258 |
| 95 | 1.37 | 555 | 2.62 | 517 | 4.53 | 478 | 7.32 | 436 | 11.7 | 394 | 17.8 | 355 | 26.8 | 315 |
| 100 | 1.87 | 675 | 3.50 | 628 | 6.05 | 580 | 9.7 | 530 | 15.5 | 480 | 23.0 | 430 | 34.2 | 383 |
| 105 | 2.50 | 800 | 4.65 | 745 | 7.90 | 690 | 12.7 | 631 | 20.0 | 573 | 29.2 | 520 | 43.0 | 463 |
| 110 | | | | | | | 16.5 | 755 | 25.7 | 688 | 37.0 | 625 | 54.5 | 560 |
| 115 | | | | | | | | | 32.5 | 810 | 46 | 740 | 67 | 665 |
| 120 | | | | | | | | | | | | | 84 | 785 |

| | 55% | | 60% | | 65% | | 70% | | 80% | | 90% | | 100% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| °C | $HNO_3$ | $H_2O$ | $HNO_3$ | $H_2O$ | $HNO_3$ | $H_2O$ | $HNO_3$ | $H_2O$ | $HNO_3$ | $H_2O$ | $HNO_3$ | $H_2O$ | $HNO_3$ |
| 0 | | 1.8 | 0.19 | 1.5 | 0.41 | 1.3 | 0.79 | 1.1 | 2 | | 5.5 | | 11 |
| 5 | 0.14 | 2.5 | .28 | 2.1 | .60 | 1.8 | 1.12 | 1.6 | 3 | | 8 | | 15 |
| 10 | .21 | 3.5 | .41 | 3.0 | .86 | 2.6 | 1.58 | 2.2 | 4 | 1.2 | 11 | | 22 |
| 15 | .31 | 4.9 | .59 | 4.1 | 1.21 | 3.5 | 2.18 | 3.0 | 6 | 1.7 | 15 | | 30 |
| 20 | .45 | 6.7 | .84 | 5.6 | 1.68 | 4.9 | 3.00 | 4.1 | 8 | 2.4 | 20 | | 42 |
| 25 | .66 | 9.1 | 1.21 | 7.7 | 2.32 | 6.6 | 4.10 | 5.5 | 10.5 | 3.2 | 27 | 1 | 57 |
| 30 | .93 | 12.2 | 1.66 | 10.3 | 3.17 | 8.8 | 5.50 | 7.4 | 14 | 4 | 36 | 1.3 | 77 |
| 35 | 1.30 | 16.1 | 2.28 | 13.6 | 4.26 | 11.6 | 7.30 | 9.8 | 18.5 | 5.5 | 47 | 1.8 | 102 |
| 40 | 1.82 | 21.3 | 3.10 | 18.1 | 5.70 | 15.5 | 9.65 | 12.8 | 24.5 | 7 | 62 | 2.4 | 133 |
| 45 | 2.50 | 28.0 | 4.20 | 23.7 | 7.55 | 20.0 | 12.6 | 16.7 | 32 | 9.5 | 80 | 3 | 170 |
| 50 | 3.41 | 36.3 | 5.68 | 31 | 10.0 | 26.0 | 16.5 | 21.8 | 41 | 12 | 103 | 4 | 215 |
| 55 | 4.54 | 46 | 7.45 | 39 | 12.8 | 33.0 | 21.0 | 27.3 | 52 | 15 | 127 | 5 | 262 |
| 60 | 6.15 | 60 | 9.9 | 51 | 16.8 | 43.0 | 27.1 | 35.3 | 67 | 20 | 157 | 6.5 | 320 |
| 65 | 8.18 | 76 | 13.0 | 64 | 21.7 | 54.5 | 34.5 | 44.5 | 85 | 25 | 192 | 8 | 385 |
| 70 | 10.7 | 95 | 16.8 | 81 | 27.5 | 68 | 43.3 | 56 | 106 | 31 | 232 | 10 | 460 |
| 75 | 13.9 | 120 | 21.8 | 102 | 35.0 | 86 | 54.5 | 70 | 130 | 38 | 282 | 13 | 540 |
| 80 | 18.0 | 148 | 27.5 | 126 | 43.5 | 106 | 67.5 | 86 | 158 | 48 | 338 | 16 | 625 |
| 85 | 23.0 | 182 | 34.8 | 156 | 54.5 | 131 | 83 | 107 | 192 | 60 | 405 | 20 | 720 |
| 90 | 29.4 | 223 | 43.7 | 192 | 67.5 | 160 | 103 | 130 | 230 | 73 | 480 | 24 | 820 |
| 95 | 37.3 | 272 | 55.0 | 233 | 83.5 | 195 | 125 | 158 | 278 | 89 | 570 | 29 | |
| 100 | 47 | 331 | 69.5 | 285 | 103 | 238 | 152 | 192 | 330 | 108 | 675 | 35 | |
| 105 | 58.5 | 400 | 84.5 | 345 | 124 | 288 | 183 | 231 | 392 | 129 | 790 | 42 | |
| 110 | 73 | 485 | 103 | 417 | 152 | 345 | 221 | 278 | 465 | 155 | | | |
| 115 | 90 | 575 | 126 | 495 | 181 | 410 | 262 | 330 | 545 | 185 | | | |
| 120 | 110 | 685 | 156 | 590 | 218 | 490 | 312 | 393 | 640 | 219 | | | |
| 125 | | | 187 | 700 | 260 | 580 | 372 | 469 | | | | | |

**TABLE 2-17 Partial Pressures of $H_2O$ and HBr over Aqueous Solutions of HBr at 20 to 55°C**

mmHg

| % HBr | 20°C | | 25°C | | 50°C | | 55°C | |
|---|---|---|---|---|---|---|---|---|
| | HBr | $H_2O$ | HBr | $H_2O$ | HBr | $H_2O$ | HBr | $H_2O$ |
| 32 | | | 0.0016 | | | | | |
| 34 | | | .0022 | | | | | |
| 36 | | | .0033 | | | | | |
| 38 | | | .0061 | | | | | |
| 40 | | | .011 | | | | | |
| 42 | | | .023 | | | | | |
| 44 | | | .048 | | | | | |
| 46 | | | .10 | | | | | |
| 48 | 0.09 | 6.2 | .13 | 8.2 | 1.3 | 30.2 | 2.0 | 38 |
| 50 | .23 | 4.5 | .37 | 6.1 | 3.2 | 24.3 | 4.6 | 31 |
| 52 | .71 | 3.3 | 1.1 | 4.5 | 7.2 | 19.3 | 10.2 | 25 |
| 54 | 2.2 | 2.4 | 3.2 | 3.3 | 17 | 16.0 | 23.0 | 21 |
| 56 | 6.8 | 1.7 | 9.3 | 2.4 | 40 | 13.3 | 51 | 18 |
| 58 | 21 | 1.3 | 27 | 1.9 | 91 | 10.4 | 115 | 14 |
| 60 | | | | | | | 260 | 11.4 |

**TABLE 2-18 Partial Pressures of HI over Aqueous Solutions of HI at 25°C**

mmHg

| %HI | 4 | 46 | 48 | 50 | 52 | 54 | 56 |
|---|---|---|---|---|---|---|---|
| $p_{HI}$ | 0.00064 | 0.0010 | 0.0022 | 0.0050 | 0.013 | 0.035 | 0.10 |

**TABLE 2-19 Vapor Pressures of the System: Water-Sulfuric Acid-Nitric Acid**

For these data reference must be made to the graphs of *International Critical Tables*, vol. 3, pp. 306–308.

**TABLE 2-20 Total Vapor Pressures of Aqueous Solutions of $CH_3COOH$**

Percentages of weight % acetic acid in the solution

mmHg

| °C | 25% | 50% | 75% |
|---|---|---|---|
| 20 | 16.3 | 15.7 | 15.3 |
| 25 | 22.1 | 21.4 | 20.8 |
| 30 | 29.6 | 28.8 | 27.8 |
| 35 | 39.4 | 38.3 | 36.6 |
| 40 | 51.7 | 50.2 | 48.1 |
| 45 | 67.0 | 65.0 | 62.0 |
| 50 | 87.2 | 85.0 | 80.1 |
| 55 | 110 | 107 | 102 |
| 60 | 141 | 138 | 130 |
| 65 | 178 | 172 | 162 |
| 70 | 223 | 216 | 203 |
| 75 | 277 | 269 | 251 |
| 80 | 342 | 331 | 310 |
| 85 | 419 | 407 | 376 |
| 90 | 510 | 497 | 458 |
| 95 | 618 | 602 | 550 |
| 100 | 743 | 725 | 666 |

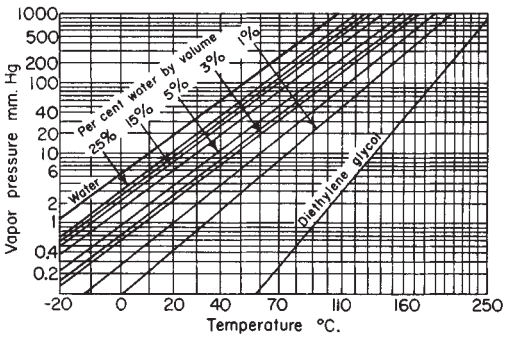


**FIG. 2-3** Vapor pressure of aqueous diethylene glycol solutions. (*Courtesy of Carbide and Carbon Chemicals Corp.*)

**TABLE 2-21 Partial Pressures of $H_2O$ over Aqueous Solutions of $NH_3$***

Pressures are in pounds per square inch absolute

| | Molal concentration of ammonia in the solutions in percentages (Weight concentration of ammonia in the solution in percentages) | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $t$, °F | 0 (0) | 5 (4.74) | 10 (9.50) | 15 (14.29) | 20 (19.10) | 25 (23.94) | 30 (28.81) | 35 (33.71) | 40 (38.64) | 45 (43.59) | 50 (48.57) | 55 (53.58) | 60 (58.62) | 65 (63.69) | 70 (68.79) | 75 (73.91) | 80 (79.07) | 85 (84.26) | 90 (89.47) | 95 (94.72) |
| 32 | 0.09 | 0.084 | 0.079 | 0.074 | 0.070 | 0.065 | 0.060 | 0.056 | 0.051 | 0.047 | 0.042 | 0.038 | 0.034 | 0.030 | 0.025 | 0.021 | 0.017 | 0.013 | 0.008 | 0.004 |
| 40 | .12 | .115 | .108 | .101 | .095 | .089 | .083 | .076 | .070 | .064 | .058 | .052 | .046 | .040 | .035 | .029 | .023 | .015 | .012 | .006 |
| 50 | .18 | .17 | .16 | .15 | .14 | .13 | .12 | .11 | .10 | .094 | .085 | .076 | .068 | .059 | .051 | .042 | .034 | .025 | .017 | .008 |
| 60 | .26 | .24 | .23 | .21 | .20 | .19 | .17 | .16 | .15 | .13 | .12 | .11 | .097 | .085 | .073 | .061 | .049 | .037 | .024 | .012 |
| 70 | .36 | .34 | .32 | .30 | .28 | .26 | .25 | .23 | .21 | .19 | .17 | .15 | .14 | .12 | .10 | .086 | .069 | .052 | .034 | .017 |
| 80 | .51 | .48 | .45 | .42 | .40 | .37 | .34 | .32 | .29 | .27 | .24 | .22 | .19 | .17 | .14 | .12 | .096 | .072 | .048 | .024 |
| 90 | .70 | .66 | .63 | .58 | .55 | .51 | .47 | .44 | .40 | .37 | .33 | .30 | .26 | .23 | .20 | .16 | .13 | .10 | .066 | .033 |
| 100 | .95 | .90 | .85 | .79 | .74 | .69 | .64 | .59 | .55 | .50 | .45 | .41 | .36 | .31 | .27 | .22 | .18 | .13 | .090 | .045 |
| 110 | 1.27 | 1.20 | 1.14 | 1.07 | 1.00 | .93 | .86 | .80 | .73 | .67 | .60 | .54 | .48 | .42 | .36 | .30 | .24 | .18 | .120 | .061 |
| 120 | 1.69 | 1.60 | 1.51 | 1.42 | 1.33 | 1.24 | 1.15 | 1.06 | .97 | .89 | .80 | .72 | .64 | .56 | .48 | .40 | .32 | .24 | .160 | .081 |
| 130 | 2.22 | 2.10 | 1.98 | 1.86 | 1.74 | 1.62 | 1.51 | 1.39 | 1.28 | 1.17 | 1.05 | .95 | .84 | .74 | .63 | .53 | .42 | .32 | .210 | .100 |
| 140 | 2.89 | 2.73 | 2.57 | 2.42 | 2.26 | 2.11 | 1.96 | 1.81 | 1.66 | 1.52 | 1.37 | 1.23 | 1.10 | .96 | .82 | .69 | .55 | .41 | .270 | .140 |
| 150 | 3.72 | 3.51 | 3.31 | 3.11 | 2.91 | 2.72 | 2.52 | 2.33 | 2.14 | 1.95 | 1.76 | 1.59 | 1.41 | 1.24 | 1.06 | .88 | .71 | .53 | .350 | .180 |
| 160 | 4.74 | 4.48 | 4.22 | 3.97 | 3.71 | 3.46 | 3.22 | 2.97 | 2.73 | 2.49 | 2.25 | 2.02 | 1.80 | 1.58 | 1.35 | 1.12 | .90 | .67 | .450 | .220 |
| 170 | 5.99 | 5.66 | 5.34 | 5.02 | 4.70 | 4.38 | 4.07 | 3.75 | 3.45 | 3.15 | 2.84 | 2.56 | 2.28 | 1.99 | 1.71 | 1.42 | 1.13 | 1.85 | .570 | .300 |
| 180 | 7.51 | 7.10 | 6.69 | 6.30 | 5.89 | 5.49 | 5.10 | 4.71 | 4.33 | 3.94 | 3.57 | 3.21 | 2.85 | 2.50 | 2.14 | 1.77 | 1.42 | 1.06 | | |
| 190 | 9.34 | 8.83 | 8.32 | 7.82 | 7.32 | 6.83 | 6.34 | 5.86 | 5.38 | 4.91 | 4.44 | 3.99 | 3.55 | 3.10 | 2.65 | | | | | |
| 200 | 11.53 | 10.90 | 10.27 | 9.65 | 9.04 | 8.43 | 7.83 | 7.23 | 6.64 | 6.06 | 5.48 | 4.93 | 4.38 | 3.81 | | | | | | |
| 210 | 14.12 | 13.35 | 12.58 | 11.82 | 11.07 | 10.32 | 9.59 | 8.86 | 8.13 | 7.42 | 6.71 | 6.04 | 5.34 | | | | | | | |
| 220 | 17.19 | 16.25 | 15.32 | 14.39 | 13.48 | 12.57 | 11.67 | 10.78 | 9.90 | 9.03 | 8.17 | 7.31 | | | | | | | | |
| 230 | 20.78 | 19.64 | 18.51 | 17.40 | 16.29 | 15.19 | 14.11 | 13.03 | 11.97 | 10.91 | 9.87 | | | | | | | | | |
| 240 | 24.97 | 23.60 | 22.25 | 20.91 | 19.58 | 18.26 | 16.95 | 15.66 | 14.38 | 13.12 | 11.86 | | | | | | | | | |
| 250 | 29.83 | 28.20 | 26.58 | 25.00 | 23.39 | 21.82 | 20.25 | 18.71 | 17.18 | 15.67 | | | | | | | | | | |

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**TABLE 2-22 Mole Percentages of $H_2O$ over Aqueous Solutions of $NH_3$***

| | Molal concentration of ammonia in the solutions in percentages (Weight concentration of ammonia in the solutions in percentages) | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *t*, °F | 0 (0) | 5 (4.74) | 10 (9.50) | 15 (14.29) | 20 (19.10) | 25 (23.94) | 30 (28.81) | 35 (33.71) | 40 (38.64) | 45 (43.59) | 50 (48.57) | 55 (53.58) | 60 (58.62) | 65 (63.69) | 70 (68.79) | 75 (73.91) | 80 (79.07) | 85 (84.26) | 90 (89.47) | 95 (94.72) | 100 (100.00) |
| 32 | 100 | 24.3 | 13.2 | 7.63 | 4.43 | 2.50 | 1.43 | 0.856 | 0.514 | 0.335 | 0.216 | 0.151 | 0.109 | 0.0816 | 0.0585 | 0.0457 | 0.0345 | 0.0249 | 0.0146 | 0.00689 | 0.00 |
| 40 | 100 | 25.3 | 14.1 | 8.15 | 4.73 | 2.74 | 1.59 | .943 | .581 | .372 | .248 | .172 | .124 | .0914 | .0706 | .0533 | .0395 | .0243 | .0185 | .00879 | |
| 50 | 100 | 26.6 | 15.2 | 9.09 | 5.24 | 3.03 | 1.78 | 1.060 | .652 | .434 | .290 | .202 | .148 | .1095 | .0838 | .0630 | .0477 | .0332 | .0215 | .00959 | |
| 60 | 100 | 27.9 | 16.2 | 9.50 | 5.69 | 3.42 | 1.97 | 1.210 | .777 | .481 | .331 | .238 | .172 | .1290 | .0986 | .0754 | .0566 | .0406 | .0251 | .01125 | |
| 70 | 100 | 29.1 | 17.4 | 10.30 | 6.14 | 3.65 | 2.27 | 1.390 | .873 | .569 | .383 | .266 | .205 | .1510 | .112 | .0882 | .0656 | .0474 | .0296 | .0135 | |
| 80 | 100 | 31.6 | 18.5 | 11.20 | 6.89 | 4.08 | 2.45 | 1.550 | .978 | .659 | .444 | .323 | .230 | .1750 | .130 | .103 | .0772 | .0528 | .0351 | .0167 | |
| 90 | 100 | 32.7 | 20.0 | 12.00 | 7.40 | 4.47 | 2.73 | 1.730 | 1.100 | .742 | .505 | .366 | .267 | .2020 | .157 | .115 | .0884 | .0647 | .0408 | .0194 | |
| 100 | 100 | 34.4 | 21.0 | 12.90 | 7.92 | 4.85 | 3.00 | 1.890 | 1.250 | .834 | .574 | .420 | .307 | .2290 | .179 | .135 | .104 | .0714 | .0473 | .0226 | |
| 110 | 100 | 35.9 | 22.2 | 13.80 | 8.59 | 5.29 | 3.30 | 2.110 | 1.370 | .932 | .644 | .466 | .347 | .2640 | .208 | .157 | .118 | .0846 | .0540 | .0262 | |
| 120 | 100 | 37.5 | 23.4 | 14.70 | 9.22 | 5.75 | 3.63 | 2.320 | 1.520 | 1.044 | .714 | .529 | .395 | .3020 | .233 | .180 | .135 | .0970 | .0619 | .0300 | |
| 130 | 100 | 39.0 | 24.5 | 15.60 | 9.85 | 6.18 | 3.95 | 2.550 | 1.690 | 1.160 | .811 | .596 | .444 | .3430 | .263 | .205 | .154 | .1117 | .0703 | .0339 | |
| 140 | 100 | 40.7 | 25.8 | 16.50 | 10.50 | 6.69 | 4.28 | 2.790 | 1.860 | 1.286 | .906 | .663 | .501 | .3840 | .297 | .232 | .175 | .124 | .0786 | .0385 | |
| 150 | 100 | 42.3 | 27.1 | 17.50 | 11.20 | 7.19 | 4.63 | 3.080 | 2.040 | 1.410 | 1.004 | .741 | .558 | .4320 | .334 | .257 | .197 | .140 | .0892 | .0439 | |
| 160 | 100 | 44.1 | 28.3 | 18.40 | 11.90 | 7.69 | 5.01 | 3.300 | 2.230 | 1.550 | 1.110 | .818 | .617 | .4800 | .372 | .287 | .218 | .154 | .1005 | .0499 | |
| 170 | 100 | 45.6 | 29.6 | 19.40 | 12.70 | 8.22 | 5.38 | 3.580 | 2.430 | 1.700 | 1.220 | .904 | .689 | .5300 | .414 | .320 | .242 | .174 | .112 | .0567 | |
| 180 | 100 | 47.3 | 30.9 | 20.40 | 13.40 | 8.76 | 5.78 | 3.870 | 2.640 | 1.850 | 1.340 | .994 | .756 | .5860 | .456 | .352 | .268 | .192 | | | |
| 190 | 100 | 48.7 | 32.2 | 21.40 | 14.10 | 9.31 | 6.18 | 4.160 | 2.860 | 2.020 | 1.460 | 1.087 | .830 | .6420 | .501 | | | | | | |
| 200 | 100 | 50.4 | 33.4 | 22.30 | 14.90 | 9.88 | 6.59 | 4.470 | 3.080 | 2.190 | 1.580 | 1.187 | .907 | .7010 | | | | | | | |
| 210 | 100 | 52.1 | 34.7 | 23.40 | 15.70 | 10.45 | 7.03 | 4.780 | 3.310 | 2.360 | 1.720 | 1.272 | .983 | | | | | | | | |
| 220 | 100 | 53.7 | 36.1 | 24.40 | 16.40 | 11.05 | 7.48 | 5.100 | 3.560 | 2.540 | 1.860 | 1.390 | | | | | | | | | |
| 230 | 100 | 55.2 | 37.3 | 25.40 | 17.30 | 11.63 | 7.91 | 5.440 | 3.810 | 2.730 | 2.000 | | | | | | | | | | |
| 240 | 100 | 56.8 | 38.6 | 26.50 | 18.00 | 12.24 | 8.36 | 5.780 | 4.060 | 2.920 | 2.150 | | | | | | | | | | |
| 250 | 100 | 58.4 | 39.8 | 27.50 | 18.80 | 12.88 | 8.82 | 6.120 | 4.340 | 3.120 | | | | | | | | | | | |

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**TABLE 2-23 Partial Pressures of $NH_3$ over Aqueous Solutions of $NH_3$***

Pressures are in pounds per square inch absolute

| | Molal concentration of ammonia in the solutions in percentages (Weight concentration of ammonia in the solutions in percentages) | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *t*, °F | 5 (4.74) | 10 (9.50) | 15 (14.29) | 20 (19.10) | 25 (23.94) | 30 (28.81) | 35 (33.71) | 40 (38.64) | 45 (43.59) | 50 (48.57) | 55 (53.58) | 60 (58.62) | 65 (63.69) | 70 (68.79) | 75 (73.91) | 80 (79.07) | 85 (84.26) | 90 (89.47) | 95 (94.72) |
| 32 | 0.26 | 0.52 | 0.90 | 1.51 | 2.67 | 4.27 | 6.54 | 8.93 | 14.13 | 19.36 | 25.12 | 31.13 | 36.74 | 42.69 | 45.92 | 49.26 | 52.13 | 54.89 | 58.01 |
| 40 | .33 | .66 | 1.14 | 1.92 | 3.16 | 5.13 | 7.98 | 11.98 | 17.14 | 23.33 | 30.15 | 37.15 | 43.69 | 49.56 | 54.40 | 58.31 | 61.62 | 64.77 | 68.31 |
| 50 | .47 | .89 | 1.50 | 2.53 | 4.16 | 6.63 | 10.24 | 15.24 | 21.56 | 29.17 | 37.46 | 45.86 | 53.79 | 60.82 | 66.63 | 71.26 | 75.22 | 79.05 | 83.40 |
| 60 | .62 | 1.19 | 2.00 | 3.21 | 5.36 | 8.48 | 13.06 | 19.15 | 26.92 | 36.14 | 46.12 | 56.22 | 65.81 | 73.99 | 80.90 | 86.44 | 91.04 | 95.67 | 100.65 |
| 70 | .83 | 1.52 | 2.60 | 4.28 | 6.87 | 10.76 | 16.33 | 23.84 | 33.20 | 44.25 | 56.29 | 68.32 | 79.42 | 89.26 | 97.42 | 104.01 | 109.55 | 114.83 | 120.61 |
| 80 | 1.04 | 1.98 | 3.34 | 5.45 | 8.69 | 13.52 | 20.29 | 29.40 | 40.69 | 53.84 | 67.97 | 82.36 | 95.52 | 107.06 | 116.42 | 124.20 | 130.57 | 136.35 | 143.70 |
| 90 | 1.36 | 2.52 | 4.25 | 6.88 | 10.89 | 16.76 | 25.04 | 35.94 | 49.45 | 64.99 | 81.61 | 98.35 | 113.79 | 127.22 | 138.18 | 147.02 | 154.46 | 161.74 | 169.73 |
| 100 | 1.72 | 3.20 | 5.34 | 8.60 | 13.53 | 20.68 | 30.57 | 43.57 | 59.49 | 77.85 | 97.27 | 116.81 | 134.70 | 150.23 | 162.94 | 173.22 | 181.97 | 190.13 | 199.17 |
| 110 | 2.14 | 4.00 | 6.65 | 10.64 | 16.65 | 25.21 | 37.01 | 52.43 | 71.20 | 92.59 | 115.16 | 137.62 | 158.42 | 176.18 | 190.85 | 203.02 | 212.71 | 222.22 | 232.79 |
| 120 | 2.67 | 4.95 | 8.21 | 13.09 | 20.30 | 30.54 | 44.56 | 62.62 | 84.44 | 109.40 | 135.48 | 161.44 | 185.14 | 205.81 | 222.28 | 236.05 | 247.14 | 258.24 | 270.02 |
| 130 | 3.28 | 6.09 | 10.05 | 15.93 | 24.58 | 36.74 | 53.16 | 74.27 | 99.69 | 128.45 | 158.45 | 188.16 | 215.14 | 238.70 | 257.87 | 272.88 | 286.08 | 298.46 | 311.80 |
| 140 | 3.97 | 7.41 | 12.21 | 19.23 | 29.43 | 43.77 | 62.97 | 87.53 | 116.72 | 149.93 | 184.17 | 218.18 | 248.70 | 275.33 | 297.12 | 314.45 | 328.99 | 342.93 | 358.46 |
| 150 | 4.78 | 8.92 | 14.70 | 23.09 | 35.09 | 51.91 | 74.28 | 102.51 | 136.15 | 173.64 | 212.91 | 251.24 | 286.00 | 316.24 | 340.82 | 360.39 | 376.57 | 392.45 | 409.62 |
| 160 | 5.68 | 10.70 | 17.57 | 27.45 | 41.56 | 61.03 | 86.91 | 119.37 | 157.71 | 200.45 | 244.98 | 288.38 | 327.82 | 361.75 | 389.08 | 411.30 | 429.73 | 447.35 | 466.38 |
| 170 | 6.75 | 12.67 | 20.85 | 32.41 | 48.89 | 71.48 | 101.09 | 138.30 | 181.95 | 230.36 | 280.54 | 329.42 | 373.61 | 411.59 | 442.28 | 466.67 | 487.85 | 507.63 | 528.50 |
| 180 | 7.90 | 14.96 | 24.56 | 38.13 | 57.19 | 83.07 | 116.97 | 159.37 | 208.66 | 263.43 | 319.89 | 374.25 | 424.10 | 466.26 | 500.63 | 528.08 | 551.24 | | |
| 190 | 9.23 | 17.55 | 28.78 | 44.49 | 66.49 | 96.22 | 134.89 | 182.72 | 238.39 | 299.86 | 363.11 | 424.15 | 479.40 | 526.15 | | | | | |
| 200 | 10.70 | 20.45 | 33.49 | 51.58 | 76.90 | 110.85 | 154.58 | 208.56 | 270.94 | 340.02 | 410.17 | 478.62 | 539.79 | | | | | | |
| 210 | 12.26 | 23.68 | 38.76 | 59.65 | 88.48 | 126.83 | 176.24 | 236.97 | 307.08 | 383.99 | 462.36 | 537.56 | | | | | | | |
| 220 | 14.02 | 27.15 | 44.61 | 68.43 | 101.24 | 144.74 | 200.46 | 268.30 | 346.07 | 431.43 | 518.19 | | | | | | | | |
| 230 | 15.95 | 31.09 | 51.06 | 78.14 | 115.45 | 164.17 | 226.67 | 302.53 | 389.29 | 483.53 | | | | | | | | | |
| 240 | 17.92 | 35.40 | 58.00 | 89.02 | 130.94 | 185.79 | 255.26 | 339.72 | 435.78 | 540.44 | | | | | | | | | |
| 250 | 20.12 | 40.09 | 65.74 | 100.69 | 147.66 | 209.37 | 286.89 | 380.42 | 486.73 | | | | | | | | | | |

*Wilson, *Univ. Ill., Eng. Expt. Sta. Bull.* 146.

**TABLE 2-24 Total Vapor Pressures of Aqueous Solutions of $NH_3$***

Pressures are in pounds per square inch absolute

| | Molal concentration of ammonia in the solutions in percentages (Weight concentration of ammonia in the solutions in percentages) | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *t*, °F | 0 (0) | 5 (4.74) | 10 (9.50) | 15 (14.29) | 20 (19.10) | 25 (23.94) | 30 (28.81) | 35 (33.71) | 40 (38.64) | 45 (43.59) | 50 (48.57) | 55 (53.58) | 60 (58.62) | 65 (63.69) | 70 (68.79) | 75 (73.91) | 80 (79.07) | 85 (84.26) | 90 (89.47) | 95 (94.72) | 100 (100.00) |
| 32 | 0.09 | 0.34 | 0.60 | 0.97 | 1.58 | 2.60 | 4.20 | 6.54 | 9.93 | 14.18 | 19.40 | 25.16 | 31.16 | 36.77 | 42.72 | 45.94 | 49.28 | 52.14 | 54.90 | 58.01 | 62.29 |
| 40 | .12 | .45 | .77 | 1.24 | 2.01 | 3.25 | 5.21 | 8.06 | 12.05 | 17.20 | 23.39 | 30.20 | 37.20 | 43.73 | 49.60 | 54.43 | 58.33 | 61.64 | 64.78 | 68.32 | 73.32 |
| 50 | .18 | .64 | 1.05 | 1.65 | 2.67 | 4.29 | 6.75 | 10.35 | 15.34 | 21.65 | 29.26 | 37.54 | 45.93 | 53.85 | 60.87 | 66.67 | 71.29 | 75.25 | 79.07 | 83.41 | 89.19 |
| 60 | .26 | .86 | 1.42 | 2.21 | 3.51 | 5.55 | 8.65 | 13.22 | 19.30 | 27.05 | 36.26 | 46.23 | 56.32 | 65.90 | 74.06 | 80.96 | 86.49 | 91.08 | 95.69 | 100.66 | 107.6 |
| 70 | .36 | 1.17 | 1.84 | 2.90 | 4.56 | 7.13 | 11.01 | 16.56 | 24.05 | 33.39 | 44.42 | 56.44 | 68.46 | 79.54 | 89.36 | 97.51 | 104.08 | 109.60 | 114.86 | 120.63 | 128.8 |
| 80 | .51 | 1.52 | 2.43 | 3.76 | 5.85 | 9.06 | 13.86 | 20.61 | 29.69 | 40.96 | 54.08 | 68.19 | 82.55 | 95.69 | 107.20 | 116.54 | 124.30 | 130.64 | 136.40 | 143.72 | 153.0 |
| 90 | .70 | 2.02 | 3.15 | 4.83 | 7.43 | 11.40 | 17.23 | 25.48 | 36.34 | 49.82 | 65.32 | 81.91 | 98.61 | 114.02 | 127.42 | 138.34 | 147.15 | 154.56 | 161.81 | 169.76 | 180.6 |
| 100 | .95 | 2.62 | 4.05 | 6.13 | 9.34 | 14.22 | 21.32 | 31.16 | 44.12 | 59.99 | 78.30 | 97.68 | 117.17 | 135.01 | 150.50 | 163.16 | 173.40 | 182.10 | 190.22 | 199.22 | 211.9 |
| 110 | 1.27 | 3.34 | 5.14 | 7.72 | 11.64 | 17.58 | 26.07 | 37.81 | 53.16 | 71.87 | 93.19 | 115.7 | 138.10 | 158.84 | 176.54 | 191.15 | 203.26 | 212.89 | 222.34 | 232.85 | 247.0 |
| 120 | 1.69 | 4.27 | 6.46 | 9.63 | 14.42 | 21.54 | 31.69 | 45.62 | 63.59 | 85.33 | 110.2 | 136.2 | 162.08 | 185.70 | 206.29 | 222.68 | 236.37 | 247.38 | 258.40 | 270.1 | 286.4 |
| 130 | 2.22 | 5.38 | 8.07 | 11.91 | 17.67 | 26.20 | 38.25 | 54.55 | 75.55 | 100.86 | 129.5 | 159.0 | 189.00 | 215.88 | 239.33 | 258.40 | 273.3 | 286.4 | 298.67 | 311.9 | 330.3 |
| 140 | 2.89 | 6.70 | 9.98 | 14.63 | 21.49 | 31.54 | 45.73 | 64.78 | 89.19 | 118.24 | 151.3 | 185.4 | 219.28 | 249.66 | 276.15 | 297.81 | 315.0 | 329.4 | 343.2 | 358.6 | 379.1 |
| 150 | 3.72 | 8.29 | 12.23 | 17.81 | 26.00 | 37.81 | 54.43 | 76.61 | 104.65 | 138.1 | 175.4 | 214.5 | 252.65 | 287.24 | 317.3 | 341.7 | 361.1 | 377.1 | 392.8 | 409.8 | 432.2 |
| 160 | 4.74 | 10.16 | 14.92 | 21.54 | 31.16 | 45.02 | 64.25 | 89.88 | 122.10 | 160.2 | 202.7 | 247.0 | 290.18 | 329.4 | 363.1 | 390.2 | 412.2 | 430.4 | 447.8 | 466.6 | 492.8 |
| 170 | 5.99 | 12.41 | 18.01 | 25.87 | 37.11 | 53.27 | 75.55 | 104.84 | 141.75 | 185.1 | 233.2 | 283.1 | 331.7 | 375.6 | 413.3 | 443.7 | 467.8 | 488.7 | 508.2 | 528.8 | 558.4 |
| 180 | 7.51 | 15.00 | 21.65 | 30.86 | 44.02 | 62.68 | 88.17 | 121.68 | 163.7 | 212.6 | 267.0 | 323.1 | 377.1 | 426.6 | 468.4 | 502.4 | 529.5 | 552.3 | | | |
| 190 | 9.34 | 18.06 | 25.87 | 36.60 | 51.81 | 73.32 | 102.56 | 140.75 | 188.1 | 243.3 | 304.3 | 367.1 | 427.7 | 482.5 | 528.8 | | | | | | |
| 200 | 11.53 | 21.60 | 30.72 | 43.14 | 60.62 | 85.33 | 118.68 | 161.81 | 215.2 | 277.0 | 345.5 | 415.1 | 483.0 | 543.6 | | | | | | | |
| 210 | 14.12 | 25.61 | 36.26 | 50.58 | 70.72 | 98.80 | 136.42 | 185.10 | 245.1 | 314.5 | 390.7 | 468.4 | 542.9 | | | | | | | | |
| 220 | 17.19 | 30.27 | 42.47 | 59.00 | 81.91 | 113.81 | 156.41 | 211.24 | 278.2 | 355.1 | 439.6 | 525.5 | | | | | | | | | |
| 230 | 20.78 | 35.59 | 49.60 | 68.46 | 94.43 | 130.64 | 178.28 | 239.70 | 314.5 | 400.2 | 493.4 | | | | | | | | | | |
| 240 | 24.97 | 41.52 | 57.65 | 78.91 | 108.60 | 149.20 | 202.74 | 270.92 | 354.1 | 448.9 | 552.3 | | | | | | | | | | |
| 250 | 29.83 | 48.32 | 66.67 | 90.74 | 124.08 | 169.48 | 229.62 | 305.60 | 397.6 | 502.4 | | | | | | | | | | | |

*Wilson, *Univ. Ill., Eng. Expt. Sta. Bull.* 146.

**TABLE 2-25 Partial Pressures of $H_2O$ over Aqueous Solutions of Sodium Carbonate**

mmHg

| | %$Na_2CO_3$ | | | | | | |
|---|---|---|---|---|---|---|---|
| $t$, °C | 0 | 5 | 10 | 15 | 20 | 25 | 30 |
| 0 | 4.5 | 4.5 | | | | | |
| 10 | 9.2 | 9.0 | 8.8 | | | | |
| 20 | 17.5 | 17.2 | 16.8 | 16.3 | | | |
| 30 | 31.8 | 31.2 | 30.4 | 29.6 | 28.8 | 27.8 | 26.4 |
| 40 | 55.3 | 54.2 | 53.0 | 57.6 | 50.2 | 48.4 | 46.1 |
| 50 | 92.5 | 90.7 | 88.7 | 86.5 | 84.1 | 81.2 | 77.5 |
| 60 | 149.5 | 146.5 | 143.5 | 139.9 | 136.1 | 131.6 | 125.7 |
| 70 | 239.8 | 235 | 230.5 | 225 | 219 | 211.5 | 202.5 |
| 80 | 355.5 | 348 | 342 | 334 | 325 | 315 | 301 |
| 90 | 526.0 | 516 | 506 | 494 | 482 | 467 | 447 |
| 100 | 760.0 | 746 | 731 | 715 | 697 | 676 | 648 |

**TABLE 2-26 Partial Pressures of $H_2O$ and $CH_3OH$ over Aqueous Solutions of Methyl Alcohol***

| Mole fraction $CH_3OH$ | 39.9°C | | Mole fraction $CH_3OH$ | 59.4°C | |
|---|---|---|---|---|---|
| | $P_{H_2O}$, mmHg | $P_{CH_3OH}$, mmHg | | $P_{H_2O}$, mmHg | $P_{CH_3OH}$, mmHg |
| 0 | 54.7 | 0 | 0 | 145.4 | 0 |
| 14.99 | 39.2 | 66.1 | 22.17 | 106.9 | 210.1 |
| 17.85 | 38.5 | 75.5 | 27.40 | 102.2 | 240.2 |
| 21.07 | 37.2 | 85.2 | 33.24 | 96.6 | 272.1 |
| 27.31 | 35.8 | 100.6 | 39.80 | 91.7 | 301.9 |
| 31.06 | 34.9 | 108.8 | 47.08 | 84.8 | 335.6 |
| 40.1 | 32.8 | 127.7 | 55.5 | 76.9 | 373.7 |
| 47.0 | 31.5 | 141.6 | 69.2 | 57.8 | 439.4 |
| 55.8 | 27.3 | 158.4 | 78.5 | 43.8 | 486.6 |
| 68.9 | 20.7 | 186.6 | 85.9 | 30.1 | 526.9 |
| 86.0 | 10.1 | 225.2 | 100.0 | 0 | 609.3 |
| 100.0 | 0 | 260.7 | | | |

**International Critical Tables,* vol. 3, McGraw-Hill, p. 290.

**TABLE 2-27 Partial Pressures of $H_2O$ over Aqueous Solutions of Sodium Hydroxide**

mmHg

| Conc. g NaOH/ 100 g $H_2O$ | Temperature, °C | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 20 | 40 | 60 | 80 | 100 | 120 | 160 | 200 | 250 | 300 | 350 |
| 0 | 4.6 | 17.5 | 55.3 | 149.5 | 355.5 | 760.0 | 1,489 | 4,633 | 11,647 | 29,771 | 64,200 | 123,600 |
| 5 | 4.4 | 16.9 | 53.2 | 143.5 | 341.5 | 730.0 | 1,430 | 4,450 | 11,200 | 28,600 | 61,800 | 118,900 |
| 10 | 4.2 | 16.0 | 50.6 | 137.0 | 325.5 | 697.0 | 1,365 | 4,260 | 10,750 | 27,500 | 59,300 | 114,100 |
| 20 | 3.6 | 13.9 | 44.2 | 120.5 | 288.5 | 621.0 | 1,225 | 3,860 | 9,800 | 25,300 | 54,700 | 105,400 |
| 30 | 2.9 | 11.3 | 36.6 | 101.0 | 246.0 | 537.0 | 1,070 | 3,460 | 8,950 | 23,300 | 50,800 | 98,000 |
| 40 | 2.2 | 8.7 | 28.7 | 81.0 | 202.0 | 450.0 | 920 | 3,090 | 8,150 | 21,500 | 47,200 | 91,600 |
| 50 | | 6.3 | 20.7 | 62.5 | 160.5 | 368.0 | 770 | 2,690 | 7,400 | 19,900 | 44,100 | 85,800 |
| 60 | | 4.4 | 15.5 | 47.0 | 124.0 | 294.0 | 635 | 2,340 | 6,750 | 18,400 | 41,200 | 80,700 |
| 70 | | 3.0 | 10.9 | 34.5 | 94.0 | 231.0 | 515 | 2,030 | 6,100 | 17,100 | 38,700 | 76,000 |
| 80 | | 2.0 | 7.6 | 24.5 | 70.5 | 179.0 | 415 | 1,740 | 5,500 | 15,800 | 36,300 | 71,900 |
| 90 | | 1.3 | 5.2 | 17.5 | 53.0 | 138.0 | 330 | 1,490 | 5,000 | 14,700 | 34,200 | 68,100 |
| 100 | | 0.9 | 3.6 | 12.5 | 38.5 | 105.0 | 262 | 1,300 | 4,500 | 13,650 | 32,200 | 64,600 |
| 120 | | | 1.7 | 6.3 | 20.5 | 61.0 | 164 | 915 | 3,650 | 11,800 | 28,800 | 58,600 |
| 140 | | | | 3.0 | 11.0 | 35.5 | 102 | 765 | 2,980 | 10,300 | 25,900 | 53,400 |
| 160 | | | | 1.5 | 6.0 | 20.5 | 63 | 470 | 2,430 | 8,960 | 23,300 | 49,000 |
| 180 | | | | | 3.5 | 12.0 | 40 | 340 | 1,980 | 7,830 | 21,200 | 45,100 |
| 200 | | | | | 2.0 | 7.0 | 25 | 245 | 1,620 | 6,870 | 19,200 | 41,800 |
| 250 | | | | | 0.5 | 2.0 | 8 | 110 | 985 | 5,000 | 15,400 | 35,000 |
| 300 | | | | | 0.1 | 0.5 | 2.7 | 50 | 610 | 3,690 | 12,500 | 29,800 |
| 350 | | | | | | | 0.9 | 23 | 380 | 2,750 | 10,300 | 25,700 |
| 400 | | | | | | | | 11 | 240 | 2,080 | 8,600 | 22,400 |
| 500 | | | | | | | | | 100 | 1,210 | 6,100 | 17,500 |
| 700 | | | | | | | | | | 440 | 3,300 | 11,500 |
| 1000 | | | | | | | | | | | 1,470 | 6,800 |
| 2000 | | | | | | | | | | | 150 | 1,760 |
| 4000 | | | | | | | | | | | | 120 |
| 8000 | | | | | | | | | | | | 7 |

# WATER-VAPOR CONTENT OF GASES

## CHART FOR GASES AT HIGH PRESSURES

The accompanying figure is useful in determining the water-vapor content of air at high pressure in contact with liquid water.

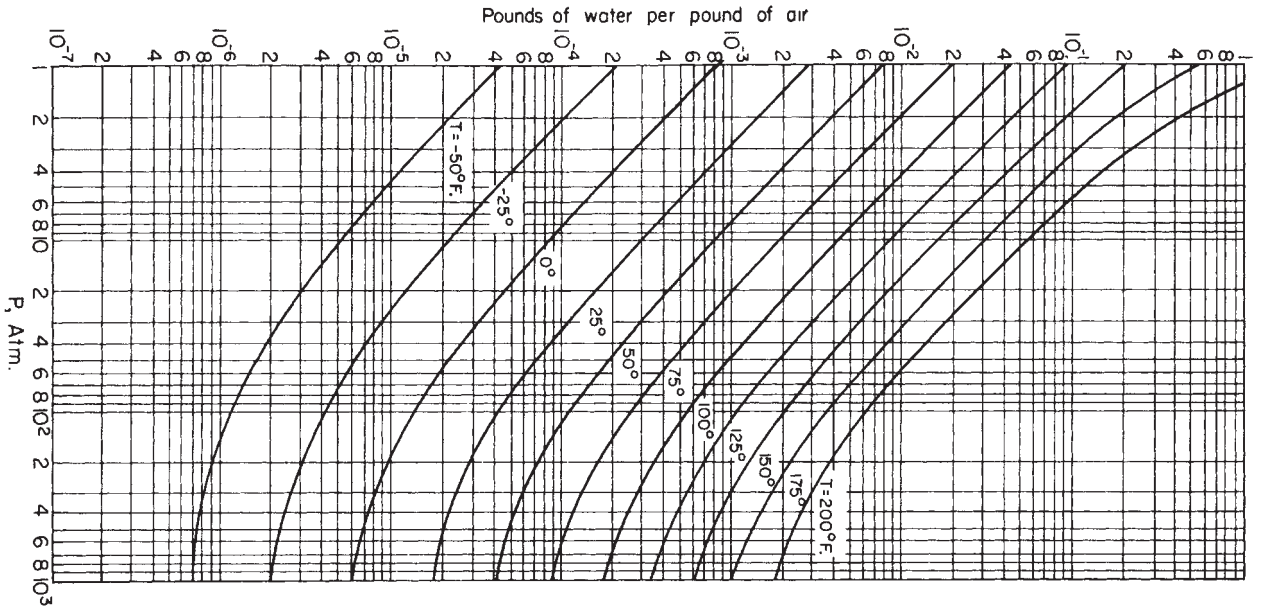


**FIG. 2-4** Water content of air, °C = (°F − 32) × 5/9. (*Landsbaum, Dadds, and Stutzman. Reprinted from vol. 47, January 1955 issue of* Ind. Eng. Chem. [*p. 192*]. *Copyright 1955 by the American Chemical Society and reproduced by permission of the copyright owner.*)

# DENSITIES OF PURE SUBSTANCES

## UNITS CONVERSIONS

For this subsection, the following units conversions are applicable:

$$°F = \tfrac{9}{5}\,°C + 32.$$

To convert kilograms per cubic meter to pounds per cubic foot, multiply by 0.06243.

**TABLE 2-28 Density (kg/m³) of Water from 0 to 100°C***

| | ρ, kg/m³ | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *t*, °C | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 |
| 0 | 999.839 | 999.846 | 999.852 | 999.859 | 999.865 | 999.871 | 999.877 | 999.882 | 999.888 | 999.893 |
| 1 | 999.898 | 999.903 | 999.908 | 999.913 | 999.917 | 999.921 | 999.925 | 999.929 | 999.933 | 999.936 |
| 2 | 999.940 | 999.943 | 999.946 | 999.949 | 999.952 | 999.954 | 999.956 | 999.959 | 999.961 | 999.962 |
| 3 | 999.964 | 999.966 | 999.967 | 999.968 | 999.969 | 999.970 | 999.971 | 999.971 | 999.972 | 999.972 |
| 4 | 999.972 | 999.972 | 999.972 | 999.971 | 999.971 | 999.970 | 999.969 | 999.968 | 999.967 | 999.965 |
| 5 | 999.964 | 999.962 | 999.960 | 999.958 | 999.956 | 999.954 | 999.951 | 999.949 | 999.946 | 999.943 |
| 6 | 999.940 | 999.937 | 999.934 | 999.930 | 999.926 | 999.923 | 999.919 | 999.915 | 999.910 | 999.906 |
| 7 | 999.901 | 999.897 | 999.892 | 999.887 | 999.882 | 999.877 | 999.871 | 999.866 | 999.860 | 999.854 |
| 8 | 999.848 | 999.842 | 999.836 | 999.829 | 999.823 | 999.816 | 999.809 | 999.802 | 999.795 | 999.788 |
| 9 | 999.781 | 999.773 | 999.765 | 999.758 | 999.750 | 999.742 | 999.734 | 999.725 | 999.717 | 999.708 |
| 10 | 999.699 | 999.691 | 999.682 | 999.672 | 999.663 | 999.654 | 999.644 | 999.635 | 999.625 | 999.615 |
| 11 | 999.605 | 999.595 | 999.584 | 999.574 | 999.563 | 999.553 | 999.542 | 999.531 | 999.520 | 999.509 |
| 12 | 999.497 | 999.486 | 999.474 | 999.462 | 999.451 | 999.439 | 999.426 | 999.414 | 999.402 | 999.389 |
| 13 | 999.377 | 999.364 | 999.351 | 999.338 | 999.325 | 999.312 | 999.299 | 999.285 | 999.272 | 999.258 |
| 14 | 999.244 | 999.230 | 999.216 | 999.202 | 999.188 | 999.173 | 999.159 | 999.144 | 999.129 | 999.114 |
| 15 | 999.099 | 999.084 | 999.069 | 999.054 | 999.038 | 999.022 | 999.007 | 998.991 | 998.975 | 998.958 |
| 16 | 998.943 | 998.926 | 998.910 | 998.894 | 998.877 | 998.860 | 998.843 | 998.826 | 998.809 | 998.792 |
| 17 | 998.775 | 998.757 | 998.740 | 998.722 | 998.704 | 998.686 | 998.668 | 998.650 | 998.632 | 998.614 |
| 18 | 998.595 | 998.577 | 998.558 | 998.539 | 998.520 | 998.502 | 998.482 | 998.463 | 998.444 | 998.425 |
| 19 | 998.405 | 998.385 | 998.366 | 998.346 | 998.326 | 998.306 | 998.286 | 998.265 | 998.245 | 998.224 |
| 20 | 998.204 | 998.183 | 998.162 | 998.141 | 998.120 | 998.099 | 998.078 | 998.057 | 998.035 | 998.014 |
| 21 | 997.992 | 997.971 | 997.949 | 997.927 | 997.905 | 997.883 | 997.860 | 997.838 | 997.816 | 997.793 |
| 22 | 997.770 | 997.747 | 997.725 | 997.702 | 997.679 | 997.656 | 997.632 | 997.609 | 997.585 | 997.562 |
| 23 | 997.538 | 997.515 | 997.491 | 997.467 | 997.443 | 997.419 | 997.394 | 997.370 | 997.345 | 997.321 |
| 24 | 997.296 | 997.272 | 997.247 | 997.222 | 997.197 | 997.172 | 997.146 | 997.121 | 997.096 | 997.070 |
| 25 | 997.045 | 997.019 | 996.993 | 996.967 | 996.941 | 996.915 | 996.889 | 996.863 | 996.836 | 996.810 |
| 26 | 996.783 | 996.757 | 996.730 | 996.703 | 996.676 | 996.649 | 996.622 | 996.595 | 996.568 | 996.540 |
| 27 | 996.513 | 996.485 | 996.458 | 996.430 | 996.402 | 996.374 | 996.346 | 996.318 | 996.290 | 996.262 |
| 28 | 996.233 | 996.205 | 996.176 | 996.148 | 996.119 | 996.090 | 996.061 | 996.032 | 996.003 | 995.974 |
| 29 | 995.945 | 995.915 | 995.886 | 995.856 | 995.827 | 995.797 | 995.767 | 995.737 | 995.707 | 995.677 |
| 30 | 995.647 | 995.617 | 995.586 | 995.556 | 995.526 | 995.495 | 995.464 | 995.433 | 995.403 | 995.372 |
| 31 | 995.341 | 995.310 | 995.278 | 995.247 | 995.216 | 995.184 | 995.153 | 995.121 | 995.090 | 995.058 |
| 32 | 995.026 | 994.997 | 994.962 | 994.930 | 994.898 | 994.865 | 994.833 | 994.801 | 994.768 | 994.735 |
| 33 | 994.703 | 994.670 | 994.637 | 994.604 | 994.571 | 994.538 | 994.505 | 994.472 | 994.438 | 994.405 |
| 34 | 994.371 | 994.338 | 994.304 | 994.270 | 994.236 | 994.202 | 994.168 | 994.134 | 994.100 | 994.066 |
| 35 | 994.032 | 993.997 | 993.963 | 993.928 | 993.893 | 993.859 | 993.824 | 993.789 | 993.754 | 993.719 |
| 36 | 993.684 | 993.648 | 993.613 | 993.578 | 993.543 | 993.507 | 993.471 | 993.436 | 993.400 | 993.364 |
| 37 | 993.328 | 993.292 | 993.256 | 993.220 | 993.184 | 993.148 | 993.111 | 993.075 | 993.038 | 993.002 |
| 38 | 992.965 | 992.928 | 992.891 | 992.855 | 992.818 | 992.780 | 992.743 | 992.706 | 992.669 | 992.631 |
| 39 | 992.594 | 992.557 | 992.519 | 992.481 | 992.444 | 992.406 | 992.368 | 992.330 | 992.292 | 992.254 |
| 40 | 992.215 | 992.177 | 992.139 | 992.100 | 992.062 | 992.023 | 991.985 | 991.946 | 991.907 | 992.868 |
| 41 | 991.830 | 991.791 | 991.751 | 991.712 | 992.673 | 991.634 | 991.594 | 991.555 | 991.515 | 991.476 |
| 42 | 991.436 | 991.396 | 991.357 | 991.317 | 991.277 | 991.237 | 991.197 | 991.157 | 991.116 | 991.076 |
| 43 | 991.036 | 990.995 | 990.955 | 990.914 | 990.873 | 990.833 | 990.792 | 990.751 | 990.710 | 990.669 |
| 44 | 990.628 | 990.587 | 990.546 | 990.504 | 990.463 | 990.421 | 990.380 | 990.338 | 990.297 | 990.255 |
| 45 | 990.213 | 990.171 | 990.129 | 990.087 | 990.045 | 990.003 | 989.961 | 989.919 | 989.876 | 989.834 |
| 46 | 989.792 | 989.749 | 989.706 | 989.664 | 989.621 | 989.578 | 989.535 | 989.492 | 989.449 | 989.406 |
| 47 | 989.363 | 989.320 | 989.276 | 989.233 | 989.190 | 989.146 | 989.103 | 989.059 | 989.015 | 988.971 |
| 48 | 988.928 | 988.884 | 988.840 | 988.796 | 988.752 | 988.707 | 988.663 | 988.619 | 988.574 | 988.530 |
| 49 | 988.485 | 988.441 | 988.396 | 988.352 | 988.307 | 988.262 | 988.217 | 988.172 | 988.127 | 988.082 |

*From "Water: Density at Atmospheric Pressure and Temperatures from 0 to 100°C," *Tables of Standard Handbook Data*, Standartov, Moscow, 1978. To conserve space, only a few tables of density values are given. The reader is reminded that density values may be found as the reciprocal of the specific volume values tabulated in the "Thermodynamic Properties: Tables" subsection.

**TABLE 2-28 Density (kg/m³) of Water from 0 to 100°C** (*Concluded*)

| | ρ, kg/m³ | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *t*, °C | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 |
| 50 | 988.037 | 987.992 | 987.946 | 987.901 | 987.844 | 987.810 | 987.764 | 987.719 | 987.673 | 987.627 |
| 51 | 987.581 | 987.536 | 987.490 | 987.444 | 987.398 | 987.351 | 987.305 | 987.259 | 987.213 | 987.166 |
| 52 | 987.120 | 987.073 | 987.027 | 986.980 | 986.933 | 986.886 | 986.840 | 986.793 | 986.746 | 986.699 |
| 53 | 986.652 | 986.604 | 986.557 | 986.510 | 986.463 | 986.415 | 986.368 | 986.320 | 986.272 | 986.225 |
| 54 | 986.177 | 986.129 | 986.081 | 986.033 | 985.985 | 985.937 | 985.889 | 985.841 | 985.793 | 985.745 |
| 55 | 985.696 | 985.648 | 985.599 | 985.551 | 985.502 | 985.454 | 985.405 | 985.356 | 985.307 | 985.258 |
| 56 | 985.219 | 985.160 | 985.111 | 985.062 | 985.013 | 984.963 | 984.914 | 984.865 | 984.815 | 984.766 |
| 57 | 984.716 | 984.666 | 984.617 | 984.567 | 984.517 | 984.467 | 984.417 | 984.367 | 984.317 | 984.267 |
| 58 | 984.217 | 984.167 | 984.116 | 984.066 | 984.016 | 983.965 | 983.914 | 983.864 | 983.813 | 983.762 |
| 59 | 983.712 | 983.661 | 983.610 | 983.559 | 983.508 | 983.457 | 983.406 | 983.354 | 983.303 | 983.252 |
| 60 | 983.200 | 983.149 | 983.097 | 983.046 | 982.994 | 982.943 | 982.891 | 982.839 | 982.787 | 982.735 |
| 61 | 982.683 | 982.631 | 982.579 | 982.527 | 982.475 | 982.422 | 982.370 | 982.318 | 982.265 | 982.213 |
| 62 | 982.160 | 982.108 | 982.055 | 982.002 | 981.949 | 981.897 | 981.844 | 981.791 | 981.738 | 981.685 |
| 63 | 981.631 | 981.578 | 981.525 | 981.472 | 981.418 | 981.365 | 981.311 | 981.258 | 981.204 | 981.151 |
| 64 | 981.097 | 981.043 | 980.989 | 980.935 | 980.881 | 980.827 | 980.773 | 980.719 | 980.665 | 980.611 |
| 65 | 980.557 | 980.502 | 980.443 | 980.393 | 980.339 | 980.284 | 980.230 | 980.175 | 980.120 | 980.065 |
| 66 | 980.011 | 979.956 | 979.901 | 979.846 | 979.791 | 979.736 | 979.680 | 979.625 | 979.570 | 979.515 |
| 67 | 979.459 | 979.403 | 979.348 | 979.293 | 979.237 | 979.181 | 979.126 | 979.070 | 979.014 | 978.958 |
| 68 | 978.902 | 978.846 | 978.790 | 978.734 | 978.678 | 978.621 | 978.565 | 978.509 | 978.452 | 978.396 |
| 69 | 978.339 | 978.283 | 978.226 | 978.170 | 978.113 | 978.056 | 977.999 | 977.942 | 977.885 | 977.828 |
| 70 | 977.771 | 977.714 | 977.657 | 977.600 | 977.543 | 977.485 | 977.428 | 977.370 | 977.313 | 977.255 |
| 71 | 977.198 | 977.140 | 977.082 | 977.025 | 976.967 | 976.909 | 976.851 | 976.793 | 976.735 | 976.677 |
| 72 | 976.619 | 976.561 | 976.503 | 976.444 | 976.386 | 976.327 | 976.269 | 976.211 | 976.152 | 976.093 |
| 73 | 976.035 | 975.976 | 975.917 | 975.858 | 975.800 | 975.741 | 975.682 | 975.623 | 975.564 | 975.504 |
| 74 | 975.445 | 975.386 | 975.327 | 975.267 | 975.208 | 975.148 | 975.089 | 975.029 | 974.970 | 974.910 |
| 75 | 974.850 | 974.791 | 974.731 | 974.671 | 974.611 | 974.551 | 974.491 | 974.431 | 974.371 | 974.311 |
| 76 | 974.250 | 974.190 | 974.130 | 974.069 | 974.009 | 973.948 | 973.888 | 973.827 | 973.767 | 973.706 |
| 77 | 973.645 | 973.584 | 973.524 | 973.463 | 973.402 | 973.341 | 973.280 | 973.218 | 973.157 | 973.096 |
| 78 | 973.025 | 972.974 | 972.912 | 972.851 | 972.789 | 972.728 | 972.666 | 972.605 | 972.543 | 972.481 |
| 79 | 972.419 | 972.358 | 972.296 | 972.234 | 972.172 | 972.110 | 972.048 | 971.986 | 971.923 | 971.861 |
| 80 | 971.799 | 971.737 | 971.674 | 971.612 | 971.549 | 971.487 | 971.424 | 971.361 | 971.299 | 971.236 |
| 81 | 971.173 | 971.110 | 971.048 | 970.985 | 970.922 | 970.859 | 970.796 | 970.732 | 970.669 | 970.606 |
| 82 | 970.543 | 970.479 | 970.416 | 970.353 | 970.289 | 970.226 | 970.162 | 970.098 | 970.035 | 969.971 |
| 83 | 969.907 | 969.843 | 969.772 | 969.715 | 969.652 | 969.587 | 969.523 | 969.459 | 969.395 | 969.331 |
| 84 | 969.267 | 969.202 | 969.138 | 969.073 | 969.009 | 968.944 | 968.880 | 968.815 | 968.751 | 968.686 |
| 85 | 968.621 | 968.556 | 968.491 | 968.427 | 968.362 | 968.297 | 969.232 | 968.166 | 968.101 | 968.036 |
| 86 | 967.971 | 967.906 | 967.840 | 967.775 | 967.709 | 967.641 | 967.578 | 967.513 | 967.447 | 967.381 |
| 87 | 967.316 | 967.250 | 967.184 | 967.118 | 967.052 | 966.986 | 966.920 | 966.854 | 966.788 | 966.722 |
| 88 | 966.656 | 966.589 | 966.523 | 966.457 | 966.390 | 966.324 | 966.257 | 966.191 | 966.124 | 966.057 |
| 89 | 965.991 | 965.924 | 965.857 | 965.790 | 965.723 | 965.656 | 965.589 | 965.522 | 965.455 | 965.388 |
| 90 | 965.321 | 965.254 | 965.187 | 965.119 | 965.052 | 964.984 | 964.917 | 964.849 | 964.782 | 964.714 |
| 91 | 964.647 | 954.579 | 964.511 | 964.443 | 964.376 | 964.308 | 964.240 | 964.172 | 964.104 | 964.036 |
| 92 | 963.967 | 963.899 | 963.831 | 963.763 | 963.694 | 963.626 | 963.558 | 963.489 | 963.421 | 963.352 |
| 93 | 963.284 | 963.215 | 963.146 | 963.077 | 963.009 | 962.940 | 962.871 | 962.802 | 962.733 | 962.664 |
| 94 | 962.595 | 962.526 | 962.457 | 962.387 | 962.318 | 962.249 | 962.180 | 962.110 | 962.041 | 961.971 |
| 95 | 961.902 | 961.832 | 961.762 | 961.693 | 961.693 | 961.553 | 961.483 | 961.414 | 961.344 | 961.274 |
| 96 | 961.204 | 961.134 | 961.064 | 960.993 | 960.923 | 960.853 | 960.783 | 960.712 | 960.642 | 960.572 |
| 97 | 960.501 | 960.431 | 960.360 | 960.289 | 960.219 | 960.148 | 960.077 | 960.006 | 959.936 | 959.865 |
| 98 | 959.794 | 959.723 | 959.652 | 959.581 | 959.510 | 959.438 | 959.367 | 959.296 | 959.225 | 959.153 |
| 99 | 959.082 | 959.010 | 958.939 | 958.867 | 958.796 | 958.724 | 958.653 | 958.581 | 958.509 | 958.431 |
| 100 | 958.365 | | | | | | | | | |

**TABLE 2-29 Density (kg/m³) of Mercury from 0 to 350°C***

| | Density, kg/m³ | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *t*, °C | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 0 | 13595.08 | 13592.61 | 13590.14 | 13587.68 | 13585.21 | 13582.75 | 13580.29 | 13577.82 | 13575.36 | 13572.90 |
| 10 | 13570.44 | 13567.98 | 13565.52 | 13563.06 | 13560.60 | 13558.14 | 13555.69 | 13553.23 | 13550.78 | 13548.32 |
| 20 | 13545.87 | 13543.41 | 13540.96 | 13538.51 | 13536.06 | 13533.61 | 13531.16 | 13528.71 | 13526.26 | 13523.81 |
| 30 | 13521.36 | 13518.91 | 13516.47 | 13514.02 | 13511.58 | 13509.13 | 13506.69 | 13504.25 | 13501.80 | 13499.36 |
| 40 | 13496.92 | 13494.48 | 13492.04 | 13489.60 | 13487.16 | 13484.72 | 13482.29 | 13479.85 | 13477.41 | 13474.98 |
| 50 | 13472.54 | 13470.11 | 13467.67 | 13465.24 | 13462.81 | 13460.38 | 13457.94 | 13455.51 | 13453.08 | 13450.65 |
| 60 | 13448.22 | 13445.80 | 13443.37 | 13440.94 | 13438.51 | 13436.09 | 13433.66 | 13431.23 | 13428.81 | 13426.39 |
| 70 | 13423.96 | 13421.54 | 13419.12 | 13416.69 | 13414.27 | 13411.85 | 13409.43 | 13407.01 | 13404.59 | 13402.17 |
| 80 | 13399.75 | 13397.34 | 13394.92 | 13392.50 | 13390.08 | 13387.67 | 13385.25 | 13382.84 | 13380.42 | 13378.01 |
| 90 | 13375.59 | 13373.18 | 13370.77 | 13368.36 | 13365.94 | 13363.53 | 13361.12 | 13358.71 | 13356.30 | 13353.89 |
| 100 | 13351.5 | 13349.1 | 13346.7 | 13344.3 | 13341.9 | 13339.4 | 13337.0 | 13334.6 | 13332.2 | 13329.8 |
| 110 | 13327.4 | 13325.0 | 13322.6 | 13320.2 | 13317.8 | 13315.4 | 13313.0 | 13310.6 | 13308.2 | 13305.8 |
| 120 | 13303.4 | 13301.0 | 13298.6 | 13296.2 | 13293.8 | 13291.4 | 13288.9 | 13286.6 | 13284.2 | 13281.8 |
| 130 | 13279.4 | 13277.0 | 13274.6 | 13272.2 | 13269.8 | 13267.4 | 13265.0 | 13262.6 | 13260.2 | 13257.8 |
| 140 | 13255.4 | 13253.0 | 13250.6 | 13248.2 | 13245.8 | 13243.4 | 13241.0 | 13238.7 | 13236.3 | 13233.9 |
| 150 | 13231.5 | 13229.1 | 13226.7 | 13224.3 | 13221.9 | 13219.5 | 13217.1 | 13214.7 | 13212.4 | 13210.0 |
| 160 | 13207.6 | 13205.2 | 13202.8 | 13200.4 | 13198.0 | 13195.6 | 13193.2 | 13190.8 | 13188.5 | 13186.1 |
| 170 | 13183.7 | 13181.3 | 13178.9 | 13176.5 | 13174.1 | 13171.7 | 13169.4 | 13167.0 | 13164.6 | 13162.2 |
| 180 | 13159.8 | 13157.4 | 13155.0 | 13152.6 | 13150.3 | 13147.9 | 13145.5 | 13143.1 | 13140.7 | 13138.3 |
| 190 | 13136.0 | 13133.6 | 13131.2 | 13128.3 | 13126.4 | 13124.0 | 13121.7 | 13119.3 | 13116.9 | 13114.5 |
| 200 | 13112.1 | 13109.7 | 13107.4 | 13105.0 | 13102.6 | 13100.2 | 13097.8 | 13095.4 | 13093.1 | 13090.7 |
| 210 | 13088.3 | 13085.9 | 13083.5 | 13081.1 | 13078.8 | 13076.4 | 13074.0 | 13071.6 | 13069.2 | 13066.8 |
| 220 | 13064.5 | 13062.1 | 13059.7 | 13057.3 | 13054.9 | 13052.6 | 13050.2 | 13047.8 | 13045.4 | 13043.0 |
| 230 | 13040.6 | 13038.3 | 13035.9 | 13033.5 | 13031.1 | 13028.7 | 13026.4 | 13024.0 | 13021.6 | 13019.2 |
| 240 | 13016.8 | 13014.5 | 13012.1 | 13009.7 | 13007.3 | 13004.9 | 13002.5 | 13000.2 | 12997.8 | 12995.4 |
| 250 | 12993.0 | 12990.6 | 12988.3 | 12985.9 | 12983.5 | 12981.1 | 12978.7 | 12976.3 | 12974.0 | 12971.6 |
| 260 | 12969.2 | 12966.8 | 12964.4 | 12962.0 | 12959.7 | 12957.3 | 12954.9 | 12952.5 | 12950.1 | 12947.7 |
| 270 | 12945.4 | 12943.0 | 12940.6 | 12938.2 | 12935.8 | 12933.4 | 12931.1 | 12928.7 | 12926.3 | 12923.9 |
| 280 | 12921.5 | 12919.1 | 12916.7 | 12914.4 | 12912.0 | 12909.6 | 12907.2 | 12904.8 | 12902.4 | 12900.0 |
| 290 | 12897.7 | 12895.3 | 12892.9 | 12890.5 | 12888.1 | 12885.7 | 12883.3 | 12880.9 | 12878.5 | 12876.2 |
| 300 | 12873.8 | 12871.4 | 12869.0 | 12866.6 | 12864.2 | 12861.8 | 12859.4 | 12857.0 | 12854.6 | 12852.2 |
| 310 | 12849.9 | 12847.5 | 12845.1 | 12842.7 | 12840.3 | 12837.9 | 12835.5 | 12833.1 | 12830.7 | 12828.3 |
| 320 | 12825.9 | 12823.5 | 12821.1 | 12818.7 | 12816.3 | 12813.9 | 12811.5 | 12809.1 | 12806.7 | 12804.3 |
| 330 | 12801.9 | 12799.5 | 12797.1 | 12794.7 | 12792.3 | 12789.9 | 12787.5 | 12785.1 | 12782.7 | 12780.2 |
| 340 | 12777.8 | 12775.4 | 12773.0 | 12770.6 | 12768.2 | 12765.8 | 12763.4 | 12761.0 | 12758.6 | 12756.1 |
| 350 | 12753.7 | | | | | | | | | |

*From "Mercury—Density and Thermal Expansion at Atmospheric Pressure and Temperatures from 0 to 350°C," *Tables of Standard Handbook Data*, Standartov, Moscow, 1978. The density values obtainable from those cited for the specific volume of the saturated liquid in the "Thermodynamic Properties" subsection show minor differences. No attempt was made to adjust either set.

**TABLE 2-30 Densities of Inorganic and Organic Liquids**

| Cmpd. no. | Name | Formula | CAS no. | Mol. wt. | C1 | C2 | C3 | C4 | $T_{min}$, K | Density at $T_{min}$ | $T_{max}$, K | Density at $T_{max}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Methane | $CH_4$ | 74828 | 16.043 | 2.9214 | 0.28976 | 190.56 | 0.28881 | 90.69 | 28.18 | 190.56 | 10.082 |
| 2 | Ethane | $C_2H_6$ | 74840 | 30.070 | 1.9122 | 0.27937 | 305.32 | 0.29187 | 90.35 | 21.64 | 305.32 | 6.845 |
| 3 | Propane | $C_3H_8$ | 74986 | 44.097 | 1.3757 | 0.27453 | 369.83 | 0.29359 | 85.47 | 16.583 | 369.83 | 5.011 |
| 4 | *n*-Butane | $C_4H_{10}$ | 106978 | 58.123 | 1.0677 | 0.27188 | 425.12 | 0.28688 | 134.86 | 12.62 | 425.12 | 3.927 |
| 5 | *n*-Pentane | $C_5H_{12}$ | 109660 | 72.150 | 0.84947 | 0.26726 | 469.7 | 0.27789 | 143.42 | 10.474 | 469.7 | 3.178 |
| 6 | *n*-Hexane | $C_6H_{14}$ | 110543 | 86.177 | 0.70824 | 0.26411 | 507.6 | 0.27537 | 177.83 | 8.747 | 507.6 | 2.682 |
| 7 | *n*-Heptane | $C_7H_{16}$ | 142825 | 100.204 | 0.61259 | 0.26211 | 540.2 | 0.28141 | 182.57 | 7.6998 | 540.2 | 2.337 |
| 8 | *n*-Octane | $C_8H_{18}$ | 111659 | 114.231 | 0.53731 | 0.26115 | 568.7 | 0.28034 | 216.38 | 6.6558 | 568.7 | 2.058 |
| 9 | *n*-Nonane | $C_9H_{20}$ | 111842 | 128.258 | 0.48387 | 0.26147 | 594.6 | 0.28281 | 219.66 | 6.007 | 594.6 | 1.851 |
| 10 | *n*-Decane | $C_{10}H_{22}$ | 124185 | 142.285 | 0.42831 | 0.25745 | 617.7 | 0.28912 | 243.51 | 5.3811 | 617.7 | 1.664 |
| 11 | *n*-Undecane | $C_{11}H_{24}$ | 1120214 | 156.312 | 0.39 | 0.25678 | 639 | 0.2913 | 247.57 | 4.9362 | 639 | 1.519 |
| 12 | *n*-Dodecane | $C_{12}H_{26}$ | 112403 | 170.338 | 0.35541 | 0.25511 | 658 | 0.29368 | 263.57 | 4.5132 | 658 | 1.393 |
| 13 | *n*-Tridecane | $C_{13}H_{28}$ | 629505 | 184.365 | 0.3216 | 0.2504 | 675 | 0.3071 | 267.76 | 4.2035 | 675 | 1.284 |
| 14 | *n*-Tetradecane | $C_{14}H_{30}$ | 629594 | 198.392 | 0.30545 | 0.2535 | 693 | 0.30538 | 279.01 | 3.8924 | 693 | 1.205 |
| 15 | *n*-Pentadecane | $C_{15}H_{32}$ | 629629 | 212.419 | 0.28445 | 0.25269 | 708 | 0.30786 | 283.07 | 3.6471 | 708 | 1.126 |
| 16 | *n*-Hexadecane | $C_{16}H_{34}$ | 544763 | 226.446 | 0.26807 | 0.25287 | 723 | 0.31143 | 291.31 | 3.4187 | 723 | 1.060 |
| 17 | *n*-Heptadecane | $C_{17}H_{36}$ | 629787 | 240.473 | 0.2545 | 0.254 | 736 | 0.31072 | 295.13 | 3.2241 | 736 | 1.002 |
| 18 | *n*-Octadecane | $C_{18}H_{38}$ | 593453 | 254.500 | 0.23864 | 0.25272 | 747 | 0.31104 | 301.31 | 3.0466 | 747 | 0.944 |
| 19 | *n*-Nonadecane | $C_{19}H_{40}$ | 629925 | 268.527 | 0.22451 | 0.25133 | 758 | 0.3133 | 305.04 | 2.8933 | 758 | 0.893 |
| 20 | *n*-Eicosane | $C_{20}H_{42}$ | 112958 | 282.553 | 0.21624 | 0.25287 | 768 | 0.31613 | 309.58 | 2.7496 | 768 | 0.855 |
| 21 | 2-Methylpropane | $C_4H_{10}$ | 75285 | 58.123 | 1.0463 | 0.27294 | 408.14 | 0.27301 | 113.54 | 12.575 | 408.14 | 3.833 |
| 22 | 2-Methylbutane | $C_5H_{12}$ | 78784 | 72.150 | 0.9079 | 0.2761 | 460.43 | 0.28673 | 113.25 | 10.776 | 460.43 | 3.288 |
| 23 | 2,3-Dimethylbutane | $C_6H_{14}$ | 79298 | 86.177 | 0.76929 | 0.27524 | 499.98 | 0.27691 | 145.19 | 9.0343 | 499.98 | 2.795 |
| 24 | 2-Methylpentane | $C_6H_{14}$ | 107835 | 86.177 | 0.73335 | 0.2687 | 497.5 | 0.28361 | 119.55 | 9.2041 | 497.5 | 2.729 |
| 25 | 2,3-Dimethylpentane | $C_7H_{16}$ | 565593 | 100.204 | 0.7229 | 0.28614 | 537.35 | 0.2713 | 160.00 | 7.8746 | 537.35 | 2.526 |
| 26 | 2,3,3-Trimethylpentane | $C_8H_{18}$ | 560214 | 114.231 | 0.6028 | 0.27446 | 573.5 | 0.2741 | 172.22 | 7.0934 | 573.5 | 2.196 |
| 27 | 2,2,4-Trimethylpentane | $C_8H_{18}$ | 540841 | 114.231 | 0.5886 | 0.27373 | 543.96 | 0.2846 | 165.78 | 6.9163 | 543.96 | 2.150 |
| 28 | Ethylene | $C_2H_4$ | 74851 | 28.054 | 2.0961 | 0.27657 | 282.34 | 0.29147 | 104.00 | 23.326 | 282.34 | 7.579 |
| 29 | Propylene | $C_3H_6$ | 115071 | 42.081 | 1.4094 | 0.26465 | 365.57 | 0.295 | 87.89 | 18.143 | 365.57 | 5.326 |
| 30 | 1-Butene | $C_4H_8$ | 106989 | 56.108 | 1.0972 | 0.2649 | 419.95 | 0.29043 | 87.80 | 14.326 | 419.95 | 4.142 |
| 31 | *cis*-2-Butene | $C_4H_8$ | 590181 | 56.108 | 1.1609 | 0.27104 | 435.58 | 0.2816 | 134.26 | 13.895 | 435.58 | 4.283 |
| 32 | *trans*-2-Butene | $C_4H_8$ | 624646 | 56.108 | 1.1426 | 0.27095 | 428.63 | 0.2854 | 167.62 | 13.1 | 428.63 | 4.217 |
| 33 | 1-Pentene | $C_5H_{10}$ | 109671 | 70.134 | 0.9038 | 0.26648 | 464.78 | 0.2905 | 107.93 | 11.543 | 464.78 | 3.392 |
| 34 | 1-Hexene | $C_6H_{12}$ | 592416 | 84.161 | 0.7389 | 0.26147 | 504.03 | 0.2902 | 133.39 | 9.6388 | 504.03 | 2.826 |
| 35 | 1-Heptene | $C_7H_{14}$ | 592767 | 98.188 | 0.63734 | 0.26319 | 537.29 | 0.27375 | 154.27 | 8.1759 | 537.29 | 2.422 |
| 36 | 1-Octene | $C_8H_{16}$ | 111660 | 112.215 | 0.5871 | 0.27005 | 566.65 | 0.27187 | 171.45 | 7.1247 | 566.65 | 2.174 |
| 37 | 1-Nonene | $C_9H_{18}$ | 124118 | 126.242 | 0.4945 | 0.26108 | 593.25 | 0.27319 | 191.78 | 6.333 | 593.25 | 1.894 |
| 38 | 1-Decene | $C_{10}H_{20}$ | 872059 | 140.269 | 0.44244 | 0.25838 | 616.4 | 0.28411 | 206.89 | 5.7131 | 616.4 | 1.712 |
| 39 | 2-Methylpropene | $C_4H_8$ | 115117 | 56.108 | 1.1454 | 0.2725 | 417.9 | 0.28186 | 132.81 | 13.506 | 417.9 | 4.203 |
| 40 | 2-Methyl-1-butene | $C_5H_{10}$ | 563462 | 70.134 | 0.91619 | 0.26752 | 465 | 0.28164 | 135.58 | 11.332 | 465 | 3.425 |
| 41 | 2-Methyl-2-butene | $C_5H_{10}$ | 513359 | 70.134 | 0.93322 | 0.27251 | 471 | 0.26031 | 139.39 | 11.218 | 471 | 3.425 |
| 42 | 1,2-Butadiene | $C_4H_6$ | 590192 | 54.092 | 1.187 | 0.26114 | 452 | 0.3065 | 136.95 | 15.123 | 452 | 4.546 |
| 43 | 1,3-Butadiene | $C_4H_6$ | 106990 | 54.092 | 1.2384 | 0.2725 | 425.17 | 0.28813 | 164.25 | 14.061 | 425.17 | 4.545 |
| 44 | 2-Methyl-1,3-butadiene[1] | $C_5H_8$ | 78795 | 68.119 | 0.95673 | 0.26488 | 484 | 0.28571 | 127.27 | 12.205 | 484 | 3.612 |
| 45 | Acetylene | $C_2H_2$ | 74862 | 26.038 | 2.4091 | 0.27223 | 308.32 | 0.28477 | 192.40 | 23.692 | 308.32 | 8.850 |
| 46 | Methylacetylene | $C_3H_4$ | 74997 | 40.065 | 1.6086 | 0.26448 | 402.39 | 0.279 | 170.45 | 19.027 | 402.39 | 6.082 |
| 47 | Dimethylacetylene | $C_4H_6$ | 503173 | 54.092 | 1.1717 | 0.25895 | 473.2 | 0.27289 | 240.91 | 13.767 | 473.2 | 4.525 |
| 48 | 3-Methyl-1-butyne | $C_5H_8$ | 598232 | 68.119 | 0.94575 | 0.26008 | 463.2 | 0.30807 | 183.45 | 11.519 | 463.2 | 3.636 |
| 49 | 1-Pentyne | $C_5H_8$ | 627190 | 68.119 | 0.8491 | 0.2352 | 481.2 | 0.353 | 167.45 | 12.532 | 481.2 | 3.610 |
| 50 | 2-Pentyne | $C_5H_8$ | 627214 | 68.119 | 0.92099 | 0.25419 | 519 | 0.31077 | 163.83 | 12.24 | 519 | 3.623 |
| 51 | 1-Hexyne | $C_6H_{10}$ | 693027 | 82.145 | 0.84427 | 0.27185 | 516.2 | 0.2771 | 141.25 | 10.23 | 516.2 | 3.106 |
| 52 | 2-Hexyne | $C_6H_{10}$ | 764352 | 82.145 | 0.76277 | 0.25248 | 549 | 0.31611 | 183.65 | 10.133 | 549 | 3.021 |
| 53 | 3-Hexyne[1] | $C_6H_{10}$ | 928494 | 82.145 | 0.78045 | 0.26065 | 544 | 0.28571 | 170.05 | 10.021 | 544 | 2.994 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 54 | 1-Heptyne | $C_7H_{12}$ | 628717 | 96.172 | 0.67366 | 0.26003 | 559 | 0.29804 | 192.22 | 8.4987 | 559 | 2.591 |
| 55 | 1-Octyne | $C_8H_{14}$ | 629050 | 110.199 | 0.59229 | 0.26118 | 585 | 0.29357 | 193.55 | 7.478 | 585 | 2.268 |
| 56 | Vinylacetylene[2] | $C_4H_4$ | 689974 | 52.076 | 1.2703 | 0.26041 | 454 | 0.297 | 173.15 | 15.664 | 454 | 4.878 |
| 57 | Cyclopentane | $C_5H_{10}$ | 287923 | 70.134 | 1.124 | 0.28859 | 511.76 | 0.2506 | 179.28 | 11.883 | 511.76 | 3.895 |
| 58 | Methylcyclopentane | $C_6H_{12}$ | 96377 | 84.161 | 0.84798 | 0.27042 | 532.79 | 0.28276 | 130.73 | 10.492 | 532.79 | 3.136 |
| 59 | Ethylcyclopentane | $C_7H_{14}$ | 1640897 | 98.188 | 0.7193 | 0.26936 | 569.52 | 0.2777 | 134.71 | 9.018 | 569.52 | 2.670 |
| 60 | Cyclohexane | $C_6H_{12}$ | 110827 | 84.161 | 0.8908 | 0.27396 | 553.58 | 0.2851 | 279.69 | 9.3797 | 553.58 | 3.252 |
| 61 | Methylcyclohexane | $C_7H_{14}$ | 108872 | 98.188 | 0.735 | 0.27041 | 572.19 | 0.2927 | 146.58 | 9.018 | 572.19 | 2.718 |
| 62 | 1,1-Dimethyl-cyclohexane | $C_8H_{16}$ | 590669 | 112.215 | 0.55873 | 0.25143 | 591.15 | 0.27758 | 239.66 | 7.3417 | 591.15 | 2.222 |
| 63 | Ethylcyclohexane | $C_8H_{16}$ | 1678917 | 112.215 | 0.61587 | 0.26477 | 609.15 | 0.28054 | 161.84 | 7.8679 | 609.15 | 2.326 |
| 64 | Cyclopentene | $C_5H_8$ | 142290 | 68.119 | 1.1035 | 0.27035 | 507 | 0.28699 | 138.13 | 13.47 | 507 | 4.082 |
| 65 | 1-Methylcyclopentene | $C_6H_{10}$ | 693890 | 82.145 | 0.88824 | 0.26914 | 542 | 0.27874 | 146.62 | 10.98 | 542 | 3.300 |
| 66 | Cyclohexene | $C_6H_{10}$ | 110838 | 82.145 | 0.92997 | 0.27056 | 560.4 | 0.28943 | 169.67 | 11.16 | 560.4 | 3.437 |
| 67 | Benzene | $C_6H_6$ | 71432 | 78.114 | 1.0162 | 0.2655 | 562.16 | 0.28212 | 278.68 | 11.421 | 562.16 | 3.828 |
| 68 | Toluene | $C_7H_8$ | 108883 | 92.141 | 0.8488 | 0.26655 | 591.8 | 0.2878 | 178.18 | 10.495 | 591.8 | 3.184 |
| 69 | *o*-Xylene | $C_8H_{10}$ | 95476 | 106.167 | 0.69883 | 0.26113 | 630.33 | 0.27429 | 247.98 | 8.6285 | 630.33 | 2.676 |
| 70 | *m*-Xylene | $C_8H_{10}$ | 108383 | 106.167 | 0.69555 | 0.26204 | 617.05 | 0.27602 | 225.30 | 8.6505 | 617.05 | 2.654 |
| 71 | *p*-Xylene | $C_8H_{10}$ | 106423 | 106.167 | 0.6816 | 0.25963 | 616.23 | 0.2768 | 286.41 | 8.1616 | 616.23 | 2.625 |
| 72 | Ethylbenzene | $C_8H_{10}$ | 100414 | 106.167 | 0.6952 | 0.26037 | 617.2 | 0.2844 | 178.15 | 9.0568 | 617.2 | 2.670 |
| 73 | Propylbenzene | $C_9H_{12}$ | 103651 | 120.194 | 0.57695 | 0.25395 | 638.32 | 0.283 | 183.15 | 7.8942 | 638.32 | 2.272 |
| 74 | 1,2,4-Trimethylbenzene | $C_9H_{12}$ | 95636 | 120.194 | 0.60394 | 0.25955 | 649.13 | 0.27716 | 229.33 | 7.6895 | 649.13 | 2.327 |
| 75 | Isopropylbenzene | $C_9H_{12}$ | 98828 | 120.194 | 0.604 | 0.25912 | 631.1 | 0.2914 | 177.14 | 7.9496 | 631.1 | 2.331 |
| 76 | 1,3,5-Trimethylbenzene | $C_9H_{12}$ | 108678 | 120.194 | 0.59879 | 0.25916 | 637.36 | 0.27968 | 228.42 | 7.6154 | 637.36 | 2.311 |
| 77 | *p*-Isopropyltoluene | $C_{10}H_{14}$ | 99876 | 134.221 | 0.51036 | 0.25383 | 653.15 | 0.28816 | 205.25 | 6.8779 | 653.15 | 2.011 |
| 78 | Naphthalene[6] | $C_{10}H_8$ | 91203 | 128.174 | 0.61674 | 0.25473 | 748.35 | 0.27355 | 333.15 | 7.7543 | 748.35 | 2.421 |
| 79 | Biphenyl | $C_{12}H_{10}$ | 92524 | 154.211 | 0.5039 | 0.25273 | 789.26 | 0.281 | 342.20 | 6.4395 | 789.26 | 1.994 |
| 80 | Styrene | $C_8H_8$ | 100425 | 104.152 | 0.7397 | 0.2603 | 636 | 0.3009 | 242.54 | 9.1088 | 636 | 2.842 |
| 81 | *m*-Terphenyl | $C_{18}H_{14}$ | 92068 | 230.309 | 0.30826 | 0.23669 | 924.85 | 0.29678 | 360.00 | 4.5223 | 924.85 | 1.302 |
| 82 | Methanol | $CH_4O$ | 67561 | 32.042 | 2.288 | 0.2685 | 512.64 | 0.2453 | 175.47 | 27.912 | 512.64 | 8.521 |
| 83 | Ethanol | $C_2H_6O$ | 64175 | 46.069 | 1.648 | 0.27627 | 513.92 | 0.2331 | 159.05 | 19.413 | 513.92 | 5.965 |
| 84 | 1-Propanol | $C_3H_8O$ | 71238 | 60.096 | 1.235 | 0.27136 | 536.78 | 0.24 | 146.95 | 15.231 | 536.78 | 4.551 |
| 85 | 1-Butanol | $C_4H_{10}O$ | 71363 | 74.123 | 0.965 | 0.2666 | 563.05 | 0.24419 | 184.51 | 12.016 | 563.05 | 3.620 |
| 86 | 2-Butanol | $C_4H_{10}O$ | 78922 | 74.123 | 0.966 | 0.26064 | 536.05 | 0.2746 | 158.45 | 12.57 | 536.05 | 3.706 |
| 87 | 2-Propanol | $C_3H_8O$ | 67630 | 60.096 | 1.24 | 0.27342 | 508.3 | 0.2353 | 185.28 | 14.547 | 508.3 | 4.535 |
| 88 | 2-Methyl-2-propanol | $C_4H_{10}O$ | 75650 | 74.123 | 0.9212 | 0.2544 | 506.21 | 0.276 | 298.97 | 10.555 | 506.21 | 3.621 |
| 89 | 1-Pentanol | $C_5H_{12}O$ | 71410 | 88.150 | 0.8164 | 0.2673 | 586.15 | 0.2506 | 195.56 | 10.057 | 586.15 | 3.054 |
| 90 | 2-Methyl-1-butanol | $C_5H_{12}O$ | 137326 | 88.150 | 0.82046 | 0.26829 | 565 | 0.2322 | 203.00 | 10.017 | 565 | 3.058 |
| 91 | 3-Methyl-1-butanol | $C_5H_{12}O$ | 123513 | 88.150 | 0.837 | 0.27375 | 577.2 | 0.22951 | 155.95 | 10.204 | 577.2 | 3.058 |
| 92 | 1-Hexanol | $C_6H_{14}O$ | 111273 | 102.177 | 0.70617 | 0.26901 | 611.35 | 0.2479 | 228.55 | 8.4506 | 611.35 | 2.625 |
| 93 | 1-Heptanol | $C_7H_{16}O$ | 111706 | 116.203 | 0.60481 | 0.2632 | 631.9 | 0.273 | 239.15 | 7.421 | 631.9 | 2.298 |
| 94 | Cyclohexanol | $C_6H_{12}O$ | 108930 | 100.161 | 0.8243 | 0.26546 | 650 | 0.2848 | 296.60 | 9.4693 | 650 | 3.105 |
| 95 | Ethylene glycol | $C_2H_6O_2$ | 107211 | 62.068 | 1.3151 | 0.25125 | 719.7 | 0.2187 | 260.15 | 18.31 | 719.7 | 5.234 |
| 96 | 1,2-Propylene glycol | $C_3H_8O_2$ | 57556 | 76.095 | 1.0923 | 0.26106 | 626 | 0.20459 | 213.15 | 14.363 | 626 | 4.184 |
| 97 | Phenol | $C_6H_6O$ | 108952 | 94.113 | 1.3798 | 0.31598 | 694.25 | 0.32768 | 314.06 | 11.244 | 694.25 | 4.367 |
| 98 | *o*-Cresol | $C_7H_8O$ | 95487 | 108.140 | 1.0861 | 0.30624 | 697.55 | 0.30587 | 304.19 | 9.5751 | 697.55 | 3.547 |
| 99 | *m*-Cresol | $C_7H_8O$ | 108394 | 108.140 | 0.9061 | 0.28268 | 705.85 | 0.2707 | 285.39 | 9.6115 | 705.85 | 3.205 |
| 100 | *p*-Cresol | $C_7H_8O$ | 106445 | 108.140 | 1.1503 | 0.31861 | 704.65 | 0.30104 | 307.93 | 9.4494 | 704.65 | 3.610 |
| 101 | Dimethyl ether | $C_2H_6O$ | 115106 | 46.069 | 1.5693 | 0.2679 | 400.1 | 0.2882 | 131.65 | 18.95 | 400.1 | 5.858 |
| 102 | Methyl ethyl ether | $C_3H_8O$ | 540670 | 60.096 | 1.2635 | 0.27878 | 437.8 | 0.2744 | 160.00 | 13.995 | 437.8 | 4.532 |
| 103 | Methyl-*n*-propyl ether | $C_4H_{10}O$ | 557175 | 74.123 | 1.0124 | 0.27942 | 476.3 | 0.2555 | 133.97 | 11.696 | 476.3 | 3.623 |
| 104 | Methyl isopropyl ether | $C_4H_{10}O$ | 598538 | 74.123 | 1.0318 | 0.28478 | 464.5 | 0.2444 | 127.93 | 11.568 | 464.5 | 3.623 |
| 105 | Methyl-*n*-butyl ether | $C_5H_{12}O$ | 628284 | 88.150 | 0.8281 | 0.27245 | 510 | 0.2827 | 157.48 | 9.8068 | 510 | 3.040 |
| 106 | Methyl isobutyl ether[1] | $C_5H_{12}O$ | 625445 | 88.150 | 0.8252 | 0.27282 | 497 | 0.2857 | 150.00 | 9.7673 | 497 | 3.025 |
| 107 | Methyl tert-butyl ether | $C_5H_{12}O$ | 1634044 | 88.150 | 0.82157 | 0.27032 | 497.1 | 0.2829 | 164.55 | 9.7682 | 497.1 | 3.039 |
| 108 | Diethyl ether | $C_4H_{10}O$ | 60297 | 74.123 | 0.9554 | 0.26847 | 466.7 | 0.2814 | 156.85 | 11.487 | 466.7 | 3.559 |

**TABLE 2-30 Densities of Inorganic and Organic Liquids** (*Continued*)

| Cmpd. no. | Name | Formula | CAS no. | Mol. wt. | C1 | C2 | C3 | C4 | $T_{min}$, K | Density at $T_{min}$ | $T_{max}$, K | Density at $T_{max}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 109 | Ethyl propyl ether | $C_5H_{12}O$ | 628320 | 88.150 | 0.7908 | 0.266 | 500.23 | 0.292 | 145.65 | 9.8474 | 500.23 | 2.973 |
| 110 | Ethyl isopropyl ether | $C_5H_{12}O$ | 625547 | 88.150 | 0.82049 | 0.26994 | 489 | 0.30381 | 140.00 | 9.9117 | 489 | 3.040 |
| 111 | Methyl phenyl ether | $C_7H_8O$ | 100663 | 108.140 | 0.77488 | 0.26114 | 645.6 | 0.28234 | 235.65 | 9.6675 | 645.6 | 2.967 |
| 112 | Diphenyl ether | $C_{12}H_{10}O$ | 101848 | 170.211 | 0.52133 | 0.26218 | 766.8 | 0.31033 | 300.03 | 6.2648 | 766.8 | 1.988 |
| 113 | Formaldehyde[3] | $CH_2O$ | 50000 | 30.026 | 1.9415 | 0.22309 | 408 | 0.28571 | 181.15 | 30.945 | 408 | 8.703 |
| 114 | Acetaldehyde | $C_2H_4O$ | 75070 | 44.053 | 1.6994 | 0.26167 | 466 | 0.2913 | 150.15 | 21.499 | 466 | 6.494 |
| 115 | 1-Propanal | $C_3H_6O$ | 123386 | 58.080 | 1.296 | 0.26439 | 504.4 | 0.29471 | 170.00 | 15.929 | 504.4 | 4.902 |
| 116 | 1-Butanal | $C_4H_8O$ | 123728 | 72.107 | 1.0361 | 0.26731 | 537.2 | 0.28397 | 176.75 | 12.589 | 537.2 | 3.876 |
| 117 | 1-Pentanal | $C_5H_{10}O$ | 110623 | 86.134 | 0.83871 | 0.26252 | 566.1 | 0.29444 | 182.00 | 10.534 | 566.1 | 3.195 |
| 118 | 1-Hexanal | $C_6H_{12}O$ | 66251 | 100.161 | 0.71899 | 0.26531 | 591 | 0.27628 | 217.15 | 8.7243 | 591 | 2.710 |
| 119 | 1-Heptanal | $C_7H_{14}O$ | 111717 | 114.188 | 0.62649 | 0.26376 | 617 | 0.29221 | 229.80 | 7.6002 | 617 | 2.375 |
| 120 | 1-Octanal | $C_8H_{16}O$ | 124130 | 128.214 | 0.56833 | 0.26939 | 638.1 | 0.26975 | 246.00 | 6.6637 | 638.1 | 2.110 |
| 121 | 1-Nonanal | $C_9H_{18}O$ | 124196 | 142.241 | 0.49587 | 0.26135 | 658 | 0.30736 | 255.15 | 6.0165 | 658 | 1.897 |
| 122 | 1-Decanal | $C_{10}H_{20}O$ | 112312 | 156.268 | 0.46802 | 0.27146 | 674.2 | 0.26869 | 267.15 | 5.3834 | 674.2 | 1.724 |
| 123 | Acetone | $C_3H_6O$ | 67641 | 58.080 | 1.2332 | 0.25886 | 508.2 | 0.2913 | 178.45 | 15.683 | 508.2 | 4.764 |
| 124 | Methyl ethyl ketone | $C_4H_8O$ | 78933 | 72.107 | 0.93767 | 0.25035 | 535.5 | 0.29964 | 186.48 | 12.663 | 535.5 | 3.745 |
| 125 | 2-Pentanone | $C_5H_{10}O$ | 107879 | 86.134 | 0.90411 | 0.27207 | 561.08 | 0.30669 | 196.29 | 10.398 | 561.08 | 3.323 |
| 126 | Methyl isopropyl ketone[1] | $C_5H_{10}O$ | 563804 | 86.134 | 0.8374 | 0.26204 | 553 | 0.2857 | 181.15 | 10.565 | 553 | 3.196 |
| 127 | 2-Hexanone | $C_6H_{12}O$ | 591786 | 100.161 | 0.70659 | 0.26073 | 587.05 | 0.2963 | 217.35 | 8.7505 | 587.05 | 2.710 |
| 128 | Methyl isobutyl ketone | $C_6H_{12}O$ | 108101 | 100.161 | 0.71791 | 0.26491 | 571.4 | 0.28544 | 189.15 | 8.8579 | 571.4 | 2.710 |
| 129 | 3-Methyl-2-pentanone[1] | $C_6H_{12}O$ | 565617 | 100.161 | 0.6969 | 0.2587 | 573 | 0.2857 | 167.15 | 9.1722 | 573 | 2.694 |
| 130 | 3-Pentanone | $C_5H_{10}O$ | 96220 | 86.134 | 0.71811 | 0.24129 | 560.95 | 0.27996 | 234.18 | 10.102 | 560.95 | 2.976 |
| 131 | Ethyl isopropyl ketone | $C_6H_{12}O$ | 565695 | 100.161 | 0.66469 | 0.24527 | 567 | 0.34305 | 200.00 | 9.0933 | 567 | 2.710 |
| 132 | Diisopropyl ketone | $C_7H_{14}O$ | 565800 | 114.188 | 0.56213 | 0.23385 | 576 | 0.2618 | 204.81 | 8.7779 | 576 | 2.404 |
| 133 | Cyclohexanone | $C_6H_{10}O$ | 108941 | 98.145 | 0.8663 | 0.26941 | 653 | 0.2977 | 242.00 | 10.081 | 653 | 3.216 |
| 134 | Methyl phenyl ketone | $C_8H_8O$ | 98862 | 120.151 | 0.64417 | 0.24863 | 709.5 | 0.28661 | 292.81 | 8.5581 | 709.5 | 2.591 |
| 135 | Formic acid | $CH_2O_2$ | 64186 | 46.026 | 1.938 | 0.24225 | 588 | 0.24435 | 281.45 | 26.806 | 588 | 8.000 |
| 136 | Acetic acid | $C_2H_4O_2$ | 64197 | 60.053 | 1.4486 | 0.25892 | 591.95 | 0.2529 | 289.81 | 17.492 | 591.95 | 5.595 |
| 137 | Propionic acid | $C_3H_6O_2$ | 79094 | 74.079 | 1.1041 | 0.25659 | 600.81 | 0.26874 | 252.45 | 13.933 | 600.81 | 4.303 |
| 138 | *n*-Butyric acid | $C_4H_8O_2$ | 107926 | 88.106 | 0.89213 | 0.25938 | 615.7 | 0.24909 | 267.95 | 11.087 | 615.7 | 3.440 |
| 139 | Isobutyric acid | $C_4H_8O_2$ | 79312 | 88.106 | 0.88575 | 0.25736 | 605 | 0.26265 | 227.15 | 11.42 | 605 | 3.442 |
| 140 | Benzoic acid[1] | $C_7H_6O_2$ | 65850 | 122.123 | 0.71587 | 0.24812 | 751 | 0.2857 | 395.45 | 8.8935 | 751 | 2.885 |
| 141 | Acetic anhydride | $C_4H_6O_3$ | 108247 | 102.090 | 0.86852 | 0.25187 | 606 | 0.31172 | 200.15 | 11.643 | 606 | 3.448 |
| 142 | Methyl formate | $C_2H_4O_2$ | 107313 | 60.053 | 1.525 | 0.2634 | 487.2 | 0.2806 | 174.15 | 18.811 | 487.2 | 5.790 |
| 143 | Methyl acetate | $C_3H_6O_2$ | 79209 | 74.079 | 1.13 | 0.2593 | 506.55 | 0.2764 | 175.15 | 14.475 | 506.55 | 4.358 |
| 144 | Methyl propionate | $C_4H_8O_2$ | 554121 | 88.106 | 0.9147 | 0.2594 | 530.6 | 0.2774 | 185.65 | 11.678 | 530.6 | 3.526 |
| 145 | Methyl *n*-butyrate | $C_5H_{10}O_2$ | 623427 | 102.133 | 0.76983 | 0.26173 | 554.5 | 0.26879 | 187.35 | 9.7638 | 554.5 | 2.941 |
| 146 | Ethyl formate | $C_3H_6O_2$ | 109944 | 74.079 | 1.1343 | 0.26168 | 508.4 | 0.2791 | 193.55 | 14.006 | 508.4 | 4.335 |
| 147 | Ethyl acetate | $C_4H_8O_2$ | 141786 | 88.106 | 0.8996 | 0.25856 | 523.3 | 0.278 | 189.60 | 11.478 | 523.3 | 3.479 |
| 148 | Ethyl propionate | $C_5H_{10}O_2$ | 105373 | 102.133 | 0.7405 | 0.25563 | 546 | 0.2795 | 199.25 | 9.6317 | 546 | 2.897 |
| 149 | Ethyl *n*-butyrate | $C_6H_{12}O_2$ | 105544 | 116.160 | 0.63566 | 0.25613 | 571 | 0.27829 | 175.15 | 8.4912 | 571 | 2.482 |
| 150 | *n*-Propyl formate | $C_4H_8O_2$ | 110747 | 88.106 | 0.915 | 0.26134 | 538 | 0.28 | 180.25 | 11.59 | 538 | 3.501 |
| 151 | *n*-Propyl acetate | $C_5H_{10}O_2$ | 109604 | 102.133 | 0.73041 | 0.25456 | 549.73 | 0.27666 | 178.15 | 9.7941 | 549.73 | 2.869 |
| 152 | *n*-Butyl acetate | $C_6H_{12}O_2$ | 123864 | 116.160 | 0.669 | 0.26028 | 579.15 | 0.309 | 199.65 | 8.3747 | 579.15 | 2.570 |
| 153 | Methyl benzoate | $C_8H_8O_2$ | 93583 | 136.150 | 0.53944 | 0.23519 | 693 | 0.2676 | 260.75 | 8.2133 | 693 | 2.294 |
| 154 | Ethyl benzoate | $C_9H_{10}O_2$ | 93890 | 150.177 | 0.4883 | 0.23878 | 698 | 0.28487 | 238.45 | 7.2924 | 698 | 2.045 |
| 155 | Vinyl acetate | $C_4H_6O_2$ | 108054 | 86.090 | 0.9591 | 0.2593 | 519.13 | 0.27448 | 180.35 | 12.287 | 519.13 | 3.699 |
| 156 | Methylamine | $CH_5N$ | 74895 | 31.057 | 1.39 | 0.21405 | 430.05 | 0.2275 | 179.69 | 25.378 | 430.05 | 6.494 |
| 157 | Dimethylamine | $C_2H_7N$ | 124403 | 45.084 | 1.5436 | 0.27784 | 437.2 | 0.2572 | 180.96 | 16.964 | 437.2 | 5.556 |
| 158 | Trimethylamine | $C_3H_9N$ | 75503 | 59.111 | 1.0116 | 0.25683 | 433.25 | 0.2696 | 156.08 | 13.144 | 433.25 | 3.939 |
| 159 | Ethylamine | $C_2H_7N$ | 75047 | 45.084 | 1.1477 | 0.23182 | 456.15 | 0.26053 | 192.15 | 17.588 | 456.15 | 4.951 |
| 160 | Diethylamine | $C_4H_{11}N$ | 109897 | 73.138 | 0.85379 | 0.25675 | 496.6 | 0.27027 | 223.35 | 10.575 | 496.6 | 3.325 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 161 | Triethylamine | $C_6H_{15}N$ | 121448 | 101.192 | 0.7035 | 0.27386 | 535.15 | 0.2872 | 158.45 | 8.2843 | 535.15 | 2.569 |
| 162 | *n*-Propylamine | $C_3H_9N$ | 107108 | 59.111 | 0.9195 | 0.23878 | 496.95 | 0.2461 | 188.36 | 13.764 | 496.95 | 3.851 |
| 163 | di-*n*-Propylamine | $C_6H_{15}N$ | 142847 | 101.192 | 0.659 | 0.26428 | 550 | 0.2766 | 210.15 | 7.9929 | 550 | 2.494 |
| 164 | Isopropylamine | $C_3H_9N$ | 75310 | 59.111 | 1.2801 | 0.2828 | 471.85 | 0.2972 | 177.95 | 13.561 | 471.85 | 4.527 |
| 165 | Diisopropylamine | $C_6H_{15}N$ | 108189 | 101.192 | 0.6181 | 0.25786 | 523.1 | 0.271 | 176.85 | 8.0541 | 523.1 | 2.397 |
| 166 | Aniline | $C_6H_7N$ | 62533 | 93.128 | 1.0405 | 0.2807 | 699 | 0.29236 | 267.13 | 11.176 | 699 | 3.707 |
| 167 | *N*-Methylaniline | $C_7H_9N$ | 100618 | 107.155 | 0.6527 | 0.24324 | 701.55 | 0.25374 | 216.15 | 9.7244 | 701.55 | 2.683 |
| 168 | *N,N*-Dimethylaniline | $C_8H_{11}N$ | 121697 | 121.182 | 0.4923 | 0.22868 | 687.15 | 0.2335 | 275.60 | 7.9705 | 687.15 | 2.153 |
| 169 | Ethylene oxide | $C_2H_4O$ | 75218 | 44.053 | 1.836 | 0.26024 | 469.15 | 0.2696 | 160.65 | 23.477 | 469.15 | 7.055 |
| 170 | Furan | $C_4H_4O$ | 110009 | 68.075 | 1.1339 | 0.24741 | 490.15 | 0.2612 | 187.55 | 15.702 | 490.15 | 4.583 |
| 171 | Thiophene | $C_4H_4S$ | 110021 | 84.142 | 1.2875 | 0.28195 | 579.35 | 0.3077 | 234.94 | 13.431 | 579.35 | 4.566 |
| 172 | Pyridine | $C_5H_5N$ | 110861 | 79.101 | 0.9815 | 0.24957 | 619.95 | 0.29295 | 231.51 | 13.193 | 619.95 | 3.933 |
| 173 | Formamide[5] | $CH_3NO$ | 75127 | 45.041 | 1.2486 | 0.20352 | 771 | 0.25178 | 275.60 | 25.488 | 771 | 6.135 |
| 174 | *N,N*-Dimethyl-formamide | $C_3H_7NO$ | 68122 | 73.095 | 0.89615 | 0.23478 | 649.6 | 0.28091 | 212.72 | 13.954 | 649.6 | 3.817 |
| 175 | Acetamide | $C_2H_5NO$ | 60355 | 59.068 | 1.016 | 0.21845 | 761 | 0.26116 | 353.33 | 16.936 | 761 | 4.651 |
| 176 | *N*-Methylacetamide | $C_3H_7NO$ | 79163 | 73.095 | 0.88268 | 0.23568 | 718 | 0.27379 | 301.15 | 13.012 | 718 | 3.745 |
| 177 | Acetonitrile | $C_2H_3N$ | 75058 | 41.053 | 1.3064 | 0.22597 | 545.5 | 0.28678 | 229.32 | 20.628 | 545.5 | 5.781 |
| 178 | Propionitrile | $C_3H_5N$ | 107120 | 55.079 | 1.0224 | 0.23452 | 564.4 | 0.2804 | 180.26 | 16.027 | 564.4 | 4.360 |
| 179 | *n*-Butyronitrile | $C_4H_7N$ | 109740 | 69.106 | 0.87533 | 0.24331 | 582.25 | 0.28586 | 161.25 | 13.047 | 582.25 | 3.598 |
| 180 | Benzonitrile | $C_7H_5N$ | 100470 | 103.123 | 0.73136 | 0.24793 | 699.35 | 0.2841 | 260.40 | 10.009 | 699.35 | 2.950 |
| 181 | Methyl mercaptan | $CH_4S$ | 74931 | 48.109 | 1.9323 | 0.28018 | 469.95 | 0.28523 | 150.18 | 21.564 | 469.95 | 6.897 |
| 182 | Ethyl mercaptan | $C_2H_6S$ | 75081 | 62.136 | 1.3047 | 0.2694 | 499.15 | 0.27866 | 125.26 | 16.242 | 499.15 | 4.843 |
| 183 | *n*-Propyl mercaptan | $C_3H_8S$ | 107039 | 76.163 | 1.0714 | 0.27214 | 536.6 | 0.29481 | 159.95 | 12.716 | 536.6 | 3.937 |
| 184 | *n*-Butyl mercaptan | $C_4H_{10}S$ | 109795 | 90.189 | 0.89458 | 0.27463 | 570.1 | 0.28512 | 157.46 | 10.585 | 570.1 | 3.257 |
| 185 | Isobutyl mercaptan | $C_4H_{10}S$ | 513440 | 90.189 | 0.88801 | 0.27262 | 559 | 0.29522 | 128.31 | 10.851 | 559 | 3.257 |
| 186 | *sec*-Butyl mercaptan | $C_4H_{10}S$ | 513531 | 90.189 | 0.89137 | 0.27365 | 554 | 0.2953 | 133.02 | 10.761 | 554 | 3.257 |
| 187 | Dimethyl sulfide | $C_2H_6S$ | 75183 | 62.136 | 1.4029 | 0.27991 | 503.04 | 0.2741 | 174.88 | 15.556 | 503.04 | 5.012 |
| 188 | Methyl ethyl sulfide | $C_3H_8S$ | 624895 | 76.163 | 1.067 | 0.27101 | 533 | 0.29363 | 167.23 | 12.672 | 533 | 3.937 |
| 189 | Diethyl sulfide | $C_4H_{10}S$ | 352932 | 90.189 | 0.82413 | 0.26333 | 557.15 | 0.27445 | 169.20 | 10.476 | 557.15 | 3.130 |
| 190 | Fluoromethane | $CH_3F$ | 593533 | 34.033 | 2.1854 | 0.24725 | 317.42 | 0.27558 | 131.35 | 29.526 | 317.42 | 8.839 |
| 191 | Chloromethane | $CH_3Cl$ | 74873 | 50.488 | 1.817 | 0.25877 | 416.25 | 0.2833 | 175.43 | 22.347 | 416.25 | 7.022 |
| 192 | Trichloromethane | $CHCl_3$ | 67663 | 119.377 | 1.0841 | 0.2581 | 536.4 | 0.2741 | 209.63 | 13.702 | 536.4 | 4.200 |
| 193 | Tetrachloromethane | $CCl_4$ | 56235 | 153.822 | 0.99835 | 0.274 | 556.35 | 0.287 | 250.33 | 10.843 | 556.35 | 3.644 |
| 194 | Bromomethane | $CH_3Br$ | 74839 | 94.939 | 1.6762 | 0.26141 | 467 | 0.28402 | 179.47 | 20.64 | 467 | 6.412 |
| 195 | Fluoroethane | $C_2H_5F$ | 353366 | 48.060 | 1.6525 | 0.27099 | 375.31 | 0.2442 | 129.95 | 19.785 | 375.31 | 6.098 |
| 196 | Chloroethane | $C_2H_5Cl$ | 75003 | 64.514 | 2.176 | 0.3377 | 460.35 | 0.3361 | 134.80 | 16.934 | 460.35 | 6.444 |
| 197 | Bromoethane | $C_2H_5Br$ | 74964 | 108.966 | 1.1908 | 0.25595 | 503.8 | 0.29152 | 154.55 | 15.833 | 503.8 | 4.653 |
| 198 | 1-Chloropropane | $C_3H_7Cl$ | 540545 | 78.541 | 1.087 | 0.26832 | 503.15 | 0.28055 | 150.35 | 13.328 | 503.15 | 4.051 |
| 199 | 2-Chloropropane | $C_3H_7Cl$ | 75296 | 78.541 | 1.1202 | 0.27669 | 489 | 0.27646 | 155.97 | 12.855 | 489 | 4.049 |
| 200 | 1,1-Dichloropropane[1] | $C_3H_6Cl_2$ | 78999 | 112.986 | 0.91064 | 0.26561 | 560 | 0.28571 | 200.00 | 11.03 | 560 | 3.429 |
| 201 | 1,2-Dichloropropane | $C_3H_6Cl_2$ | 78875 | 112.986 | 0.89833 | 0.26142 | 572 | 0.2868 | 172.71 | 11.526 | 572 | 3.436 |
| 202 | Vinyl chloride | $C_2H_3Cl$ | 75014 | 62.499 | 1.5115 | 0.2707 | 432 | 0.2716 | 119.36 | 18.481 | 432 | 5.584 |
| 203 | Fluorobenzene | $C_6H_5F$ | 462066 | 96.104 | 1.0146 | 0.27277 | 560.09 | 0.28291 | 230.94 | 11.374 | 560.09 | 3.720 |
| 204 | Chlorobenzene | $C_6H_5Cl$ | 108907 | 112.558 | 0.8711 | 0.26805 | 632.35 | 0.2799 | 227.95 | 10.385 | 632.35 | 3.250 |
| 205 | Bromobenzene | $C_6H_5Br$ | 108861 | 157.010 | 0.8226 | 0.26632 | 670.15 | 0.2821 | 242.43 | 9.9087 | 670.15 | 3.089 |
| 206 | Air | | 132259100 | 28.951 | 2.8963 | 0.26733 | 132.45 | 0.27341 | 59.15 | 33.279 | 132.45 | 10.834 |
| 207 | Hydrogen | $H_2$ | 1333740 | 2.016 | 5.414 | 0.34893 | 33.19 | 0.2706 | 13.95 | 38.487 | 33.19 | 15.516 |
| 208 | Helium-4[4] | He | 7440597 | 4.003 | 7.2475 | 0.41865 | 5.2 | 0.24096 | 2.20 | 37.115 | 5.2 | 17.312 |
| 209 | Neon | Ne | 7440019 | 20.180 | 7.3718 | 0.3067 | 44.4 | 0.2786 | 24.56 | 61.796 | 44.4 | 24.036 |
| 210 | Argon | Ar | 7440371 | 39.948 | 3.8469 | 0.2881 | 150.86 | 0.29783 | 83.78 | 35.491 | 150.86 | 13.353 |
| 211 | Fluorine | $F_2$ | 7782414 | 37.997 | 4.2895 | 0.28587 | 144.12 | 0.28776 | 53.48 | 44.888 | 144.12 | 15.005 |
| 212 | Chlorine | $Cl_2$ | 7782505 | 70.905 | 2.23 | 0.27645 | 417.15 | 0.2926 | 172.12 | 24.242 | 417.15 | 8.067 |
| 213 | Bromine | $Br_2$ | 7726956 | 159.808 | 2.1872 | 0.29527 | 584.15 | 0.3295 | 265.85 | 20.109 | 584.15 | 7.408 |
| 214 | Oxygen | $O_2$ | 7782447 | 31.999 | 3.9143 | 0.28772 | 154.58 | 0.2924 | 54.35 | 40.77 | 154.58 | 13.605 |
| 215 | Nitrogen | $N_2$ | 7727379 | 28.014 | 3.2091 | 0.2861 | 126.2 | 0.2966 | 63.15 | 31.063 | 126.2 | 11.217 |
| 216 | Ammonia | $NH_3$ | 7664417 | 17.031 | 3.5383 | 0.25443 | 405.65 | 0.2888 | 195.41 | 43.141 | 405.65 | 13.907 |
| 217 | Hydrazine | $N_2H_4$ | 302012 | 32.045 | 1.0516 | 0.16613 | 653.15 | 0.1898 | 274.69 | 31.934 | 653.15 | 6.330 |

**TABLE 2-30 Densities of Inorganic and Organic Liquids** (*Concluded*)

| Cmpd. no. | Name | Formula | CAS no. | Mol. wt. | C1 | C2 | C3 | C4 | $T_{min}$, K | Density at $T_{min}$ | $T_{max}$, K | Density at $T_{max}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 218 | Nitrous oxide | $N_2O$ | 10024972 | 44.013 | 2.781 | 0.27244 | 309.57 | 0.2882 | 182.30 | 27.928 | 309.57 | 10.208 |
| 219 | Nitric oxide | NO | 10102439 | 30.006 | 5.246 | 0.3044 | 180.15 | 0.242 | 109.50 | 44.487 | 180.15 | 17.234 |
| 220 | Cyanogen | $C_2N_2$ | 460195 | 52.036 | 1.0761 | 0.20984 | 400.15 | 0.20635 | 245.25 | 18.513 | 400.15 | 5.128 |
| 221 | Carbon monoxide | CO | 630080 | 28.010 | 2.897 | 0.27532 | 132.92 | 0.2813 | 68.15 | 30.18 | 132.92 | 10.522 |
| 222 | Carbon dioxide | $CO_2$ | 124389 | 44.010 | 2.768 | 0.26212 | 304.21 | 0.2908 | 216.58 | 26.828 | 304.21 | 10.560 |
| 223 | Carbon disulfide | $CS_2$ | 75150 | 76.143 | 1.7968 | 0.28749 | 552 | 0.3226 | 161.11 | 19.064 | 552 | 6.250 |
| 224 | Hydrogen fluoride | HF | 7664393 | 20.006 | 2.5635 | 0.1766 | 461.15 | 0.3733 | 189.79 | 60.203 | 461.15 | 14.516 |
| 225 | Hydrogen chloride | HCl | 7647010 | 36.461 | 3.342 | 0.2729 | 324.65 | 0.3217 | 158.97 | 34.854 | 324.65 | 12.246 |
| 226 | Hydrogen bromide[1] | HBr | 10035106 | 80.912 | 2.832 | 0.2832 | 363.15 | 0.28571 | 185.15 | 27.985 | 363.15 | 10.000 |
| 227 | Hydrogen cyanide | HCN | 74908 | 27.026 | 1.3413 | 0.18589 | 456.65 | 0.28206 | 259.83 | 27.202 | 456.65 | 7.216 |
| 228 | Hydrogen sulfide | $H_2S$ | 7783064 | 34.082 | 2.7672 | 0.27369 | 373.53 | 0.29015 | 187.68 | 29.13 | 373.53 | 10.111 |
| 229 | Sulfur dioxide | $SO_2$ | 7446095 | 64.065 | 2.106 | 0.25842 | 430.75 | 0.2895 | 197.67 | 25.298 | 430.75 | 8.150 |
| 230 | Sulfur trioxide | $SO_3$ | 7446119 | 80.064 | 1.4969 | 0.19013 | 490.85 | 0.4359 | 289.95 | 24.241 | 490.85 | 7.873 |
| 231 | Water[7] | $H_2O$ | 7732185 | 18.015 | 5.459 | 0.30542 | 647.13 | 0.081 | 273.16 | 55.583 | 333.15 | 54.703 |

All substances are listed in alphabetical order in Table 2-6*a*. Compiled from Daubert, T. E., R. P. Danner, H. M. Sibul, and C. C. Stebbins, DIPPR Data Compilation of Pure Compound Properties, Project 801 Sponsor Release, July, 1993, Design Institute for Physical Property Data, AIChE, New York, NY; and from Thermodynamics Research Center, "Selected Values of Properties of Hydrocarbons and Related Compounds," Thermodynamics Research Center Hydrocarbon Project, Texas A&M University, College Station, Texas (extant 1994).

Temperatures are in kelvins. Liquid densities are in kmol/m$^3$. Density formulas: kmol/m$^3$ × (mol. wt./1E+03) = g/cm$^3$; kmol/m$^3$ × (mol. wt./1.601846E+01) = lb/ft$^3$.

The liquid density equation is $C1/C2^{[1+(1-T/C3)^{C4}]}$ unless otherwise noted.

[1] The modified Rackett equation, density = $(P_c/RT_c)/ZRA^{1+[1-(T/T_c)]2/7}$, was used. See Spencer, C. F., and R. P. Danner, "Improved Equation for Prediction of Saturated Liquid Density," *J. Chem. Eng. Data* **17,** 236 (1972).

[2] Decomposes violently on heating. Forms explosive peroxides with air or oxygen. Polymerizes under pressure and heat.

[3] For the hypothetical pure liquid.

[4] Exhibits superfluid properties below 2.2 K.

[5] Coefficients are hypothetical above the decomposition temperature.

[6] Lower limit is for the undercooled liquid.

[7] For the temperature range 333.15 to 403.15 K, use the coefficients: $C_1$ = 4.9669E+00, $C_2$ = 2.7788E–01, $C_3$ = 6.4713E+02, $C_4$ = 1.8740E–01. For the temperature range 403.15 to 647.13 K, use $C_1$ = 4.3910E+00, $C_2$ = 2.4870E–01, $C_3$ = 6.4713E+02, $C_4$ = 2.5340E–01.

# DENSITIES OF AQUEOUS INORGANIC SOLUTIONS

## UNITS AND UNITS CONVERSIONS

Densities are given in grams per cubic centimeter. To convert to pounds per cubic foot, multiply by 62.43. °F = ⅘ °C + 32.

## ADDITIONAL REFERENCES

For more detailed data on densities see *International Critical Tables:* tabular index, vol. 3, p. 1; abrasives, vol. 2, p. 87; air, moist, vol. 1, p. 71; building stones, vol. 2, p. 52; clays, vol. 2, p. 56; coals, vol. 2, p. 135; compounds, vol. 1. pp. 106, 176, 313, 341; elements, vol. 1, pp. 102, 340; fibers, vol. 2, p. 237; gases and vapors, vol. 3, pp. 3, 345; glass, vol. 2, p. 93; liquids and vitreous solids, vol. 3, p. 22; vol. 1, pp. 102, 340; vol. 2, pp. 456, 463; vol. 3, pp. 20, 35; liquid coolants and saturated vapors are available from WADC-TR-59-598, 1959; plastics are collected in the *Handbook of Chemistry and Physics,* Chemical Rubber Publishing Co.: solid helium, neon, argon, fluorine, and methane data are given by Johnson (ed.), WADD-TR-60-56, 1960; temperatures of maximum solubility, vol. 3, p. 107; metals, vol. 2, p. 463; oils, fats, and waxes, vol. 2, p. 201; orthobaric, vol. 3, pp. 202, 228, 237, 244; petroleums, vol. 2, pp. 137, 144; plastics, vol. 2, p. 296; porcelains, vol. 2, pp. 68, 75; refrigerating brines, vol. 2, p. 327; rubber, vol. 2, pp. 255, 259; soaps, vol. 5, p. 447; metallic solid solutions, vol. 2, p. 358; solids, vol. 3, pp. 43, 45; vol. 2, p. 456; vol. 3, p. 21; solutions and mixtures, vol. 3, pp. 17, 51, 95, 104, 107, 111, 125, 130; woods, vol. 2, p. 1. Also see the *Handbook of Chemistry and Physics,* Chemical Rubber Publishing Co., 40th ed., etc.

**TABLE 2-31 Aluminum Sulfate [$Al_2(SO_4)_3$]**

| % | $d_4^{15}$ | % | $d_4^{15}$ |
|---|---|---|---|
| 1 | 1.0093 | 16 | 1.1770 |
| 2 | 1.0195 | 20 | 1.2272 |
| 4 | 1.0404 | 24 | 1.2803 |
| 8 | 1.0837 | 26 | 1.3079 |
| 12 | 1.1293 | | |

**TABLE 2-32 Ammonia ($NH_3$)**

| % | −15°C | −10°C | −5°C | 0°C | 5°C | 10°C | 20°C | 25°C | % | $d_4^{15}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 0.9943 | 0.9954 | 0.9959 | 0.9958 | 0.9955 | 0.9939 | 0.993 | 32 | 0.889 |
| 2 | | .9906 | .9915 | .9919 | .9917 | .9913 | .9895 | .988 | 36 | .877 |
| 4 | | .9834 | .9840 | .9842 | .9837 | .9832 | .9811 | .980 | 40 | .865 |
| 8 | 0.970 | .9701 | .9701 | .9695 | .9686 | .9677 | .9651 | .964 | 45 | .849 |
| 12 | .958 | .9576 | .9571 | .9561 | .9548 | .9534 | .9501 | .948 | 50 | .832 |
| 16 | .947 | .9461 | .9450 | .9435 | .9420 | .9402 | .9362 | .934 | 60 | .796 |
| 20 | | .9353 | .9335 | .9316 | .9296 | .9275 | .9229 | | 70 | .755 |
| 24 | | .9249 | .9226 | .9202 | .9179 | .9155 | .9101 | | 80 | .711 |
| 28 | | .9150 | .9122 | .9094 | .9067 | .9040 | .8980 | | 90 | .665 |
| 30 | | .9101 | .9070 | .9040 | .9012 | .8983 | .8920 | | 100 | .618 |

**TABLE 2-33 Ammonium Acetate* ($CH_3COONH_4$)**

| % | $d_4^{25}$ |
|---|---|
| 1 | 0.9992 |
| 2 | 1.0013 |
| 4 | 1.0055 |
| 8 | 1.0136 |
| 12 | 1.0216 |
| 16 | 1.0294 |
| 20 | 1.0368 |
| 24 | 1.0439 |
| 28 | 1.0507 |
| 30 | 1.0540 |
| 35 | 1.0618 |
| 40 | 1.0691 |
| 45 | 1.0760 |

*For data at 16°C for 3(1)52 percent see Atack *Handbook of Chemical Data,* p. 33, Reinhold, New York, 1957.

**TABLE 2-34 Ammonium Bichromate [$(NH_4)_2Cr_2O_7$]**

| % | $d_4^{12}$ |
|---|---|
| 1 | 1.0051 |
| 2 | 1.0108 |
| 4 | 1.0223 |
| 8 | 1.0463 |
| 12 | 1.0715 |
| 16 | 1.0981 |
| 20 | 1.1263 |

**TABLE 2-35 Ammonium Chloride ($NH_4Cl$)**

| % | 0°C | 10°C | 20°C | 30°C | 50°C | 80°C | 100°C |
|---|---|---|---|---|---|---|---|
| 1 | 1.0033 | 1.0029 | 1.0013 | 0.9987 | 0.9910 | 0.9749 | 0.9617 |
| 2 | 1.0067 | 1.0062 | 1.0045 | 1.0018 | .9940 | .9780 | .9651 |
| 4 | 1.0135 | 1.0126 | 1.0107 | 1.0077 | .9999 | .9842 | .9718 |
| 8 | 1.0266 | 1.0251 | 1.0227 | 1.0195 | 1.0116 | .9963 | .9849 |
| 12 | 1.0391 | 1.0370 | 1.0344 | 1.0310 | 1.0231 | 1.0081 | .9975 |
| 16 | 1.0510 | 1.0485 | 1.0457 | 1.0422 | 1.0343 | 1.0198 | 1.0096 |
| 20 | 1.0625 | 1.0596 | 1.0567 | 1.0532 | 1.0454 | 1.0312 | 1.0213 |
| 24 | 1.0736 | 1.0705 | 1.0674 | 1.0641 | 1.0564 | 1.0426 | 1.0327 |

**TABLE 2-36 Ammonium Chromate [$(NH_4)_2CrO_4$]**

| % | °C | $d_4^t$ |
|---|---|---|
| 3.80 | 20 | 1.0219 |
| 10.52 | 13 | 1.0627 |
| 19.75 | 13.7 | 1.1189 |
| 28.04 | 19.6 | 1.1707 |

**TABLE 2-37 Ammonium Nitrate ($NH_4NO_3$)**

| % | 0°C | 10°C | 25°C | 40°C | 60°C | 80°C |
|---|---|---|---|---|---|---|
| 1.0 | 1.0043 | 1.0039 | 1.0011 | 0.9961 | 0.9870 | 0.9755 |
| 2.0 | 1.0088 | 1.0082 | 1.0051 | 1.0000 | .9908 | .9793 |
| 4.0 | 1.0178 | 1.0168 | 1.0132 | 1.0079 | .9985 | .9869 |
| 8.0 | 1.0358 | 1.0340 | 1.0297 | 1.0238 | 1.0142 | 1.0024 |
| 12.0 | 1.0539 | 1.0515 | 1.0464 | 1.0400 | 1.0301 | 1.0181 |
| 16.0 | 1.0721 | 1.0691 | 1.0633 | 1.0565 | 1.0462 | 1.0342 |
| 20.0 | 1.0905 | 1.0870 | 1.0806 | 1.0734 | 1.0627 | 1.0506 |
| 24.0 | 1.1090 | 1.1051 | 1.0982 | 1.0907 | 1.0796 | 1.0673 |
| 28.0 | 1.1277 | 1.1234 | 1.1161 | 1.1082 | 1.0968 | 1.0844 |
| 30.0 | 1.1371 | 1.1327 | 1.1252 | 1.1171 | 1.1055 | 1.0931 |
| 40.0 | 1.1862 | 1.1810 | 1.1727 | 1.1640 | 1.1515 | 1.1385 |
| 50.0 | 1.2380 | 1.2320 | 1.2229 | 1.2136 | 1.2006 | 1.1868 |

**TABLE 2-38 Ammonium Sulfate [$(NH_4)_2SO_4$]**

| % | 0°C | 20°C | 40°C | 80°C | 100°C |
|---|---|---|---|---|---|
| 1 | 1.0061 | 1.0041 | 0.9980 | 0.9777 | 0.9644 |
| 2 | 1.0124 | 1.0101 | 1.0039 | .9836 | .9705 |
| 4 | 1.0248 | 1.0220 | 1.0155 | .9953 | .9826 |
| 8 | 1.0495 | 1.0456 | 1.0387 | 1.0187 | 1.0066 |
| 12 | 1.0740 | 1.0691 | 1.0619 | 1.0421 | 1.0303 |
| 16 | 1.0980 | 1.0924 | 1.0849 | 1.0653 | 1.0539 |
| 20 | 1.1215 | 1.1154 | 1.1077 | 1.0883 | 1.0772 |
| 24 | 1.1448 | 1.1383 | 1.1304 | 1.1111 | 1.1003 |
| 28 | 1.1677 | 1.1609 | 1.1529 | 1.1338 | 1.1232 |
| 35 | 1.2072 | 1.2800 | 1.1919 | 1.1731 | 1.1629 |
| 40 | 1.2350 | 1.2277 | 1.2196 | 1.2011 | 1.1910 |
| 50 | 1.2899 | 1.2825 | 1.2745 | 1.2568 | 1.2466 |

**TABLE 2-39 Arsenic Acid ($H_3A_3O_4$)**

| % | $d_4^{15}$ | % | $d_4^{15}$ |
|---|---|---|---|
| 1 | 1.0057 | 20 | 1.1447 |
| 2 | 1.0124 | 30 | 1.2331 |
| 6 | 1.0398 | 40 | 1.3370 |
| 10 | 1.0681 | 50 | 1.4602 |
| 16 | 1.1128 | 60 | 1.6070 |
| | | 70 | 1.7811 |

**TABLE 2-40 Barium Chloride ($BaCl_2$)**

| % | 0°C | 20°C | 40°C | 60°C | 80°C | 100°C |
|---|---|---|---|---|---|---|
| 2 | 1.0181 | 1.0159 | 1.0096 | 1.0004 | 0.9890 | 0.9755 |
| 4 | 1.0368 | 1.0341 | 1.0275 | 1.0181 | 1.0066 | .9931 |
| 8 | 1.0760 | 1.0721 | 1.0648 | 1.0551 | 1.0434 | 1.0299 |
| 12 | 1.1178 | 1.1128 | 1.1047 | 1.0948 | 1.0827 | 1.0692 |
| 16 | 1.1627 | 1.1564 | 1.1478 | 1.1373 | 1.1249 | 1.1113 |
| 20 | 1.2105 | 1.2031 | 1.1938 | 1.1828 | 1.1702 | 1.1563 |
| 24 | | 1.2531 | 1.2430 | 1.2316 | 1.2186 | 1.2045 |
| 26 | | 1.2793 | 1.2688 | 1.2571 | 1.2440 | 1.2298 |

**TABLE 2-41 Cadmium Nitrate [$Cd(NO_3)_2$]**

| % | $d_4^{18}$ | % | $d_4^{18}$ |
|---|---|---|---|
| 2 | 1.0154 | 20 | 1.1904 |
| 4 | 1.0326 | 25 | 1.2488 |
| 8 | 1.0683 | 30 | 1.3124 |
| 12 | 1.1061 | 40 | 1.4590 |
| 16 | 1.1468 | 50 | 1.6356 |

**TABLE 2-42 Calcium Chloride ($CaCl_2$)**

| % | −5°C | 0°C | 20°C | 30°C | 40°C | 60°C | 80°C | 100°C | 120°C* | 140°C |
|---|---|---|---|---|---|---|---|---|---|---|
| 2 | | 1.0171 | 1.0148 | 1.0120 | 1.0084 | 0.9994 | 0.9881 | 0.9748 | 0.9596 | 0.9428 |
| 4 | | 1.0346 | 1.0316 | 1.0286 | 1.0249 | 1.0158 | 1.0046 | .9915 | .9765 | .9601 |
| 8 | 1.0708 | 1.0703 | 1.0659 | 1.0626 | 1.0586 | 1.0492 | 1.0382 | 1.0257 | 1.0111 | .9954 |
| 12 | 1.1083 | 1.1072 | 1.1015 | 1.0978 | 1.0937 | 1.0840 | 1.0730 | 1.0610 | 1.0466 | 1.0317 |
| 16 | 1.1471 | 1.1454 | 1.1386 | 1.1345 | 1.1301 | 1.1202 | 1.1092 | 1.0973 | 1.0835 | 1.0691 |
| 20 | 1.1874 | 1.1853 | 1.1775 | 1.1730 | 1.1684 | 1.1581 | 1.1471 | 1.1352 | 1.1219 | 1.1080 |
| 25 | | 1.2376 | 1.2284 | 1.2236 | 1.2186 | 1.2079 | 1.1965 | 1.1846 | | |
| 30 | | 1.2922 | 1.2816 | 1.2764 | 1.2709 | 1.2597 | 1.2478 | 1.2359 | | |
| 35 | | | 1.3373 | 1.3316 | 1.3255 | 1.3137 | 1.3013 | 1.2893 | | |
| 40 | | | 1.3957 | 1.3895 | 1.3826 | 1.3700 | 1.3571 | 1.3450 | | |

*Corrected to atmospheric pressure.

**TABLE 2-43 Calcium Hydroxide [$Ca(OH)_2$]**

| % | $d_4^{15}$ | $d_4^{25}$ |
|---|---|---|
| 0.05 | 0.99979 | 0.99773 |
| .10 | 1.00044 | .99838 |
| .15 | 1.00110 | .99904 |

**TABLE 2-44 Calcium Hypochlorite* ($CaOCl_2$)**

| % total salt | $d_4^{15}$ |
|---|---|
| 2 | 1.0169 |
| 4 | 1.0345 |
| 6 | 1.0520 |
| 8 | 1.0697 |
| 10 | 1.0876 |
| 12 | 1.1060 |

*$CaOCl_2$ = 89.15%
$CaCl_2$ = 7.31%
$Ca(ClO_3)_2$ = 0.26%
$Ca(OH)_2$ = 2.92%.

**TABLE 2-45 Calcium Nitrate [$Ca(NO_3)_2$]**

| % | 6°C | 18°C | 25°C | 30°C |
|---|---|---|---|---|
| 2* | 1.0157 | 1.0137 | 1.0120 | 1.0105 |
| 4 | 1.0316 | 1.0291 | 1.0272 | 1.0256 |
| 8 | 1.0641 | 1.0608 | 1.0585 | 1.0565 |
| 12 | 1.0979 | 1.0937 | 1.0911 | 1.0887 |
| 16 | 1.1330 | 1.1279 | 1.1250 | 1.1224 |
| 20 | 1.1694 | 1.1636 | 1.1602 | 1.1575 |
| 25 | 1.2168 | 1.2106 | 1.2065 | 1.2032 |
| 30 | | 1.260 | | |
| 35 | | 1.311 | | |
| 40 | | 1.365 | | |
| 45 | | 1.422 | | |
| 68* | | 1.747 | 1.741 | 1.736 |

*Supercooled tetrahydrate (m.p. 41.4°C).

**TABLE 2-46 Chromic Acid ($CrO_3$)**

| % | $d_4^{15}$ | % | $d_4^{15}$ |
|---|---|---|---|
| 1 | 1.006 | 20 | 1.163 |
| 2 | 1.014 | 26 | 1.220 |
| 6 | 1.045 | 30 | 1.260 |
| 10 | 1.076 | 40 | 1.371 |
| 16 | 1.127 | 50 | 1.505 |
| | | 60 | 1.663 |

**TABLE 2-47 Chromium Chloride ($CrCl_3$)**

| | $d_4^{18}$ | | |
|---|---|---|---|
| % | Violet | Green | Equilibrium mixture of violet and green |
| 1 | 1.0076 | 1.0071 | 1.0075 |
| 2 | 1.0166 | 1.0157 | 1.0165 |
| 4 | 1.0349 | 1.0332 | 1.0347 |
| 8 | 1.0724 | 1.0691 | 1.0722 |
| 12 | 1.1114 | 1.1065 | 1.1111 |
| 14 | 1.1316 | | |

**TABLE 2-48 Copper Nitrate [$Cu(NO_3)_2$]**

| % | $d_4^{20}$ | % | $d_4^{20}$ |
|---|---|---|---|
| 1 | 1.007 | 12 | 1.107 |
| 2 | 1.015 | 16 | 1.147 |
| 4 | 1.032 | 20 | 1.189 |
| 8 | 1.069 | 25 | 1.248 |

**TABLE 2-49 Copper Sulfate ($CuSO_4$)**

| % | 0°C | 20°C | 40°C |
|---|---|---|---|
| 1 | 1.0104 | 1.0086 | 1.0024 |
| 4 | 1.0429 | 1.0401 | 1.0332 |
| 8 | 1.0887 | 1.084 | 1.0764 |
| 12 | 1.1379 | 1.1308 | 1.1222 |
| 16 | | 1.180 | |
| 18 | | 1.206 | |

**TABLE 2-50 Cuprous Chloride ($Cu_2Cl_2$)**

| % | 0°C | 20°C | 40°C |
|---|---|---|---|
| 1 | 1.0095 | 1.0072 | 1.002 |
| 4 | 1.0387 | 1.036 | 1.0305 |
| 8 | 1.0788 | 1.0754 | 1.0682 |
| 12 | 1.1208 | 1.1165 | 1.107 |
| 16 | 1.1653 | 1.1595 | 1.151 |
| 20 | 1.2121 | 1.2052 | 1.1953 |

**TABLE 2-51 Ferric Chloride ($FeCl_3$)**

| % | 0°C | 10°C | 20°C | 30°C |
|---|---|---|---|---|
| 1 | 1.0086 | 1.0084 | 1.0068 | 1.0040 |
| 2 | 1.0174 | 1.0168 | 1.0152 | 1.0122 |
| 4 | 1.0347 | 1.0341 | 1.0324 | 1.0292 |
| 8 | 1.0703 | 1.0692 | 1.0669 | 1.0636 |
| 12 | 1.1088 | 1.1071 | 1.1040 | 1.1006 |
| 16 | 1.1475 | 1.1449 | 1.1418 | 1.1386 |
| 20 | 1.1870 | 1.1847 | 1.1820 | 1.1786 |
| 25 | 1.2400 | 1.2380 | 1.2340 | 1.2290 |
| 30 | 1.2970 | 1.2950 | 1.2910 | 1.2850 |
| 35 | 1.3605 | 1.3580 | 1.3530 | 1.3475 |
| 40 | 1.4280 | 1.4235 | 1.4175 | 1.4115 |
| 45 | | 1.4920 | 1.4850 | |
| 50 | | 1.5610 | 1.5510 | |

**TABLE 2-52 Ferric Sulfate [$Fe_2(SO_4)_3$]**

| % | $d_4^{17.5}$ |
|---|---|
| 1 | 1.0072 |
| 2 | 1.0157 |
| 4 | 1.0327 |
| 8 | 1.0670 |
| 12 | 1.1028 |
| 16 | 1.1409 |
| 20 | 1.1811 |
| 30 | 1.3073 |
| 40 | 1.4487 |
| 50 | 1.6127 |
| 60 | 1.7983 |

**TABLE 2-53 Ferric Nitrate [$Fe(NO_3)_3$]**

| % | $d_4^{18}$ |
|---|---|
| 1 | 1.0065 |
| 2 | 1.0144 |
| 4 | 1.0304 |
| 8 | 1.0636 |
| 12 | 1.0989 |
| 16 | 1.1359 |
| 20 | 1.1748 |
| 25 | 1.2281 |

**TABLE 2-54 Ferrous Sulfate ($FeSO_4$)**

| % | 15°C | 18°C | 20°C |
|---|---|---|---|
| 0.2 | | 1.00068 | 1.0002 |
| 0.4 | | 1.00275 | 1.0022 |
| 0.8 | | 1.00645 | 1.0062 |
| 1.0 | 1.0090 | 1.0085 | 1.0082 |
| 4.0 | 1.0380 | 1.0375 | |
| 8.0 | 1.0790 | 1.0785 | |
| 12.0 | 1.1235 | 1.1220 | |
| 16.0 | 1.1690 | 1.1675 | |
| 20.0 | 1.2150 | 1.2135 | |

**TABLE 2-55 Hydrogen Bromide (HBr)**

| % | $d_4^4$ | $d_4^{10}$ | $d_4^{25}$ |
|---|---|---|---|
| 1.0 | 1.0073 | 1.0068 | 1.0041 |
| 2.0 | 1.0146 | 1.0139 | 1.0111 |
| 4.0 | 1.0295 | 1.0285 | 1.0255 |
| 6.0 | 1.0448 | 1.0435 | 1.0402 |
| 8.0 | 1.0604 | 1.0589 | 1.0552 |
| 10.0 | 1.0764 | 1.0747 | 1.0707 |
| 12.0 | 1.0928 | 1.0910 | 1.0867 |
| 14.0 | 1.1097 | 1.1078 | 1.1032 |
| 16.0 | 1.1272 | 1.1251 | 1.1202 |
| 18.0 | 1.1453 | 1.1430 | 1.1377 |
| 20.0 | 1.1640 | 1.1615 | 1.1557 |
| 22.0 | 1.1832 | 1.1806 | 1.1743 |
| 24.0 | 1.2030 | 1.2003 | 1.1935 |
| 26.0 | 1.2235 | 1.2206 | 1.2134 |
| 28.0 | 1.2446 | 1.2415 | 1.2340 |
| 30.0 | 1.2663 | 1.2630 | 1.2552 |
| 40.0 | 1.3877 | 1.3838 | 1.3736 |
| 50.0 | 1.5305 | 1.5257 | 1.5127 |
| 60.0 | 1.6950 | 1.6892 | 1.6731 |
| 65.0 | 1.7854 | 1.7792 | 1.7613 |

**TABLE 2-56 Hydrogen Cyanide (HCN)**

| % | $d_4^{15}$ |
|---|---|
| 1 | 0.998 |
| 2 | .996 |
| 4 | .993 |
| 8 | .984 |
| 12 | .971 |
| 16 | .956 |
| 82 | .752 |
| 90 | .724 |
| 100 | .691 |

**TABLE 2-57 Hydrogen Chloride (HCl)**

| % | −5°C | 0°C | 10°C | 20°C | 40°C | 60°C | 80°C | 100°C |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.0048 | 1.0052 | 1.0048 | 1.0032 | 0.9970 | 0.9881 | 0.9768 | 0.9636 |
| 2 | 1.0104 | 1.0106 | 1.0100 | 1.0082 | 1.0019 | .9930 | 0.9819 | .9688 |
| 4 | 1.0213 | 1.0213 | 1.0202 | 1.0181 | 1.0116 | 1.0026 | 0.9919 | .9791 |
| 6 | 1.0321 | 1.0319 | 1.0303 | 1.0279 | 1.0211 | 1.0121 | 1.0016 | .9892 |
| 8 | 1.0428 | 1.0423 | 1.0403 | 1.0376 | 1.0305 | 1.0215 | 1.0111 | .9992 |
| 10 | 1.0536 | 1.0528 | 1.0504 | 1.0474 | 1.0400 | 1.0310 | 1.0206 | 1.0090 |
| 12 | 1.0645 | 1.0634 | 1.0607 | 1.0574 | 1.0497 | 1.0406 | 1.0302 | 1.0188 |
| 14 | 1.0754 | 1.0741 | 1.0711 | 1.0675 | 1.0594 | 1.0502 | 1.0398 | 1.0286 |
| 16 | 1.0864 | 1.0849 | 1.0815 | 1.0776 | 1.0692 | 1.0598 | 1.0494 | 1.0383 |
| 18 | 1.0975 | 1.0958 | 1.0920 | 1.0878 | 1.0790 | 1.0694 | 1.0590 | 1.0479 |
| 20 | 1.1087 | 1.1067 | 1.1025 | 1.0980 | 1.0888 | 1.0790 | 1.0685 | 1.0574 |
| 22 | 1.1200 | 1.1177 | 1.1131 | 1.1083 | 1.0986 | 1.0886 | 1.0780 | 1.0668 |
| 24 | 1.1314 | 1.1287 | 1.1238 | 1.1187 | 1.1085 | 1.0982 | 1.0874 | 1.0761 |
| 26 | 1.1426 | 1.1396 | 1.1344 | 1.1290 | 1.1183 | 1.1076 | 1.0967 | 1.0853 |
| 28 | 1.1537 | 1.1505 | 1.1449 | 1.1392 | 1.1280 | 1.1169 | 1.1058 | 1.0942 |
| 30 | 1.1648 | 1.1613 | 1.1553 | 1.1493 | 1.1376 | 1.1260 | 1.1149 | 1.1030 |
| 32 | | | | 1.1593 | | | | |
| 34 | | | | 1.1691 | | | | |
| 36 | | | | 1.1789 | | | | |
| 38 | | | | 1.1885 | | | | |
| 40 | | | | 1.1980 | | | | |

**TABLE 2-58 Hydrogen Fluoride (HF)**

| % | $d_4^{20}$ | $d_4^0$ |
|---|---|---|
| 5 | 1.020 | 1.017 |
| 10 | 1.040 | 1.035 |
| 20 | 1.080 | 1.070 |
| 30 | 1.119 | 1.101 |
| 40 | 1.159 | 1.130 |
| 50 | 1.198 | 1.155 |
| 60 | 1.235 | |
| 70 | 1.258 | |
| 80 | 1.259 | |
| 90 | 1.178 | |
| 95 | 1.089 | |
| 100 | 1.0005 | |

**TABLE 2-59 Hydrogen Peroxide ($H_2O_2$)**

| % | $d_4^{18}$ | % | $d_4^{18}$ |
|---|---|---|---|
| 1 | 1.0022 | 26 | 1.0959 |
| 2 | 1.0058 | 28 | 1.1040 |
| 4 | 1.0131 | 30 | 1.1122 |
| 6 | 1.0204 | 35 | 1.1327 |
| 8 | 1.0277 | 40 | 1.1536 |
| 10 | 1.0351 | 45 | 1.1749 |
| 12 | 1.0425 | 50 | 1.1966 |
| 14 | 1.0499 | 55 | 1.2188 |
| 16 | 1.0574 | 60 | 1.2416 |
| 18 | 1.0649 | 70 | 1.2897 |
| 20 | 1.0725 | 80 | 1.3406 |
| 22 | 1.0802 | 90 | 1.3931 |
| 24 | 1.0880 | 100 | 1.4465 |

**TABLE 2-60 Hydrofluosilic Acid ($H_2SiF_6$)**

| % | $d_4^{17.5}$ | % | $d_4^{17.5}$ |
|---|---|---|---|
| 1 | 1.0080 | 16 | 1.1373 |
| 2 | 1.0161 | 20 | 1.1748 |
| 4 | 1.0324 | 25 | 1.2235 |
| 8 | 1.0661 | 30 | 1.2742 |
| 12 | 1.1011 | 34 | 1.3162 |

**TABLE 2-61 Magnesium Chloride ($MgCl_2$)**

| % | 0°C | 20°C | 40°C | 60°C | 80°C | 100°C |
|---|---|---|---|---|---|---|
| 2 | 1.0168 | 1.0146 | 1.0084 | 0.9995 | 0.9883 | 0.9753 |
| 4 | 1.0338 | 1.0311 | 1.0248 | 1.0159 | 1.0050 | .9923 |
| 8 | 1.0683 | 1.0646 | 1.0580 | 1.0493 | 1.0388 | 1.0269 |
| 12 | 1.1035 | 1.0989 | 1.0921 | 1.0836 | 1.0735 | 1.0622 |
| 16 | 1.1395 | 1.1342 | 1.1272 | 1.1188 | 1.1092 | 1.0984 |
| 20 | 1.1764 | 1.1706 | 1.1635 | 1.1552 | 1.1460 | 1.1359 |
| 25 | 1.2246 | 1.2184 | 1.2111 | 1.2031 | 1.1942 | 1.1847 |
| 30 | 1.2754 | 1.2688 | 1.2614 | 1.2535 | 1.2451 | 1.2360 |

**TABLE 2-62 Magnesium Sulfate ($MgSO_4$)**

| % | 0°C | 20°C | 30°C | 40°C | 50°C | 60°C | 80°C |
|---|---|---|---|---|---|---|---|
| 2 | 1.0210 | 1.0186 | 1.0158 | 1.0123 | 1.0081 | 1.0032 | 0.9916 |
| 4 | 1.0423 | 1.0392 | 1.0362 | 1.0326 | 1.0283 | 1.0234 | 1.0118 |
| 8 | 1.0858 | 1.0816 | 1.0782 | 1.0743 | 1.0700 | 1.0650 | 1.0534 |
| 12 | 1.1309 | 1.1256 | 1.1220 | 1.1179 | 1.1135 | 1.1083 | 1.0968 |
| 16 | 1.1777 | 1.1717 | 1.1679 | 1.1637 | 1.1592 | | |
| 20 | 1.2264 | 1.2198 | 1.2159 | 1.2117 | 1.2072 | | |
| 26 | 1.3032 | 1.2961 | 1.2922 | 1.2879 | 1.2836 | | |

**TABLE 2-63 Nickel Chloride ($NiCl_2$)**

| % | $d_4^{18}$ |
|---|---|
| 1 | 1.0082 |
| 2 | 1.0179 |
| 4 | 1.0375 |
| 8 | 1.0785 |
| 12 | 1.1217 |
| 16 | 1.1674 |
| 20 | 1.2163 |
| 30 | 1.353 |

**TABLE 2-64 Nickel Nitrate [$Ni(NO_3)_2$]**

| % | $d_4^{20}$ |
|---|---|
| 1 | 1.0065 |
| 2 | 1.0150 |
| 4 | 1.0325 |
| 8 | 1.0688 |
| 12 | 1.1070 |
| 16 | 1.1480 |
| 20 | 1.191 |
| 30 | 1.311 |
| 35 | 1.377 |

**TABLE 2-65 Nickel Sulfate ($NiSO_4$)**

| % | $d_4^{18}$ |
|---|---|
| 1 | 1.0091 |
| 2 | 1.0198 |
| 4 | 1.0415 |
| 8 | 1.0852 |
| 12 | 1.1325 |
| 16 | 1.1825 |
| 18 | 1.2090 |

**TABLE 2-66 Nitric Acid ($HNO_3$)**

| % | 0°C | 5°C | 10°C | 15°C | 20°C | 25°C | 30°C | 40°C | 50°C | 60°C | 80°C | 100°C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0058 | 1.00572 | 1.00534 | 1.00464 | 1.00364 | 1.00241 | 1.0009 | 0.9973 | 0.9931 | 0.9882 | 0.9767 | 0.9632 |
| 2 | 1.0117 | 1.01149 | 1.01099 | 1.01018 | 1.00909 | 1.00778 | 1.0061 | 1.0025 | .9982 | .9932 | .9816 | .9681 |
| 3 | 1.0176 | 1.01730 | 1.01668 | 1.01576 | 1.01457 | 1.01318 | 1.0114 | 1.0077 | 1.0033 | .9982 | .9865 | .9730 |
| 4 | 1.0236 | 1.02315 | 1.02240 | 1.02137 | 1.02008 | 1.01861 | 1.0168 | 1.0129 | 1.0084 | 1.0033 | .9915 | .9779 |
| 5 | 1.0296 | 1.02904 | 1.02816 | 1.02702 | 1.02563 | 1.02408 | 1.0222 | 1.0182 | 1.0136 | 1.0084 | .9965 | .9829 |
| 6 | 1.0357 | 1.03497 | 1.03397 | 1.03272 | 1.03122 | 1.02958 | 1.0277 | 1.0235 | 1.0188 | 1.0136 | 1.0015 | .9879 |
| 7 | 1.0418 | 1.0410 | 1.0399 | 1.0385 | 1.0369 | 1.0352 | 1.0333 | 1.0289 | 1.0241 | 1.0188 | 1.0066 | .9929 |
| 8 | 1.0480 | 1.0471 | 1.0458 | 1.0443 | 1.0427 | 1.0409 | 1.0389 | 1.0344 | 1.0295 | 1.0241 | 1.0117 | .9980 |
| 9 | 1.0543 | 1.0532 | 1.0518 | 1.0502 | 1.0485 | 1.0466 | 1.0446 | 1.0399 | 1.0349 | 1.0294 | 1.0169 | 1.0032 |
| 10 | 1.0606 | 1.0594 | 1.0578 | 1.0561 | 1.0543 | 1.0523 | 1.0503 | 1.0455 | 1.0403 | 1.0347 | 1.0221 | 1.0083 |
| 11 | 1.0669 | 1.0656 | 1.0639 | 1.0621 | 1.0602 | 1.0581 | 1.0560 | 1.0511 | 1.0458 | 1.0401 | 1.0273 | 1.0134 |
| 12 | 1.0733 | 1.0718 | 1.0700 | 1.0681 | 1.0661 | 1.0640 | 1.0618 | 1.0567 | 1.0513 | 1.0455 | 1.0326 | 1.0186 |
| 13 | 1.0797 | 1.0781 | 1.0762 | 1.0742 | 1.0721 | 1.0699 | 1.0676 | 1.0624 | 1.0568 | 1.0509 | 1.0379 | 1.0238 |
| 14 | 1.0862 | 1.0845 | 1.0824 | 1.0803 | 1.0781 | 1.0758 | 1.0735 | 1.0681 | 1.0624 | 1.0564 | 1.0432 | 1.0289 |
| 15 | 1.0927 | 1.0909 | 1.0887 | 1.0865 | 1.0842 | 1.0818 | 1.0794 | 1.0739 | 1.0680 | 1.0619 | 1.0485 | 1.0341 |
| 16 | 1.0992 | 1.0973 | 1.0950 | 1.0927 | 1.0903 | 1.0879 | 1.0854 | 1.0797 | 1.0737 | 1.0675 | 1.0538 | 1.0393 |
| 17 | 1.1057 | 1.1038 | 1.1014 | 1.0989 | 1.0964 | 1.0940 | 1.0914 | 1.0855 | 1.0794 | 1.0731 | 1.0592 | 1.0444 |
| 18 | 1.1123 | 1.1103 | 1.1078 | 1.1052 | 1.1026 | 1.1001 | 1.0974 | 1.0913 | 1.0851 | 1.0787 | 1.0646 | 1.0496 |
| 19 | 1.1189 | 1.1168 | 1.1142 | 1.1115 | 1.1088 | 1.1062 | 1.1034 | 1.0972 | 1.0908 | 1.0843 | 1.0700 | 1.0547 |
| 20 | 1.1255 | 1.1234 | 1.1206 | 1.1178 | 1.1150 | 1.1123 | 1.1094 | 1.1031 | 1.0966 | 1.0899 | 1.0754 | 1.0598 |
| 21 | 1.1322 | 1.1300 | 1.1271 | 1.1242 | 1.1213 | 1.1185 | 1.1155 | 1.1090 | 1.1024 | 1.0956 | 1.0808 | 1.0650 |
| 22 | 1.1389 | 1.1366 | 1.1336 | 1.1306 | 1.1276 | 1.1247 | 1.1217 | 1.1150 | 1.1083 | 1.1013 | 1.0862 | 1.0701 |
| 23 | 1.1457 | 1.1433 | 1.1402 | 1.1371 | 1.1340 | 1.1310 | 1.1280 | 1.1210 | 1.1142 | 1.1070 | 1.0917 | 1.0753 |
| 24 | 1.1525 | 1.1501 | 1.1469 | 1.1437 | 1.1404 | 1.1374 | 1.1343 | 1.1271 | 1.1201 | 1.1127 | 1.0972 | 1.0805 |
| 25 | 1.1594 | 1.1569 | 1.1536 | 1.1503 | 1.1469 | 1.1438 | 1.1406 | 1.1332 | 1.1260 | 1.1185 | 1.1027 | 1.0857 |
| 26 | 1.1663 | 1.1638 | 1.1603 | 1.1569 | 1.1534 | 1.1502 | 1.1469 | 1.1394 | 1.1320 | 1.1244 | 1.1083 | 1.0910 |
| 27 | 1.1733 | 1.1707 | 1.1670 | 1.1635 | 1.1600 | 1.1566 | 1.1533 | 1.1456 | 1.1381 | 1.1303 | 1.1139 | 1.0963 |
| 28 | 1.1803 | 1.1777 | 1.1738 | 1.1702 | 1.1666 | 1.1631 | 1.1597 | 1.1519 | 1.1442 | 1.1362 | 1.1195 | 1.1016 |
| 29 | 1.1874 | 1.1847 | 1.1807 | 1.1770 | 1.1733 | 1.1697 | 1.1662 | 1.1582 | 1.1503 | 1.1422 | 1.1251 | 1.1069 |
| 30 | 1.1945 | 1.1917 | 1.1876 | 1.1838 | 1.1800 | 1.1763 | 1.1727 | 1.1645 | 1.1564 | 1.1482 | 1.1307 | 1.1122 |
| 31 | 1.2016 | 1.1988 | 1.1945 | 1.1906 | 1.1867 | 1.1829 | 1.1792 | 1.1708 | 1.1625 | 1.1542 | 1.1363 | 1.1175 |
| 32 | 1.2088 | 1.2059 | 1.2014 | 1.1974 | 1.1934 | 1.1896 | 1.1857 | 1.1772 | 1.1687 | 1.1602 | 1.1419 | 1.1228 |
| 33 | 1.2160 | 1.2131 | 1.2084 | 1.2043 | 1.2002 | 1.1963 | 1.1922 | 1.1836 | 1.1749 | 1.1662 | 1.1476 | 1.1281 |
| 34 | 1.2233 | 1.2203 | 1.2155 | 1.2113 | 1.2071 | 1.2030 | 1.1988 | 1.1901 | 1.1812 | 1.1723 | 1.1533 | 1.1335 |
| 35 | 1.2306 | 1.2275 | 1.2227 | 1.2183 | 1.2140 | 1.2098 | 1.2055 | 1.1966 | 1.1876 | 1.1784 | 1.1591 | 1.1390 |
| 36 | 1.2375 | 1.2344 | 1.2294 | 1.2249 | 1.2205 | 1.2163 | 1.2119 | 1.2028 | 1.1936 | 1.1842 | 1.1645 | 1.1440 |
| 37 | 1.2444 | 1.2412 | 1.2361 | 1.2315 | 1.2270 | 1.2227 | 1.2182 | 1.2089 | 1.1995 | 1.1899 | 1.1699 | 1.1490 |
| 38 | 1.2513 | 1.2479 | 1.2428 | 1.2381 | 1.2335 | 1.2291 | 1.2245 | 1.2150 | 1.2054 | 1.1956 | 1.1752 | 1.1540 |
| 39 | 1.2581 | 1.2546 | 1.2494 | 1.2446 | 1.2399 | 1.2354 | 1.2308 | 1.2210 | 1.2112 | 1.2013 | 1.1805 | 1.1589 |
| 40 | 1.2649 | 1.2613 | 1.2560 | 1.2511 | 1.2463 | 1.2417 | 1.2370 | 1.2270 | 1.2170 | 1.2069 | 1.1858 | 1.1638 |
| 41 | 1.2717 | 1.2680 | 1.2626 | 1.2576 | 1.2527 | 1.2480 | 1.2432 | 1.2330 | 1.2229 | 1.2126 | 1.1911 | 1.1687 |
| 42 | 1.2786 | 1.2747 | 1.2692 | 1.2641 | 1.2591 | 1.2543 | 1.2494 | 1.2390 | 1.2287 | 1.2182 | 1.1963 | 1.1735 |
| 43 | 1.2854 | 1.2814 | 1.2758 | 1.2706 | 1.2655 | 1.2606 | 1.2556 | 1.2450 | 1.2345 | 1.2238 | 1.2015 | 1.1783 |
| 44 | 1.2922 | 1.2880 | 1.2824 | 1.2771 | 1.2719 | 1.2669 | 1.2618 | 1.2510 | 1.2403 | 1.2294 | 1.2067 | 1.1831 |
| 45 | 1.2990 | 1.2947 | 1.2890 | 1.2836 | 1.2783 | 1.2732 | 1.2680 | 1.2570 | 1.2461 | 1.2350 | 1.2119 | 1.1879 |
| 46 | 1.3058 | 1.3014 | 1.2955 | 1.2901 | 1.2847 | 1.2795 | 1.2742 | 1.2630 | 1.2519 | 1.2406 | 1.2171 | 1.1927 |
| 47 | 1.3126 | 1.3080 | 1.3021 | 1.2966 | 1.2911 | 1.2858 | 1.2804 | 1.2690 | 1.2577 | 1.2462 | 1.2223 | 1.1976 |
| 48 | 1.3194 | 1.3147 | 1.3087 | 1.3031 | 1.2975 | 1.2921 | 1.2867 | 1.2750 | 1.2635 | 1.2518 | 1.2275 | 1.2024 |
| 49 | 1.3263 | 1.3214 | 1.3153 | 1.3096 | 1.3040 | 1.2984 | 1.2929 | 1.2811 | 1.2693 | 1.2575 | 1.2328 | 1.2073 |
| 50 | 1.3327 | 1.3277 | 1.3215 | 1.3157 | 1.3100 | 1.3043 | 1.2987 | 1.2867 | 1.2748 | 1.2628 | 1.2377 | 1.2118 |
| 51 | 1.3391 | 1.3339 | 1.3277 | 1.3218 | 1.3160 | 1.3102 | 1.3045 | 1.2923 | 1.2802 | 1.2680 | 1.2425 | 1.2163 |
| 52 | 1.3454 | 1.3401 | 1.3338 | 1.3278 | 1.3219 | 1.3160 | 1.3102 | 1.2978 | 1.2856 | 1.2731 | 1.2473 | 1.2208 |
| 53 | 1.3517 | 1.3462 | 1.3399 | 1.3338 | 1.3278 | 1.3218 | 1.3159 | 1.3033 | 1.2909 | 1.2782 | 1.2521 | 1.2252 |
| 54 | 1.3579 | 1.3523 | 1.3459 | 1.3397 | 1.3336 | 1.3275 | 1.3215 | 1.3087 | 1.2961 | 1.2833 | 1.2568 | 1.2296 |
| 55 | 1.3640 | 1.3583 | 1.3518 | 1.3455 | 1.3393 | 1.3331 | 1.3270 | 1.3141 | 1.3013 | 1.2883 | 1.2615 | 1.2339 |
| 56 | 1.3700 | 1.3642 | 1.3576 | 1.3512 | 1.3449 | 1.3386 | 1.3324 | 1.3194 | 1.3064 | 1.2932 | 1.2661 | 1.2382 |
| 57 | 1.3759 | 1.3700 | 1.3634 | 1.3569 | 1.3505 | 1.3441 | 1.3377 | 1.3246 | 1.3114 | 1.2981 | 1.2706 | 1.2424 |
| 58 | 1.3818 | 1.3757 | 1.3691 | 1.3625 | 1.3560 | 1.3495 | 1.3430 | 1.3298 | 1.3164 | 1.3029 | 1.2751 | 1.2466 |
| 59 | 1.3875 | 1.3813 | 1.3747 | 1.3680 | 1.3614 | 1.3548 | 1.3482 | 1.3348 | 1.3213 | 1.3077 | 1.2795 | 1.2507 |
| 60 | 1.3931 | 1.3868 | 1.3801 | 1.3734 | 1.3667 | 1.3600 | 1.3533 | 1.3398 | 1.3261 | 1.3124 | 1.2839 | 1.2547 |
| 61 | 1.3986 | 1.3922 | 1.3855 | 1.3787 | 1.3719 | 1.3651 | 1.3583 | 1.3447 | 1.3308 | 1.3169 | 1.2881 | 1.2587 |
| 62 | 1.4039 | 1.3975 | 1.3907 | 1.3838 | 1.3769 | 1.3700 | 1.3632 | 1.3494 | 1.3354 | 1.3213 | 1.2922 | 1.2625 |
| 63 | 1.4091 | 1.4027 | 1.3958 | 1.3888 | 1.3818 | 1.3748 | 1.3679 | 1.3540 | 1.3398 | 1.3255 | 1.2962 | 1.2661 |
| 64 | | 1.4078 | 1.4007 | 1.3936 | 1.3866 | 1.3795 | 1.3725 | | | | | |

**TABLE 2-66 Nitric Acid ($HNO_3$)** (*Concluded*)

| % | 0°C | 5°C | 10°C | 15°C | 20°C | 25°C | 30°C | 40°C | 50°C | 60°C | 80°C | 100°C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 65 | | 1.4128 | 1.4055 | 1.3984 | 1.3913 | 1.3841 | 1.3770 | | | | | |
| 66 | | 1.4177 | 1.4103 | 1.4031 | 1.3959 | 1.3887 | 1.3814 | | | | | |
| 67 | | 1.4224 | 1.4150 | 1.4077 | 1.4004 | 1.3932 | 1.3857 | | | | | |
| 68 | | 1.4271 | 1.4196 | 1.4122 | 1.4048 | 1.3976 | 1.3900 | | | | | |
| 69 | | 1.4317 | 1.4241 | 1.4166 | 1.4091 | 1.4019 | 1.3942 | | | | | |
| 70 | | 1.4362 | 1.4285 | 1.4210 | 1.4134 | 1.4061 | 1.3983 | | | | | |
| 71 | | 1.4406 | 1.4328 | 1.4252 | 1.4176 | 1.4102 | 1.4023 | | | | | |
| 72 | | 1.4449 | 1.4371 | 1.4294 | 1.4218 | 1.4142 | 1.4063 | | | | | |
| 73 | | 1.4491 | 1.4413 | 1.4335 | 1.4258 | 1.4182 | 1.4103 | | | | | |
| 74 | | 1.4532 | 1.4454 | 1.4376 | 1.4298 | 1.4221 | 1.4142 | | | | | |
| 75 | | 1.4573 | 1.4494 | 1.4415 | 1.4337 | 1.4259 | 1.4180 | | | | | |
| 76 | | 1.4613 | 1.4533 | 1.4454 | 1.4375 | 1.4296 | 1.4217 | | | | | |
| 77 | | 1.4652 | 1.4572 | 1.4492 | 1.4413 | 1.4333 | 1.4253 | | | | | |
| 78 | | 1.4690 | 1.4610 | 1.4529 | 1.4450 | 1.4369 | 1.4288 | | | | | |
| 79 | | 1.4727 | 1.4647 | 1.4565 | 1.4486 | 1.4404 | 1.4323 | | | | | |
| 80 | | 1.4764 | 1.4683 | 1.4601 | 1.4521 | 1.4439 | 1.4357 | | | | | |
| 81 | | 1.4800 | 1.4718 | 1.4636 | 1.4555 | 1.4473 | 1.4391 | | | | | |
| 82 | | 1.4835 | 1.4753 | 1.4670 | 1.4589 | 1.4507 | 1.4424 | | | | | |
| 83 | | 1.4869 | 1.4787 | 1.4704 | 1.4622 | 1.4540 | 1.4456 | | | | | |
| 84 | | 1.4903 | 1.4820 | 1.4737 | 1.4655 | 1.4572 | 1.4487 | | | | | |
| 85 | | 1.4936 | 1.4852 | 1.4769 | 1.4686 | 1.4603 | 1.4518 | | | | | |
| 86 | | 1.4968 | 1.4883 | 1.4799 | 1.4716 | 1.4633 | 1.4548 | | | | | |
| 87 | | 1.4999 | 1.4913 | 1.4829 | 1.4745 | 1.4662 | 1.4577 | | | | | |
| 88 | | 1.5029 | 1.4942 | 1.4858 | 1.4773 | 1.4690 | 1.4605 | | | | | |
| 89 | | 1.5058 | 1.4970 | 1.4885 | 1.4800 | 1.4716 | 1.4631 | | | | | |
| 90 | | 1.5085 | 1.4997 | 1.4911 | 1.4826 | 1.4741 | 1.4656 | | | | | |
| 91 | | 1.5111 | 1.5023 | 1.4936 | 1.4850 | 1.4766 | 1.4681 | | | | | |
| 92 | | 1.5136 | 1.5048 | 1.4960 | 1.4873 | 1.4789 | 1.4704 | | | | | |
| 93 | | 1.5156 | 1.5068 | 1.4979 | 1.4892 | 1.4807 | 1.4722 | | | | | |
| 94 | | 1.5177 | 1.5088 | 1.4999 | 1.4912 | 1.4826 | 1.4741 | | | | | |
| 95 | | 1.5198 | 1.5109 | 1.5019 | 1.4932 | 1.4846 | 1.4761 | | | | | |
| 96 | | 1.5220 | 1.5130 | 1.5040 | 1.4952 | 1.4867 | 1.4781 | | | | | |
| 97 | | 1.5244 | 1.5152 | 1.5062 | 1.4974 | 1.4889 | 1.4802 | | | | | |
| 98 | | 1.5278 | 1.5187 | 1.5096 | 1.5008 | 1.4922 | 1.4835 | | | | | |
| 99 | | 1.5327 | 1.5235 | 1.5144 | 1.5056 | 1.4969 | 1.4881 | | | | | |
| 100 | | 1.5402 | 1.5310 | 1.5217 | 1.5129 | 1.5040 | 1.4952 | | | | | |

**TABLE 2-67 Perchloric Acid ($HClO_4$)**

| % | $d_4^{15}$ | $d_4^{20}$ | $d_4^{25}$ | $d_4^{50}$ | % | $d_4^{15}$ | $d_4^{20}$ | $d_4^{50}$ |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.0050 | | 1.0020 | 0.9933 | 28 | 1.1900 | 1.1851 | 1.1645 |
| 2 | 1.0109 | | 1.0070 | 0.9986 | 30 | 1.2067 | 1.2013 | 1.1800 |
| 4 | 1.0228 | | 1.0169 | 0.9906 | 32 | 1.2239 | 1.2183 | 1.1960 |
| 6 | 1.0348 | | 1.0270 | 1.0205 | 34 | 1.2418 | 1.2359 | 1.2130 |
| 8 | 1.0471 | | 1.0372 | 1.0320 | 36 | 1.2603 | 1.2542 | 1.2310 |
| 10 | 1.0597 | | 1.0475 | 1.0440 | 38 | 1.2794 | 1.2732 | 1.2490 |
| 12 | 1.0726 | | | 1.0560 | 40 | 1.2991 | 1.2927 | 1.2680 |
| 14 | 1.0589 | | | 1.0680 | 45 | 1.3521 | 1.3450 | 1.3180 |
| 16 | 1.0995 | | | 1.0810 | 50 | 1.4103 | 1.4018 | 1.3730 |
| 18 | 1.1135 | | | 1.0940 | 55 | 1.4733 | 1.4636 | 1.4320 |
| 20 | 1.1279 | | | 1.1070 | 60 | 1.5389 | 1.5298 | 1.4950 |
| 22 | 1.1428 | | | 1.1205 | 65 | 1.6059 | 1.5986 | 1.5620 |
| 24 | 1.1581 | | | 1.1345 | 70 | 1.6736 | 1.6680 | 1.6290 |
| 26 | 1.1738 | 1.1697 | | 1.1490 | | | | |

**TABLE 2-68 Phosphoric Acid ($H_3PO_4$)**

| °C | 2% | 6% | 14% | 20% | 26% | 35% | 50% | 75% | 100% |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 1.0113 | 1.0339 | 1.0811 | 1.1192 | | | | | |
| 10 | 1.0109 | 1.0330 | 1.0792 | 1.1167 | 1.1567 | 1.221 | 1.341 | | |
| 20 | 1.0092 | 1.0309 | 1.0764 | 1.1134 | 1.1529 | 1.216 | 1.335 | 1.579 | 1.870 |
| 30 | 1.0065 | 1.0279 | 1.0728 | 1.1094 | 1.1484 | 1.211 | 1.329 | 1.572 | 1.862 |
| 40 | 1.0029 | 1.0241 | 1.0685 | 1.1048 | | | | | |

**TABLE 2-69 Potassium Bicarbonate ($KHCO_3$)**

| °C | 1% | 2% | 4% | 6% | 8% | 10% |
|---|---|---|---|---|---|---|
| 0 | 1.0066 | 1.0134 | 1.0270 | | | |
| 10 | 1.0064 | 1.0132 | 1.0268 | | | |
| 15 | 1.0058 | 1.0125 | 1.0260 | 1.0396 | 1.0534 | 1.0674 |
| 20 | 1.0049 | 1.0117 | 1.0252 | | | |
| 30 | 1.0024 | 1.0092 | 1.0228 | | | |
| 40 | 0.9990 | 1.0058 | 1.0195 | | | |
| 50 | .9949 | 1.0017 | 1.0154 | | | |
| 60 | .9901 | 0.9969 | 1.0106 | | | |
| 80 | .9786 | .9855 | 0.9993 | | | |
| 100 | .9653 | .9722 | .9860 | | | |

**TABLE 2-70 Potassium Bromide (KBr)**

| % | $d_4^{20}$ |
|---|---|
| 1 | 1.0054 |
| 2 | 1.0127 |
| 6 | 1.0426 |
| 12 | 1.0903 |
| 20 | 1.1601 |
| 30 | 1.2593 |
| 40 | 1.3746 |

**TABLE 2-71 Potassium Carbonate ($K_2CO_3$)**

| % | 0°C | 10°C | 20°C | 40°C | 60°C | 80°C | 100°C |
|---|---|---|---|---|---|---|---|
| 1 | 1.0094 | 1.0089 | 1.0072 | 1.0010 | 0.9919 | 0.9803 | 0.9670 |
| 2 | 1.0189 | 1.0182 | 1.0163 | 1.0098 | 1.0005 | .9889 | .9756 |
| 4 | 1.0381 | 1.0369 | 1.0345 | 1.0276 | 1.0180 | 1.0063 | .9951 |
| 8 | 1.0768 | 1.0746 | 1.0715 | 1.0640 | 1.0538 | 1.0418 | 1.0291 |
| 12 | 1.1160 | 1.1131 | 1.1096 | 1.1013 | 1.0906 | 1.0786 | 1.0663 |
| 16 | 1.1562 | 1.1530 | 1.1490 | 1.1399 | 1.1290 | 1.1170 | 1.1049 |
| 20 | 1.1977 | 1.1941 | 1.1898 | 1.1801 | 1.1690 | 1.1570 | 1.1451 |
| 24 | 1.2405 | 1.2366 | 1.2320 | 1.2219 | 1.2106 | 1.1986 | 1.1869 |
| 28 | 1.2846 | 1.2804 | 1.2756 | 1.2652 | 1.2538 | 1.2418 | 1.2301 |
| 30 | 1.3071 | 1.3028 | 1.2979 | 1.2873 | 1.2759 | 1.2640 | 1.2522 |
| 35 | 1.3646 | 1.3600 | 1.3548 | 1.3440 | 1.3324 | 1.3206 | 1.3089 |
| 40 | 1.4244 | 1.4195 | 1.4141 | 1.4029 | 1.3913 | 1.3795 | 1.3678 |
| 45 | 1.4867 | 1.4815 | 1.4759 | 1.4644 | 1.4528 | 1.4408 | 1.4290 |
| 50 | 1.5517 | 1.5462 | 1.5404 | 1.5285 | 1.5169 | 1.5048 | 1.4928 |

**TABLE 2-72 Potassium Chromate ($K_2CrO_4$)**

| % | $d_4^{15}$ | $d_4^{18}$ |
|---|---|---|
| 1 | 1.0073 | 1.0066 |
| 2 | 1.0155 | 1.0147 |
| 4 | 1.0321 | 1.0311 |
| 8 | 1.0659 | 1.0647 |
| 12 | 1.1009 | 1.0999 |
| 16 | | 1.1366 |
| 20 | | 1.1748 |
| 24 | | 1.2147 |
| 28 | | 1.2566 |
| 30 | | 1.2784 |

**TABLE 2-73 Potassium Chlorate ($KClO_3$)**

| °C | 1% | 2% | 3% | 4% |
|---|---|---|---|---|
| 0 | 1.0061 | 1.0124 | 1.0189 | 1.0256 |
| 10 | 1.0059 | 1.0122 | 1.0187 | 1.0254 |
| 20 | 1.0045 | 1.0109 | 1.0174 | 1.0241 |
| 30 | 1.0020 | 1.0085 | 1.0151 | 1.0218 |
| 40 | 0.9986 | 1.0051 | 1.0116 | 1.0183 |
| 60 | .9895 | 0.9959 | 1.0024 | 1.0091 |
| 80 | .9781 | .9845 | 0.9910 | 0.9977 |
| 100 | .9646 | .9709 | .9774 | .9840 |

**TABLE 2-74 Potassium Chloride (KCl)**

| % | 0°C | 20°C | 25°C | 40°C | 60°C | 80°C | 100°C |
|---|---|---|---|---|---|---|---|
| 1.0 | 1.00661 | 1.00462 | 1.00342 | 0.99847 | 0.9894 | 0.9780 | 0.9646 |
| 2.0 | 1.01335 | 1.01103 | 1.00977 | 1.00471 | .9956 | .9842 | .9708 |
| 4.0 | 1.02690 | 1.02391 | 1.02255 | 1.01727 | 1.0080 | .9966 | .9634 |
| 8.0 | 1.05431 | 1.05003 | 1.04847 | 1.04278 | 1.0333 | 1.0219 | 1.0888 |
| 12.0 | 1.08222 | 1.07679 | 1.07506 | 1.06897 | 1.0592 | 1.0478 | 1.0350 |
| 16.0 | 1.11068 | 1.10434 | 1.10245 | 1.09600 | 1.0861 | 1.0746 | 1.0619 |
| 20.0 | 1.13973 | 1.13280 | 1.13072 | 1.12399 | 1.1138 | 1.1024 | 1.0897 |
| 24.0 | | 1.16226 | 1.15995 | 1.15299 | 1.1425 | 1.1311 | 1.1185 |
| 28.0 | | | | 1.18304 | 1.1723 | 1.1609 | 1.1483 |

| % | 110°C | 120°C | 130°C | 140°C |
|---|---|---|---|---|
| 3.79 | 0.9733 | 0.9663 | 0.9583 | 0.9502 |
| 7.45 | .9978 | .9899 | .9827 | .9745 |
| 13.62 | 1.0388 | 1.0313 | 1.0238 | 1.0159 |

**TABLE 2-75 Potassium Chrome Alum [$K_2Cr_2(SO_4)_4$]**

| % | $d_4^{15}$ |
|---|---|
| 1 | 1.007 |
| 2 | 1.016 |
| 6 | 1.052 |
| 10 | 1.089 |
| 14 | 1.129 |
| 20 | 1.193 |
| 30 | 1.315 |
| 40 | 1.456 |
| 50 | 1.615 |

**TABLE 2-76 Potassium Hydroxide (KOH)**

| % | $d_4^{15}$ |
|---|---|
| 1.0 | 1.0083 |
| 2.0 | 1.0175 |
| 4.0 | 1.0359 |
| 6.0 | 1.0544 |
| 8.0 | 1.0730 |
| 10.0 | 1.0918 |
| 15.0 | 1.1396 |
| 20.0 | 1.1884 |
| 25.0 | 1.2387 |
| 30.0 | 1.2905 |
| 35.0 | 1.3440 |
| 40.0 | 1.3991 |
| 45.0 | 1.4558 |
| 50.0 | 1.5143 |
| 51.7 | 1.5355 (sat'd. soln.) |

**TABLE 2-77 Potassium Nitrate ($KNO_3$)**

| % | 0°C | 10°C | 20°C | 40°C | 60°C | 80°C | 100°C |
|---|---|---|---|---|---|---|---|
| 1 | 1.00654 | 1.00615 | 1.00447 | 0.99825 | 0.9890 | 0.9776 | 0.9641 |
| 2 | 1.01326 | 1.01262 | 1.01075 | 1.00430 | .9949 | .9834 | .9699 |
| 4 | 1.02677 | 1.02566 | 1.02344 | 1.01652 | 1.0068 | .9951 | .9816 |
| 8 | 1.05419 | 1.05226 | 1.04940 | 1.04152 | 1.0313 | 1.0192 | 1.0056 |
| 12 | 1.08221 | 1.07963 | 1.07620 | 1.06740 | 1.0567 | 1.0442 | 1.0304 |
| 16 | | | 1.10392 | 1.09432 | 1.0831 | 1.0703 | 1.0562 |
| 20 | | | 1.13261 | 1.12240 | 1.1106 | 1.0974 | 1.0831 |
| 24 | | | 1.16233 | 1.15175 | 1.1391 | 1.1256 | 1.1110 |

**TABLE 2-78 Potassium Dichromate ($K_2Cr_2O_7$)**

| % | $d_4^{20}$ |
|---|---|
| 1 | 1.0052 |
| 2 | 1.0122 |
| 4 | 1.0264 |
| 6 | 1.0408 |
| 8 | 1.0554 |
| 10 | 1.0703 |

**TABLE 2-79 Potassium Sulfate ($K_2SO_4$)**

| % | $d_4^{20}$ |
|---|---|
| 1 | 1.0063 |
| 2 | 1.0145 |
| 4 | 1.0310 |
| 6 | 1.0477 |
| 8 | 1.0646 |
| 10 | 1.0817 |

**TABLE 2-80 Potassium Sulfite ($K_2SO_3$)**

| % | $d_4^{15}$ |
|---|---|
| 1 | 1.0073 |
| 2 | 1.0155 |
| 4 | 1.0322 |
| 8 | 1.0667 |
| 12 | 1.1026 |
| 16 | 1.1402 |
| 20 | 1.1793 |
| 24 | 1.2197 |
| 26 | 1.2404 |

**TABLE 2-81 Sodium Acetate ($NaC_2H_3O_2$)**

| % | $d_4^{20}$ |
|---|---|
| 1 | 1.0033 |
| 2 | 1.0084 |
| 4 | 1.0186 |
| 8 | 1.0392 |
| 12 | 1.0598 |
| 18 | 1.0807 |
| 20 | 1.1021 |
| 26 | 1.1351 |
| 28 | 1.1462 |

**TABLE 2-82 Sodium Arsenate ($Na_3AsO_4$)**

| % | $d_4^{17}$ |
|---|---|
| 1 | 1.0097 |
| 2 | 1.0207 |
| 4 | 1.0431 |
| 8 | 1.0892 |
| 10 | 1.1130 |
| 12 | 1.1373 |

**TABLE 2-83 Sodium Bichromate ($Na_2Cr_2O_7$)**

| % | $d_4^{15}$ |
|---|---|
| 1 | 1.006 |
| 2 | 1.013 |
| 4 | 1.027 |
| 8 | 1.056 |
| 12 | 1.084 |
| 16 | 1.112 |
| 20 | 1.140 |
| 24 | 1.166 |
| 28 | 1.193 |
| 30 | 1.207 |
| 35 | 1.244 |
| 40 | 1.279 |
| 45 | 1.312 |
| 50 | 1.342 |

**TABLE 2-84 Sodium Bromide (NaBr)**

| % | $d_4^{17}$ |
|---|---|
| 1 | 1.0060 |
| 2 | 1.0139 |
| 4 | 1.0298 |
| 8 | 1.0631 |
| 10 | 1.0803 |
| 12 | 1.0981 |
| 20 | 1.1745 |
| 30 | 1.2841 |
| 40 | 1.4138 |

**TABLE 2-85 Sodium Formate (HCOONa)**

| % | $d_4^{25}$ |
|---|---|
| 1 | 1.003 |
| 2 | 1.009 |
| 4 | 1.022 |
| 8 | 1.048 |
| 12 | 1.074 |
| 16 | 1.100 |
| 20 | 1.127 |
| 24 | 1.155 |
| 28 | 1.184 |
| 30 | 1.199 |
| 35 | 1.236 |
| 40 | 1.274 |

**TABLE 2-86 Sodium Carbonate ($Na_2CO_3$)**

| % | 0°C | 10°C | 20°C | 30°C | 40°C | 60°C | 80°C | 100°C |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.0109 | 1.0103 | 1.0086 | 1.0058 | 1.0022 | 0.9929 | 0.9814 | 0.9683 |
| 2 | 1.0219 | 1.0210 | 1.0190 | 1.0159 | 1.0122 | 1.0027 | .9910 | .9782 |
| 4 | 1.0439 | 1.0423 | 1.0398 | 1.0363 | 1.0323 | 1.0223 | 1.0105 | .9980 |
| 8 | 1.0878 | 1.0850 | 1.0816 | 1.0775 | 1.0732 | 1.0625 | 1.0503 | 1.0380 |
| 12 | 1.1319 | 1.1284 | 1.1244 | 1.1200 | 1.1150 | 1.1039 | 1.0914 | 1.0787 |
| 14 | 1.1543 | 1.1506 | 1.1463 | 1.1417 | 1.1365 | 1.1251 | 1.1125 | 1.0996 |
| 16 | | | | 1.1636 | | | | |
| 18 | | | | 1.1859 | | | | |
| 20 | | | | 1.2086 | | | | |
| 24 | | | | 1.2552 | | | | |
| 28 | | | | 1.3031 | | | | |
| 30 | | | | 1.3274 | | | | |

**TABLE 2-87 Sodium Chlorate ($NaClO_3$)**

| % | $d_4^{18}$ | % | $d_4^{18}$ |
|---|---|---|---|
| 1 | 1.0053 | 18 | 1.1288 |
| 2 | 1.0121 | 20 | 1.1449 |
| 4 | 1.0258 | 22 | 1.1614 |
| 6 | 1.0397 | 24 | 1.1782 |
| 8 | 1.0538 | 26 | 1.1953 |
| 10 | 1.0681 | 28 | 1.2128 |
| 12 | 1.0827 | 30 | 1.2307 |
| 14 | 1.0977 | 32 | 1.2491 |
| 16 | 1.1131 | 34 | 1.2680 |

**TABLE 2-88 Sodium Chloride (NaCl)**

| % | 0°C | 10°C | 25°C | 40°C | 60°C | 80°C | 100°C |
|---|---|---|---|---|---|---|---|
| 1 | 1.00747 | 1.00707 | 1.00409 | 0.99908 | 0.9900 | 0.9785 | 0.9651 |
| 2 | 1.01509 | 1.01442 | 1.01112 | 1.00593 | .9967 | .9852 | .9719 |
| 4 | 1.03038 | 1.02920 | 1.02530 | 1.01977 | 1.0103 | .9988 | .9855 |
| 8 | 1.06121 | 1.05907 | 1.05412 | 1.04798 | 1.0381 | 1.0264 | 1.0134 |
| 12 | 1.09244 | 1.08946 | 1.08365 | 1.07699 | 1.0667 | 1.0549 | 1.0420 |
| 16 | 1.12419 | 1.12056 | 1.11401 | 1.10688 | 1.0962 | 1.0842 | 1.0713 |
| 20 | 1.15663 | 1.15254 | 1.14533 | 1.13774 | 1.1268 | 1.1146 | 1.1017 |
| 24 | 1.18999 | 1.18557 | 1.17776 | 1.16971 | 1.1584 | 1.1463 | 1.1331 |
| 26 | 1.20709 | 1.20254 | 1.19443 | 1.18614 | 1.1747 | 1.1626 | 1.1492 |

**TABLE 2-89 Sodium Chromate ($Na_2CrO_4$)**

| % | $d_4^{18}$ |
|---|---|
| 1 | 1.0074 |
| 2 | 1.0164 |
| 4 | 1.0344 |
| 8 | 1.0718 |
| 12 | 1.1110 |
| 16 | 1.1518 |
| 20 | 1.1942 |
| 24 | 1.2383 |
| 26 | 1.2611 |

**TABLE 2-90 Sodium Hydroxide (NaOH)**

| % | 0°C | 15°C | 20°C | 40°C | 60°C | 80°C | 100°C |
|---|---|---|---|---|---|---|---|
| 1 | 1.0124 | 1.01065 | 1.0095 | 1.0033 | 0.9941 | 0.9824 | 0.9693 |
| 2 | 1.0244 | 1.02198 | 1.0207 | 1.0139 | 1.0045 | .9929 | .9797 |
| 4 | 1.0482 | 1.04441 | 1.0428 | 1.0352 | 1.0254 | 1.0139 | 1.0009 |
| 8 | 1.0943 | 1.08887 | 1.0869 | 1.0780 | 1.0676 | 1.0560 | 1.0432 |
| 12 | 1.1399 | 1.13327 | 1.1309 | 1.1210 | 1.1101 | 1.0983 | 1.0855 |
| 16 | 1.1849 | 1.17761 | 1.1751 | 1.1645 | 1.1531 | 1.1408 | 1.1277 |
| 20 | 1.2296 | 1.22183 | 1.2191 | 1.2079 | 1.1960 | 1.1833 | 1.1700 |
| 24 | 1.2741 | 1.26582 | 1.2629 | 1.2512 | 1.2388 | 1.2259 | 1.2124 |
| 28 | 1.3182 | 1.3094 | 1.3064 | 1.2942 | 1.2814 | 1.2682 | 1.2546 |
| 32 | 1.3614 | 1.3520 | 1.3490 | 1.3362 | 1.3232 | 1.3097 | 1.2960 |
| 36 | 1.4030 | 1.3933 | 1.3900 | 1.3768 | 1.3634 | 1.3498 | 1.3360 |
| 40 | 1.4435 | 1.4334 | 1.4300 | 1.4164 | 1.4027 | 1.3889 | 1.3750 |
| 44 | 1.4825 | 1.4720 | 1.4685 | 1.4545 | 1.4405 | 1.4266 | 1.4127 |
| 48 | 1.5210 | 1.5102 | 1.5065 | 1.4922 | 1.4781 | 1.4641 | 1.4503 |
| 50 | 1.5400 | 1.5290 | 1.5253 | 1.5109 | 1.4967 | 1.4827 | 1.4690 |

**TABLE 2-91 Sodium Nitrate ($NaNO_3$)**

| % | 0°C | 20°C | 40°C | 60°C | 80°C | 100°C |
|---|---|---|---|---|---|---|
| 1 | 1.0071 | 1.0049 | 0.9986 | 0.9894 | 0.9779 | 0.9644 |
| 2 | 1.0144 | 1.0117 | 1.0050 | .9956 | .9840 | .9704 |
| 4 | 1.0290 | 1.0254 | 1.0180 | 1.0082 | .9964 | .9826 |
| 8 | 1.0587 | 1.0532 | 1.0447 | 1.0340 | 1.0218 | 1.0078 |
| 12 | 1.0891 | 1.0819 | 1.0724 | 1.0609 | 1.0481 | 1.0340 |
| 16 | 1.1203 | 1.1118 | 1.1013 | 1.0892 | 1.0757 | 1.0614 |
| 20 | 1.1526 | 1.1429 | 1.1314 | 1.1187 | 1.1048 | 1.0901 |
| 24 | 1.1860 | 1.1752 | 1.1629 | 1.1496 | 1.1351 | 1.1200 |
| 28 | 1.2204 | 1.2085 | 1.1955 | 1.1816 | 1.1667 | 1.1513 |
| 30 | 1.2380 | 1.2256 | 1.2122 | 1.1980 | 1.1830 | 1.1674 |
| 35 | 1.2834 | 1.2701 | 1.2560 | 1.2413 | 1.2258 | 1.2100 |
| 40 | 1.3316 | 1.3175 | 1.3027 | 1.2875 | 1.2715 | 1.2555 |
| 45 | | 1.3683 | 1.3528 | 1.3371 | 1.3206 | 1.3044 |

**TABLE 2-92 Sodium Nitrite ($NaNO_2$)**

| % | $d_4^{15}$ |
|---|---|
| 1 | 1.0058 |
| 2 | 1.0125 |
| 4 | 1.0260 |
| 8 | 1.0535 |
| 12 | 1.0816 |
| 16 | 1.1103 |
| 20 | 1.1394 |

**TABLE 2-93 Sodium Silicates**

| | Concentration, % | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 4 | 8 | 10 | 14 | 20 | 24 | 30 | 36 | 40 | 45 | 50 |
| Formula | $d_4^{20}$ | | | | | | | | | | | | |
| $Na_2O/3.9SiO_2$ | 1.006 | 1.014 | 1.030 | 1.063 | 1.080 | 1.116 | 1.172 | 1.211 | 1.275 | | | | |
| $Na_2O/3.36SiO_2$ | 1.006 | 1.014 | 1.030 | 1.065 | 1.083 | 1.120 | 1.179 | 1.222 | 1.290 | 1.365 | | | |
| $Na_2O/2.40SiO_2$ | 1.007 | 1.016 | 1.034 | 1.071 | 1.090 | 1.130 | | | | | | | |
| $Na_2O/2.44SiO_2$ | | | | | | | | | 1.309 | 1.387 | 1.445 | | |
| $Na_2O/2.06SiO_2$ | 1.007 | 1.016 | 1.035 | 1.073 | 1.093 | 1.134 | 1.200 | 1.247 | 1.321 | 1.397 | 1.450 | 1.520 | 1.594 |
| $Na_2O/1.69SiO_2$ | 1.007 | 1.017 | 1.036 | 1.077 | 1.098 | 1.141 | 1.210 | 1.259 | 1.337 | 1.424 | | | |

**TABLE 2-94 Sodium Sulfate ($Na_2SO_4$)**

| % | 0°C | 20°C | 30°C | 40°C | 60°C | 80°C | 100°C |
|---|---|---|---|---|---|---|---|
| 1 | 1.0094 | 1.0073 | 1.0046 | 1.0010 | 0.9919 | 0.9805 | 0.9671 |
| 2 | 1.0189 | 1.0164 | 1.0135 | 1.0098 | 1.0007 | .9892 | .9758 |
| 4 | 1.0381 | 1.0348 | 1.0315 | 1.0276 | 1.0184 | 1.0068 | .9934 |
| 8 | 1.0773 | 1.0724 | 1.0682 | 1.0639 | 1.0544 | 1.0426 | 1.0292 |
| 12 | 1.1174 | 1.1109 | 1.1062 | 1.1015 | 1.0915 | 1.0795 | 1.0661 |
| 16 | 1.1585 | 1.1586 | 1.1456 | 1.1406 | 1.1299 | 1.1176 | 1.1042 |
| 20 | 1.2008 | 1.1915 | 1.1865 | 1.1813 | 1.1696 | 1.1569 | |
| 24 | 1.2443 | 1.2336 | 1.2292 | 1.2237 | | | |

**TABLE 2-95 Sodium Sulfide ($Na_2S$)**

| % | $d_4^{18}$ |
|---|---|
| 1 | 1.0098 |
| 2 | 1.0211 |
| 4 | 1.0440 |
| 8 | 1.0907 |
| 12 | 1.1388 |
| 16 | 1.1885 |
| 18 | 1.2140 |

**TABLE 2-96 Sodium Sulfite ($Na_2SO_3$)**

| % | $d_4^{19}$ |
|---|---|
| 1 | 1.0078 |
| 2 | 1.0172 |
| 4 | 1.0363 |
| 8 | 1.0751 |
| 12 | 1.1146 |
| 16 | 1.1549 |
| 18 | 1.1755 |

**TABLE 2-97 Sodium Thiosulfate ($Na_2S_2O_3$)**

| % | $d_4^{20}$ |
|---|---|
| 1 | 1.0065 |
| 2 | 1.0148 |
| 4 | 1.0315 |
| 8 | 1.0654 |
| 12 | 1.1003 |
| 16 | 1.1365 |
| 20 | 1.1740 |
| 24 | 1.2128 |
| 28 | 1.2532 |
| 30 | 1.2739 |
| 35 | 1.3273 |
| 40 | 1.3827 |

**TABLE 2-98 Sodium Thiosulfate Pentahydrate ($Na_2S_2O_3 \cdot 5H_2O$)**

| % | $d_4^{19}$ |
|---|---|
| 1 | 1.0052 |
| 2 | 1.0105 |
| 4 | 1.0211 |
| 8 | 1.0423 |
| 12 | 1.0639 |
| 16 | 1.0863 |
| 20 | 1.1087 |
| 24 | 1.1322 |
| 28 | 1.1558 |
| 30 | 1.1676 |
| 40 | 1.2297 |
| 50 | 1.2954 |

**TABLE 2-99 Stannic Chloride ($SnCl_4$)**

| % | $d_4^{15}$ |
|---|---|
| 1 | 1.007 |
| 2 | 1.015 |
| 4 | 1.031 |
| 8 | 1.064 |
| 12 | 1.099 |
| 16 | 1.135 |
| 20 | 1.173 |
| 24 | 1.212 |
| 28 | 1.255 |
| 30 | 1.278 |
| 35 | 1.337 |
| 40 | 1.403 |
| 45 | 1.475 |
| 50 | 1.555 |
| 55 | 1.644 |
| 60 | 1.742 |
| 65 | 1.851 |
| 70 | 1.971 |

**TABLE 2-100 Stannous Chloride ($SnCl_2$)**

| % | $d_4^{15}$ |
|---|---|
| 1 | 1.0068 |
| 2 | 1.0146 |
| 4 | 1.0306 |
| 8 | 1.0638 |
| 12 | 1.0986 |
| 16 | 1.1353 |
| 20 | 1.1743 |
| 24 | 1.2159 |
| 28 | 1.2603 |
| 30 | 1.2837 |
| 35 | 1.3461 |
| 40 | 1.4145 |
| 45 | 1.4897 |
| 50 | 1.5729 |
| 55 | 1.6656 |
| 60 | 1.7695 |
| 65 | 1.8865 |

**TABLE 2-101 Sulfuric Acid ($H_2SO_4$)**

| % | 0°C | 10°C | 15°C | 20°C | 25°C | 30°C | 40°C | 50°C | 60°C | 80°C | 100°C |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.0074 | 1.0068 | 1.0060 | 1.0051 | 1.0038 | 1.0022 | 0.9986 | 0.9944 | 0.9895 | 0.9779 | 0.9645 |
| 2 | 1.0147 | 1.0138 | 1.0129 | 1.0118 | 1.0104 | 1.0087 | 1.0050 | 1.0006 | .9956 | .9839 | .9705 |
| 3 | 1.0219 | 1.0206 | 1.0197 | 1.0184 | 1.0169 | 1.0152 | 1.0113 | 1.0067 | 1.0017 | .9900 | .9766 |
| 4 | 1.0291 | 1.0275 | 1.0264 | 1.0250 | 1.0234 | 1.0216 | 1.0176 | 1.0129 | 1.0078 | .9961 | .9827 |
| 5 | 1.0364 | 1.0344 | 1.0332 | 1.0317 | 1.0300 | 1.0281 | 1.0240 | 1.0192 | 1.0140 | 1.0022 | .9888 |
| 6 | 1.0437 | 1.0414 | 1.0400 | 1.0385 | 1.0367 | 1.0347 | 1.0305 | 1.0256 | 1.0203 | 1.0084 | .9950 |
| 7 | 1.0511 | 1.0485 | 1.0469 | 1.0453 | 1.0434 | 1.0414 | 1.0371 | 1.0321 | 1.0266 | 1.0146 | 1.0013 |
| 8 | 1.0585 | 1.0556 | 1.0539 | 1.0522 | 1.0502 | 1.0481 | 1.0437 | 1.0386 | 1.0330 | 1.0209 | 1.0076 |
| 9 | 1.0660 | 1.0628 | 1.0610 | 1.0591 | 1.0571 | 1.0549 | 1.0503 | 1.0451 | 1.0395 | 1.0273 | 1.0140 |
| 10 | 1.0735 | 1.0700 | 1.0681 | 1.0661 | 1.0640 | 1.0617 | 1.0570 | 1.0517 | 1.0460 | 1.0338 | 1.0204 |
| 11 | 1.0810 | 1.0773 | 1.0753 | 1.0731 | 1.0710 | 1.0686 | 1.0637 | 1.0584 | 1.0526 | 1.0403 | 1.0269 |
| 12 | 1.0886 | 1.0846 | 1.0825 | 1.0802 | 1.0780 | 1.0756 | 1.0705 | 1.0651 | 1.0593 | 1.0469 | 1.0335 |
| 13 | 1.0962 | 1.0920 | 1.0898 | 1.0874 | 1.0851 | 1.0826 | 1.0774 | 1.0719 | 1.0661 | 1.0536 | 1.0402 |
| 14 | 1.1039 | 1.0994 | 1.0971 | 1.0947 | 1.0922 | 1.0897 | 1.0844 | 1.0788 | 1.0729 | 1.0603 | 1.0469 |
| 15 | 1.1116 | 1.1069 | 1.1045 | 1.1020 | 1.0994 | 1.0968 | 1.0914 | 1.0857 | 1.0798 | 1.0671 | 1.0537 |
| 16 | 1.1194 | 1.1145 | 1.1120 | 1.1094 | 1.1067 | 1.1040 | 1.0985 | 1.0927 | 1.0868 | 1.0740 | 1.0605 |
| 17 | 1.1272 | 1.1221 | 1.1195 | 1.1168 | 1.1141 | 1.1113 | 1.1057 | 1.0998 | 1.0938 | 1.0809 | 1.0674 |
| 18 | 1.1351 | 1.1298 | 1.1271 | 1.1243 | 1.1215 | 1.1187 | 1.1129 | 1.1070 | 1.1009 | 1.0879 | 1.0744 |
| 19 | 1.1430 | 1.1375 | 1.1347 | 1.1318 | 1.1290 | 1.1261 | 1.1202 | 1.1142 | 1.1081 | 1.0950 | 1.0814 |
| 20 | 1.1510 | 1.1453 | 1.1424 | 1.1394 | 1.1365 | 1.1335 | 1.1275 | 1.1215 | 1.1153 | 1.1021 | 1.0885 |
| 21 | 1.1590 | 1.1531 | 1.1501 | 1.1471 | 1.1441 | 1.1410 | 1.1349 | 1.1288 | 1.1226 | 1.1093 | 1.0957 |
| 22 | 1.1670 | 1.1609 | 1.1579 | 1.1548 | 1.1517 | 1.1486 | 1.1424 | 1.1362 | 1.1299 | 1.1166 | 1.1029 |
| 23 | 1.1751 | 1.1688 | 1.1657 | 1.1626 | 1.1594 | 1.1563 | 1.1500 | 1.1437 | 1.1373 | 1.1239 | 1.1102 |
| 24 | 1.1832 | 1.1768 | 1.1736 | 1.1704 | 1.1672 | 1.1640 | 1.1576 | 1.1512 | 1.1448 | 1.1313 | 1.1176 |
| 25 | 1.1914 | 1.1848 | 1.1816 | 1.1783 | 1.1750 | 1.1718 | 1.1653 | 1.1588 | 1.1523 | 1.1388 | 1.1250 |
| 26 | 1.1996 | 1.1929 | 1.1896 | 1.1862 | 1.1829 | 1.1796 | 1.1730 | 1.1665 | 1.1599 | 1.1463 | 1.1325 |
| 27 | 1.2078 | 1.2010 | 1.1976 | 1.1942 | 1.1909 | 1.1875 | 1.1808 | 1.1742 | 1.1676 | 1.1539 | 1.1400 |
| 28 | 1.2160 | 1.2091 | 1.2057 | 1.2023 | 1.1989 | 1.1955 | 1.1887 | 1.1820 | 1.1753 | 1.1616 | 1.1476 |
| 29 | 1.2243 | 1.2173 | 1.2138 | 1.2104 | 1.2069 | 1.2035 | 1.1966 | 1.1898 | 1.1831 | 1.1693 | 1.1553 |
| 30 | 1.2326 | 1.2255 | 1.2220 | 1.2185 | 1.2150 | 1.2115 | 1.2046 | 1.1977 | 1.1909 | 1.1771 | 1.1630 |
| 31 | 1.2409 | 1.2338 | 1.2302 | 1.2267 | 1.2232 | 1.2196 | 1.2126 | 1.2057 | 1.1988 | 1.1849 | 1.1708 |
| 32 | 1.2493 | 1.2421 | 1.2385 | 1.2349 | 1.2314 | 1.2278 | 1.2207 | 1.2137 | 1.2068 | 1.1928 | 1.1787 |
| 33 | 1.2577 | 1.2504 | 1.2468 | 1.2432 | 1.2396 | 1.2360 | 1.2289 | 1.2218 | 1.2148 | 1.2008 | 1.1866 |
| 34 | 1.2661 | 1.2588 | 1.2552 | 1.2515 | 1.2479 | 1.2443 | 1.2371 | 1.2300 | 1.2229 | 1.2088 | 1.1946 |
| 35 | 1.2746 | 1.2672 | 1.2636 | 1.2599 | 1.2563 | 1.2526 | 1.2454 | 1.2383 | 1.2311 | 1.2169 | 1.2027 |
| 36 | 1.2831 | 1.2757 | 1.2720 | 1.2684 | 1.2647 | 1.2610 | 1.2538 | 1.2466 | 1.2394 | 1.2251 | 1.2109 |
| 37 | 1.2917 | 1.2843 | 1.2805 | 1.2769 | 1.2732 | 1.2695 | 1.2622 | 1.2550 | 1.2477 | 1.2334 | 1.2192 |
| 38 | 1.3004 | 1.2929 | 1.2891 | 1.2855 | 1.2818 | 1.2780 | 1.2707 | 1.2635 | 1.2561 | 1.2418 | 1.2276 |
| 39 | 1.3091 | 1.3016 | 1.2978 | 1.2941 | 1.2904 | 1.2866 | 1.2793 | 1.2720 | 1.2646 | 1.2503 | 1.2361 |
| 40 | 1.3179 | 1.3103 | 1.3065 | 1.3028 | 1.2991 | 1.2953 | 1.2880 | 1.2806 | 1.2732 | 1.2589 | 1.2446 |
| 41 | 1.3268 | 1.3191 | 1.3153 | 1.3116 | 1.3079 | 1.3041 | 1.2967 | 1.2893 | 1.2819 | 1.2675 | 1.2532 |
| 42 | 1.3357 | 1.3280 | 1.3242 | 1.3205 | 1.3167 | 1.3129 | 1.3055 | 1.2981 | 1.2907 | 1.2762 | 1.2619 |
| 43 | 1.3447 | 1.3370 | 1.3332 | 1.3294 | 1.3256 | 1.3218 | 1.3144 | 1.3070 | 1.2996 | 1.2850 | 1.2707 |
| 44 | 1.3538 | 1.3461 | 1.3423 | 1.3384 | 1.3346 | 1.3308 | 1.3234 | 1.3160 | 1.3086 | 1.2939 | 1.2796 |
| 45 | 1.3630 | 1.3553 | 1.3515 | 1.3476 | 1.3437 | 1.3399 | 1.3325 | 1.3251 | 1.3177 | 1.3029 | 1.2886 |
| 46 | 1.3724 | 1.3646 | 1.3608 | 1.3569 | 1.3530 | 1.3492 | 1.3417 | 1.3343 | 1.3269 | 1.3120 | 1.2976 |
| 47 | 1.3819 | 1.3740 | 1.3702 | 1.3663 | 1.3624 | 1.3586 | 1.3510 | 1.3435 | 1.3362 | 1.3212 | 1.3067 |
| 48 | 1.3915 | 1.3835 | 1.3797 | 1.3758 | 1.3719 | 1.3680 | 1.3604 | 1.3528 | 1.3455 | 1.3305 | 1.3159 |
| 49 | 1.4012 | 1.3931 | 1.3893 | 1.3854 | 1.3814 | 1.3775 | 1.3699 | 1.3623 | 1.3549 | 1.3399 | 1.3253 |
| 50 | 1.4110 | 1.4029 | 1.3990 | 1.3951 | 1.3911 | 1.3872 | 1.3795 | 1.3719 | 1.3644 | 1.3494 | 1.3348 |
| 51 | 1.4209 | 1.4128 | 1.4088 | 1.4049 | 1.4009 | 1.3970 | 1.3893 | 1.3816 | 1.3740 | 1.3590 | 1.3444 |
| 52 | 1.4310 | 1.4228 | 1.4188 | 1.4148 | 1.4109 | 1.4069 | 1.3991 | 1.3914 | 1.3837 | 1.3687 | 1.3540 |
| 53 | 1.4412 | 1.4329 | 1.4289 | 1.4248 | 1.4209 | 1.4169 | 1.4091 | 1.4013 | 1.3936 | 1.3785 | 1.3637 |
| 54 | 1.4515 | 1.4431 | 1.4391 | 1.4350 | 1.4310 | 1.4270 | 1.4191 | 1.4113 | 1.4036 | 1.3884 | 1.3735 |
| 55 | 1.4619 | 1.4535 | 1.4494 | 1.4453 | 1.4412 | 1.4372 | 1.4293 | 1.4214 | 1.4137 | 1.3984 | 1.3834 |
| 56 | 1.4724 | 1.4640 | 1.4598 | 1.4557 | 1.4516 | 1.4475 | 1.4396 | 1.4317 | 1.4239 | 1.4085 | 1.3934 |
| 57 | 1.4830 | 1.4746 | 1.4703 | 1.4662 | 1.4621 | 1.4580 | 1.4500 | 1.4420 | 1.4342 | 1.4187 | 1.4035 |
| 58 | 1.4937 | 1.4852 | 1.4809 | 1.4768 | 1.4726 | 1.4685 | 1.4604 | 1.4524 | 1.4446 | 1.4290 | 1.4137 |
| 59 | 1.5045 | 1.4959 | 1.4916 | 1.4875 | 1.4832 | 1.4791 | 1.4709 | 1.4629 | 1.4551 | 1.4393 | 1.4240 |
| 60 | 1.5154 | 1.5067 | 1.5024 | 1.4983 | 1.4940 | 1.4898 | 1.4816 | 1.4735 | 1.4656 | 1.4497 | 1.4344 |
| 61 | 1.5264 | 1.5177 | 1.5133 | 1.5091 | 1.5048 | 1.5006 | 1.4923 | 1.4842 | 1.4762 | 1.4602 | 1.4449 |
| 62 | 1.5375 | 1.5287 | 1.5243 | 1.5200 | 1.5157 | 1.5115 | 1.5031 | 1.4950 | 1.4869 | 1.4708 | 1.4554 |
| 63 | 1.5487 | 1.5398 | 1.5354 | 1.5310 | 1.5267 | 1.5225 | 1.5140 | 1.5058 | 1.4977 | 1.4815 | 1.4660 |
| 64 | 1.5600 | 1.5510 | 1.5465 | 1.5421 | 1.5378 | 1.5335 | 1.5250 | 1.5167 | 1.5086 | 1.4923 | 1.4766 |

**TABLE 2-101 Sulfuric Acid ($H_2SO_4$)** (*Concluded*)

| % | 0°C | 10°C | 15°C | 20°C | 25°C | 30°C | 40°C | 50°C | 60°C | 80°C | 100°C |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 65 | 1.5714 | 1.5623 | 1.5578 | 1.5533 | 1.5490 | 1.5446 | 1.5361 | 1.5277 | 1.5195 | 1.5031 | 1.4873 |
| 66 | 1.5828 | 1.5736 | 1.5691 | 1.5646 | 1.5602 | 1.5558 | 1.5472 | 1.5388 | 1.5305 | 1.5140 | 1.4981 |
| 67 | 1.5943 | 1.5850 | 1.5805 | 1.5760 | 1.5715 | 1.5671 | 1.5584 | 1.5499 | 1.5416 | 1.5249 | 1.5089 |
| 68 | 1.6059 | 1.5965 | 1.5920 | 1.5874 | 1.5829 | 1.5785 | 1.5697 | 1.5611 | 1.5528 | 1.5359 | 1.5198 |
| 69 | 1.6176 | 1.6081 | 1.6035 | 1.5989 | 1.5944 | 1.5899 | 1.5811 | 1.5724 | 1.5640 | 1.5470 | 1.5307 |
| 70 | 1.6293 | 1.6198 | 1.6151 | 1.6105 | 1.6059 | 1.6014 | 1.5925 | 1.5838 | 1.5753 | 1.5582 | 1.5417 |
| 71 | 1.6411 | 1.6315 | 1.6268 | 1.6221 | 1.6175 | 1.6130 | 1.6040 | 1.5952 | 1.5867 | 1.5694 | 1.5527 |
| 72 | 1.6529 | 1.6433 | 1.6385 | 1.6338 | 1.6292 | 1.6246 | 1.6155 | 1.6067 | 1.5981 | 1.5806 | 1.5637 |
| 73 | 1.6648 | 1.6551 | 1.6503 | 1.6456 | 1.6409 | 1.6363 | 1.6271 | 1.6182 | 1.6095 | 1.5919 | 1.5747 |
| 74 | 1.6768 | 1.6670 | 1.6622 | 1.6574 | 1.6526 | 1.6480 | 1.6387 | 1.6297 | 1.6209 | 1.6031 | 1.5857 |
| 75 | 1.6888 | 1.6789 | 1.6740 | 1.6692 | 1.6644 | 1.6597 | 1.6503 | 1.6412 | 1.6322 | 1.6142 | 1.5966 |
| 76 | 1.7008 | 1.6908 | 1.6858 | 1.6810 | 1.6761 | 1.6713 | 1.6619 | 1.6526 | 1.6435 | 1.6252 | 1.6074 |
| 77 | 1.7128 | 1.7026 | 1.6976 | 1.6927 | 1.6878 | 1.6829 | 1.6734 | 1.6640 | 1.6547 | 1.6361 | 1.6181 |
| 78 | 1.7247 | 1.7144 | 1.7093 | 1.7043 | 1.6994 | 1.6944 | 1.6847 | 1.6751 | 1.6657 | 1.6469 | 1.6286 |
| 79 | 1.7365 | 1.7261 | 1.7209 | 1.7158 | 1.7108 | 1.7058 | 1.6959 | 1.6862 | 1.6766 | 1.6575 | 1.6390 |
| 80 | 1.7482 | 1.7376 | 1.7323 | 1.7272 | 1.7221 | 1.7170 | 1.7069 | 1.6971 | 1.6873 | 1.6680 | 1.6493 |
| 81 | 1.7597 | 1.7489 | 1.7435 | 1.7383 | 1.7331 | 1.7279 | 1.7177 | 1.7077 | 1.6978 | 1.6782 | 1.6594 |
| 82 | 1.7709 | 1.7599 | 1.7544 | 1.7491 | 1.7437 | 1.7385 | 1.7281 | 1.7180 | 1.7080 | 1.6882 | 1.6692 |
| 83 | 1.7815 | 1.7704 | 1.7649 | 1.7594 | 1.7540 | 1.7487 | 1.7382 | 1.7279 | 1.7179 | 1.6979 | 1.6787 |
| 84 | 1.7916 | 1.7804 | 1.7748 | 1.7693 | 1.7639 | 1.7585 | 1.7479 | 1.7375 | 1.7274 | 1.7072 | 1.6878 |
| 85 | 1.8009 | 1.7897 | 1.7841 | 1.7786 | 1.7732 | 1.7678 | 1.7571 | 1.7466 | 1.7364 | 1.7161 | 1.6966 |
| 86 | 1.8095 | 1.7983 | 1.7927 | 1.7872 | 1.7818 | 1.7763 | 1.7657 | 1.7552 | 1.7449 | 1.7245 | 1.7050 |
| 87 | 1.8173 | 1.8061 | 1.8006 | 1.7951 | 1.7897 | 1.7842 | 1.7736 | 1.7632 | 1.7529 | 1.7324 | 1.7129 |
| 88 | 1.8243 | 1.8132 | 1.8077 | 1.8022 | 1.7968 | 1.7914 | 1.7809 | 1.7705 | 1.7602 | 1.7397 | 1.7202 |
| 89 | 1.8306 | 1.8195 | 1.8141 | 1.8087 | 1.8033 | 1.7979 | 1.7874 | 1.7770 | 1.7669 | 1.7464 | 1.7269 |
| 90 | 1.8361 | 1.8252 | 1.8198 | 1.8144 | 1.8091 | 1.8038 | 1.7933 | 1.7829 | 1.7729 | 1.7525 | 1.7331 |
| 91 | 1.8410 | 1.8302 | 1.8248 | 1.8195 | 1.8142 | 1.8090 | 1.7986 | 1.7883 | 1.7783 | 1.7581 | 1.7388 |
| 92 | 1.8453 | 1.8346 | 1.8293 | 1.8240 | 1.8188 | 1.8136 | 1.8033 | 1.7932 | 1.7832 | 1.7633 | 1.7439 |
| 93 | 1.8490 | 1.8384 | 1.8331 | 1.8279 | 1.8227 | 1.8176 | 1.8074 | 1.7974 | 1.7876 | 1.7681 | 1.7485 |
| 94 | 1.8520 | 1.8415 | 1.8363 | 1.8312 | 1.8260 | 1.8210 | 1.8109 | 1.8011 | 1.7914 | | |
| 95 | 1.8544 | 1.8439 | 1.8388 | 1.8337 | 1.8286 | 1.8236 | 1.8137 | 1.8040 | 1.7944 | | |
| 96 | 1.8560 | 1.8457 | 1.8406 | 1.8355 | 1.8305 | 1.8255 | 1.8157 | 1.8060 | 1.7965 | | |
| 97 | 1.8569 | 1.8466 | 1.8414 | 1.8364 | 1.8314 | 1.8264 | 1.8166 | 1.8071 | 1.7977 | | |
| 98 | 1.8567 | 1.8463 | 1.8411 | 1.8361 | 1.8310 | 1.8261 | 1.8163 | 1.8068 | 1.7976 | | |
| 99 | 1.8551 | 1.8445 | 1.8393 | 1.8342 | 1.8292 | 1.8242 | 1.8145 | 1.8050 | 1.7958 | | |
| 100 | 1.8517 | 1.8409 | 1.8357 | 1.8305 | 1.8255 | 1.8205 | 1.8107 | 1.8013 | 1.7922 | | |

| % | $d_4^{5.96}$ | % | $d_4^{13.00}$ | $d_4^{18.00}$ |
|---|---|---|---|---|
| 0.005 | 1.000 0140 | 0.05 | 0.999 810 | 0.999 028 |
| .01 | 1.000 0576 | .1 | 1.000 185 | .999 400 |
| .02 | 1.000 1434 | .2 | 1.000 912 | 1.000 119 |
| .03 | 1.000 2276 | .3 | 1.001 623 | 1.000 820 |
| .04 | 1.000 3104 | .4 | 1.002 326 | 1.001 512 |
| .05 | 1.000 3920 | .5 | 1.003 023 | 1.002 197 |
| .06 | 1.000 4726 | .6 | 1.003 716 | 1.002 877 |
| .07 | 1.000 5523 | .8 | 1.005 090 | 1.004 227 |
| .08 | 1.000 6313 | 1.0 | 1.006 452 | 1.005 570 |
| .09 | 1.000 7098 | 1.2 | 1.007 807 | 1.006 909 |
| .10 | 1.000 7880 | 1.4 | 1.009 159 | 1.008 247 |
| .15 | 1.001 1732 | 1.6 | 1.010 510 | 1.009 583 |
| .20 | 1.001 5514 | 1.8 | 1.011 860 | 1.010 918 |
| .25 | 1.001 9254 | 2.0 | 1.013 209 | 1.012 252 |
| .30 | 1.002 2961 | 2.2 | 1.014 557 | 1.013 586 |
| .35 | 1.002 6639 | 2.4 | 1.015 904 | 1.014 919 |
| .40 | 1.003 0292 | | | |
| .45 | 1.003 3923 | | | |
| .50 | 1.003 7534 | | | |

**TABLE 2-102 Zinc Bromide ($ZnBr_2$)**

| % | 0°C | 20°C | 40°C | 60°C | 80°C | 100°C |
|---|---|---|---|---|---|---|
| 2 | 1.0188 | 1.0167 | 1.0102 | 1.0008 | 0.9890 | 0.9751 |
| 4 | 1.0381 | 1.0354 | 1.0285 | 1.0187 | 1.0065 | 0.9921 |
| 8 | 1.0777 | 1.0738 | 1.0660 | 1.0554 | 1.0422 | 1.0270 |
| 12 | 1.1186 | 1.1135 | 1.1046 | 1.0932 | 1.0789 | 1.0629 |
| 16 | 1.1609 | 1.1544 | 1.1445 | 1.1320 | 1.1169 | 1.1000 |
| 20 | 1.2043 | 1.1965 | 1.1855 | 1.1720 | 1.1560 | 1.1382 |
| 30 | 1.3288 | 1.3170 | 1.3030 | 1.2868 | 1.2688 | 1.2489 |
| 40 | 1.477 | 1.462 | 1.445 | 1.427 | 1.406 | 1.385 |
| 50 | 1.661 | 1.643 | 1.623 | 1.602 | 1.579 | 1.555 |
| 60 | 1.891 | 1.869 | 1.845 | 1.822 | 1.797 | 1.771 |
| 65 | 2.026 | 2.002 | 1.976 | 1.951 | 1.924 | 1.898 |

**TABLE 2-103 Zinc Chloride ($ZnCl_2$)**

| % | 0°C | 20°C | 40°C | 60°C | 80°C | 100°C |
|---|---|---|---|---|---|---|
| 2 | 1.0192 | 1.0167 | 1.0099 | 1.0003 | 0.9882 | 0.9739 |
| 4 | 1.0384 | 1.0350 | 1.0274 | 1.0172 | 1.0044 | .9894 |
| 8 | 1.0769 | 1.0715 | 1.0624 | 1.0508 | 1.0369 | 1.0211 |
| 12 | 1.1159 | 1.1085 | 1.0980 | 1.0853 | 1.0704 | 1.0541 |
| 16 | 1.1558 | 1.1468 | 1.1350 | 1.1212 | 1.1055 | 1.0888 |
| 20 | 1.1970 | 1.1866 | 1.1736 | 1.1590 | 1.1428 | 1.1255 |
| 30 | 1.3062 | 1.2928 | 1.2778 | 1.2614 | 1.2438 | 1.2252 |
| 40 | 1.4329 | 1.4173 | 1.4003 | 1.3824 | 1.3637 | 1.3441 |
| 50 | 1.5860 | 1.5681 | 1.5495 | 1.5300 | 1.5097 | 1.4892 |
| 60 | | 1.749 | | | | |
| 70 | | 1.962 | | | | |

**TABLE 2-104 Zinc Nitrate [$Zn(NO_3)_2$]**

| % | 18°C | % | 18°C |
|---|---|---|---|
| 2 | 1.0154 | 18 | 1.1652 |
| 4 | 1.0322 | 20 | 1.1865 |
| 6 | 1.0496 | 25 | 1.2427 |
| 8 | 1.0675 | 30 | 1.3029 |
| 10 | 1.0859 | 35 | 1.3678 |
| 12 | 1.1048 | 40 | 1.4378 |
| 14 | 1.1244 | 45 | 1.5134 |
| 16 | 1.1445 | 50 | 1.5944 |

**TABLE 2-105 Zinc Sulfate ($ZnSO_4$)**

| % | 20°C |
|---|---|
| 2 | 1.019 |
| 4 | 1.0403 |
| 6 | 1.0620 |
| 8 | 1.0842 |
| 10 | 1.1071 |
| 12 | 1.1308 |
| 14 | 1.1553 |
| 16 | 1.1806 |

# DENSITIES OF AQUEOUS ORGANIC SOLUTIONS*

## UNITS AND UNITS CONVERSIONS

Unless otherwise noted, densities are given in grams per cubic centimeter. To convert to pounds per cubic foot, multiply by 62.43.

$$°F = \tfrac{9}{5}\,°C + 32$$

From *International Critical Tables*, vol. 3, pp. 115–129. All compositions are in weight percent in vacuo. All density values are $d_4^t$ = g/mL in vacuo.

*For gasoline and aircraft fuels see Hibbard, NACA Res. Mem. E56I21 (declassified 1958).

**TABLE 2-106 Formic Acid (HCOOH)**

| % | 0°C | 15°C | 20°C | 30°C | % | 0°C | 15°C | 20°C | 30°C | % | 0°C | 15°C | 20°C | 30°C | % | 0°C | 15°C | 20°C | 30°C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.9999 | 0.9991 | 0.9982 | 0.9957 | 25 | 1.0706 | 1.0627 | 1.0609 | 1.0540 | 50 | 1.1349 | 1.1225 | 1.1207 | 1.1098 | 75 | 1.1953 | 1.1794 | 1.1769 | 1.1636 |
| 1 | 1.0028 | 1.0019 | 1.0019 | 0.9980 | 26 | 1.0733 | 1.0652 | 1.0633 | 1.0564 | 51 | 1.1374 | 1.1248 | 1.1223 | 1.1120 | 76 | 1.1976 | 1.1816 | 1.1785 | 1.1656 |
| 2 | 1.0059 | 1.0045 | 1.0044 | 1.0004 | 27 | 1.0760 | 1.0678 | 1.0656 | 1.0587 | 52 | 1.1399 | 1.1271 | 1.1244 | 1.1142 | 77 | 1.1999 | 1.1837 | 1.1801 | 1.1676 |
| 3 | 1.0090 | 1.0072 | 1.0070 | 1.0028 | 28 | 1.0787 | 1.0702 | 1.0681 | 1.0609 | 53 | 1.1424 | 1.1294 | 1.1269 | 1.1164 | 78 | 1.2021 | 1.1859 | 1.1818 | 1.1697 |
| 4 | 1.0120 | 1.0100 | 1.0093 | 1.0053 | 29 | 1.0813 | 1.0726 | 1.0705 | 1.0632 | 54 | 1.1448 | 1.1318 | 1.1295 | 1.1186 | 79 | 1.2043 | 1.1881 | 1.1837 | 1.1717 |
| 5 | 1.0150 | 1.0124 | 1.0115 | 1.0075 | 30 | 1.0839 | 1.0750 | 1.0729 | 1.0654 | 55 | 1.1472 | 1.1341 | 1.1320 | 1.1208 | 80 | 1.2065 | 1.1902 | 1.1806 | 1.1737 |
| 6 | 1.0179 | 1.0151 | 1.0141 | 1.0101 | 31 | 1.0866 | 1.0774 | 1.0753 | 1.0676 | 56 | 1.1497 | 1.1365 | 1.1342 | 1.1230 | 81 | 1.2088 | 1.1924 | 1.1876 | 1.1758 |
| 7 | 1.0207 | 1.0177 | 1.0170 | 1.0125 | 32 | 1.0891 | 1.0798 | 1.0777 | 1.0699 | 57 | 1.1523 | 1.1388 | 1.1361 | 1.1253 | 82 | 1.2110 | 1.1944 | 1.1896 | 1.1778 |
| 8 | 1.0237 | 1.0204 | 1.0196 | 1.0149 | 33 | 1.0916 | 1.0821 | 1.0800 | 1.0721 | 58 | 1.1548 | 1.1411 | 1.1381 | 1.1274 | 83 | 1.2132 | 1.1965 | 1.1914 | 1.1798 |
| 9 | 1.0266 | 1.0230 | 1.0221 | 1.0173 | 34 | 1.0941 | 1.0844 | 1.0823 | 1.0743 | 59 | 1.1573 | 1.1434 | 1.1401 | 1.1295 | 84 | 1.2154 | 1.1985 | 1.1929 | 1.1817 |
| 10 | 1.0295 | 1.0256 | 1.0246 | 1.0197 | 35 | 1.0966 | 1.0867 | 1.0847 | 1.0766 | 60 | 1.1597 | 1.1458 | 1.1424 | 1.1317 | 85 | 1.2176 | 1.2005 | 1.1953 | 1.1837 |
| 11 | 1.0324 | 1.0281 | 1.0271 | 1.0221 | 36 | 1.0993 | 1.0892 | 1.0871 | 1.0788 | 61 | 1.1621 | 1.1481 | 1.1448 | 1.1338 | 86 | 1.2196 | 1.2025 | 1.1976 | 1.1856 |
| 12 | 1.0351 | 1.0306 | 1.0296 | 1.0244 | 37 | 1.1018 | 1.0916 | 1.0895 | 1.0810 | 62 | 1.1645 | 1.1504 | 1.1473 | 1.1360 | 87 | 1.2217 | 1.2045 | 1.1994 | 1.1875 |
| 13 | 1.0379 | 1.0330 | 1.0321 | 1.0267 | 38 | 1.1043 | 1.0940 | 1.0919 | 1.0832 | 63 | 1.1669 | 1.1526 | 1.1493 | 1.1382 | 88 | 1.2237 | 1.2064 | 1.2012 | 1.1893 |
| 14 | 1.0407 | 1.0355 | 1.0345 | 1.0290 | 39 | 1.1069 | 1.0964 | 1.0940 | 1.0854 | 64 | 1.1694 | 1.1549 | 1.1517 | 1.1403 | 89 | 1.2258 | 1.2084 | 1.2028 | 1.1910 |
| 15 | 1.0435 | 1.0380 | 1.0370 | 1.0313 | 40 | 1.1095 | 1.0988 | 1.0963 | 1.0876 | 65 | 1.1718 | 1.1572 | 1.1543 | 1.1425 | 90 | 1.2278 | 1.2102 | 1.2044 | 1.1927 |
| 16 | 1.0463 | 1.0405 | 1.0393 | 1.0336 | 41 | 1.1122 | 1.1012 | 1.0990 | 1.0898 | 66 | 1.1742 | 1.1595 | 1.1565 | 1.1446 | 91 | 1.2297 | 1.2121 | 1.2059 | 1.1945 |
| 17 | 1.0491 | 1.0430 | 1.0417 | 1.0358 | 42 | 1.1148 | 1.1036 | 1.1015 | 1.0920 | 67 | 1.1766 | 1.1618 | 1.1584 | 1.1467 | 92 | 1.2316 | 1.2139 | 1.2078 | 1.1961 |
| 18 | 1.0518 | 1.0455 | 1.0441 | 1.0381 | 43 | 1.1174 | 1.1060 | 1.1038 | 1.0943 | 68 | 1.1790 | 1.1640 | 1.1604 | 1.1489 | 93 | 1.2335 | 1.2157 | 1.2099 | 1.1978 |
| 19 | 1.0545 | 1.0480 | 1.0464 | 1.0404 | 44 | 1.1199 | 1.1084 | 1.1062 | 1.0965 | 69 | 1.1813 | 1.1663 | 1.1628 | 1.1510 | 94 | 1.2354 | 1.2174 | 1.2117 | 1.1994 |
| 20 | 1.0571 | 1.0505 | 1.0488 | 1.0427 | 45 | 1.1224 | 1.1109 | 1.1085 | 1.0987 | 70 | 1.1835 | 1.1685 | 1.1655 | 1.1531 | 95 | 1.2372 | 1.2191 | 1.2140 | 1.2008 |
| 21 | 1.0598 | 1.0532 | 1.0512 | 1.0451 | 46 | 1.1249 | 1.1133 | 1.1108 | 1.1009 | 71 | 1.1858 | 1.1707 | 1.1677 | 1.1552 | 96 | 1.2390 | 1.2208 | 1.2158 | 1.2022 |
| 22 | 1.0625 | 1.0556 | 1.0537 | 1.0473 | 47 | 1.1274 | 1.1156 | 1.1130 | 1.1031 | 72 | 1.1882 | 1.1729 | 1.1702 | 1.1573 | 97 | 1.2408 | 1.2224 | 1.2170 | 1.2036 |
| 23 | 1.0652 | 1.0580 | 1.0561 | 1.0496 | 48 | 1.1299 | 1.1179 | 1.1157 | 1.1053 | 73 | 1.1906 | 1.1751 | 1.1728 | 1.1595 | 98 | 1.2425 | 1.2240 | 1.2183 | 1.2048 |
| 24 | 1.0679 | 1.0604 | 1.0585 | 1.0518 | 49 | 1.1324 | 1.1202 | 1.1185 | 1.1076 | 74 | 1.1929 | 1.1773 | 1.1752 | 1.1615 | 99 | 1.2441 | 1.2257 | 1.2202 | 1.2061 |
| | | | | | | | | | | | | | | | 100 | 1.2456 | 1.2273 | 1.2212 | 1.2073 |

**TABLE 2-107 Acetic Acid ($CH_3COOH$)**

| % | 0°C | 10°C | 15°C | 20°C | 25°C | 30°C | 40°C | % | 0°C | 10°C | 15°C | 20°C | 25°C | 30°C | 40°C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.9999 | 0.9997 | 0.9991 | 0.9982 | 0.9971 | 0.9957 | 0.9922 | 50 | 1.0729 | 1.0654 | 1.0613 | 1.0575 | 1.0534 | 1.0492 | 1.0408 |
| 1 | 1.0016 | 1.0013 | 1.0006 | .9996 | .9987 | .9971 | .9934 | 51 | 1.0738 | 1.0663 | 1.0622 | 1.0582 | 1.0542 | 1.0499 | 1.0414 |
| 2 | 1.0033 | 1.0029 | 1.0021 | 1.0012 | 1.0000 | .9984 | .9946 | 52 | 1.0748 | 1.0671 | 1.0629 | 1.0590 | 1.0549 | 1.0506 | 1.0421 |
| 3 | 1.0051 | 1.0044 | 1.0036 | 1.0025 | 1.0013 | .9997 | .9958 | 53 | 1.0757 | 1.0679 | 1.0637 | 1.0597 | 1.0555 | 1.0512 | 1.0427 |
| 4 | 1.0070 | 1.0060 | 1.0051 | 1.0040 | 1.0027 | 1.0011 | .9970 | 54 | 1.0765 | 1.0687 | 1.0644 | 1.0604 | 1.0562 | 1.0518 | 1.0432 |
| 5 | 1.0088 | 1.0076 | 1.0066 | 1.0055 | 1.0041 | 1.0024 | .9982 | 55 | 1.0774 | 1.0694 | 1.0651 | 1.0611 | 1.0568 | 1.0525 | 1.0438 |
| 6 | 1.0106 | 1.0092 | 1.0081 | 1.0069 | 1.0055 | 1.0037 | .9994 | 56 | 1.0782 | 1.0701 | 1.0658 | 1.0618 | 1.0574 | 1.0531 | 1.0443 |
| 7 | 1.0124 | 1.0108 | 1.0096 | 1.0083 | 1.0068 | 1.0050 | 1.0006 | 57 | 1.0790 | 1.0708 | 1.0665 | 1.0624 | 1.0580 | 1.0536 | 1.0448 |
| 8 | 1.0142 | 1.0124 | 1.0111 | 1.0097 | 1.0081 | 1.0063 | 1.0018 | 58 | 1.0798 | 1.0715 | 1.0672 | 1.0631 | 1.0586 | 1.0542 | 1.0453 |
| 9 | 1.0159 | 1.0140 | 1.0126 | 1.0111 | 1.0094 | 1.0076 | 1.0030 | 59 | 1.0805 | 1.0722 | 1.0678 | 1.0637 | 1.0592 | 1.0547 | 1.0458 |
| 10 | 1.0177 | 1.0156 | 1.0141 | 1.0125 | 1.0107 | 1.0089 | 1.0042 | 60 | 1.0813 | 1.0728 | 1.0684 | 1.0642 | 1.0597 | 1.0552 | 1.0462 |
| 11 | 1.0194 | 1.0171 | 1.0155 | 1.0139 | 1.0120 | 1.0102 | 1.0054 | 61 | 1.0820 | 1.0734 | 1.0690 | 1.0648 | 1.0602 | 1.0557 | 1.0466 |
| 12 | 1.0211 | 1.0187 | 1.0170 | 1.0154 | 1.0133 | 1.0115 | 1.0065 | 62 | 1.0826 | 1.0740 | 1.0696 | 1.0653 | 1.0607 | 1.0562 | 1.0470 |
| 13 | 1.0228 | 1.0202 | 1.0184 | 1.0168 | 1.0146 | 1.0127 | 1.0077 | 63 | 1.0833 | 1.0746 | 1.0701 | 1.0658 | 1.0612 | 1.0566 | 1.0473 |
| 14 | 1.0245 | 1.0217 | 1.0199 | 1.0182 | 1.0159 | 1.0139 | 1.0088 | 64 | 1.0838 | 1.0752 | 1.0706 | 1.0662 | 1.0616 | 1.0571 | 1.0477 |
| 15 | 1.0262 | 1.0232 | 1.0213 | 1.0195 | 1.0172 | 1.0151 | 1.0099 | 65 | 1.0844 | 1.0757 | 1.0711 | 1.0666 | 1.0621 | 1.0575 | 1.0480 |
| 16 | 1.0278 | 1.0247 | 1.0227 | 1.0209 | 1.0185 | 1.0163 | 1.0110 | 66 | 1.0850 | 1.0762 | 1.0716 | 1.0671 | 1.0624 | 1.0578 | 1.0483 |
| 17 | 1.0295 | 1.0262 | 1.0241 | 1.0223 | 1.0198 | 1.0175 | 1.0121 | 67 | 1.0856 | 1.0767 | 1.0720 | 1.0675 | 1.0628 | 1.0582 | 1.0486 |
| 18 | 1.0311 | 1.0276 | 1.0255 | 1.0236 | 1.0210 | 1.0187 | 1.0132 | 68 | 1.0860 | 1.0771 | 1.0725 | 1.0678 | 1.0631 | 1.0585 | 1.0489 |
| 19 | 1.0327 | 1.0291 | 1.0269 | 1.0250 | 1.0223 | 1.0198 | 1.0142 | 69 | 1.0865 | 1.0775 | 1.0729 | 1.0682 | 1.0634 | 1.0588 | 1.0491 |
| 20 | 1.0343 | 1.0305 | 1.0283 | 1.0263 | 1.0235 | 1.0210 | 1.0153 | 70 | 1.0869 | 1.0779 | 1.0732 | 1.0685 | 1.0637 | 1.0590 | 1.0493 |
| 21 | 1.0358 | 1.0319 | 1.0297 | 1.0276 | 1.0248 | 1.0222 | 1.0164 | 71 | 1.0874 | 1.0783 | 1.0736 | 1.0687 | 1.0640 | 1.0592 | 1.0495 |
| 22 | 1.0374 | 1.0333 | 1.0310 | 1.0288 | 1.0260 | 1.0233 | 1.0174 | 72 | 1.0877 | 1.0786 | 1.0738 | 1.0690 | 1.0642 | 1.0594 | 1.0496 |
| 23 | 1.0389 | 1.0347 | 1.0323 | 1.0301 | 1.0272 | 1.0244 | 1.0185 | 73 | 1.0881 | 1.0789 | 1.0741 | 1.0693 | 1.0644 | 1.0595 | 1.0497 |
| 24 | 1.0404 | 1.0361 | 1.0336 | 1.0313 | 1.0283 | 1.0256 | 1.0195 | 74 | 1.0884 | 1.0792 | 1.0743 | 1.0694 | 1.0645 | 1.0596 | 1.0498 |
| 25 | 1.0419 | 1.0375 | 1.0349 | 1.0326 | 1.0295 | 1.0267 | 1.0205 | 75 | 1.0887 | 1.0794 | 1.0745 | 1.0696 | 1.0647 | 1.0597 | 1.0499 |
| 26 | 1.0434 | 1.0388 | 1.0362 | 1.0338 | 1.0307 | 1.0278 | 1.0215 | 76 | 1.0889 | 1.0796 | 1.0746 | 1.0698 | 1.0648 | 1.0598 | 1.0499 |
| 27 | 1.0449 | 1.0401 | 1.0374 | 1.0349 | 1.0318 | 1.0289 | 1.0225 | 77 | 1.0891 | 1.0797 | 1.0747 | 1.0699 | 1.0648 | 1.0598 | 1.0499 |
| 28 | 1.0463 | 1.0414 | 1.0386 | 1.0361 | 1.0329 | 1.0299 | 1.0234 | 78 | 1.0893 | 1.0798 | 1.0747 | 1.0700 | 1.0648 | 1.0598 | 1.0498 |
| 29 | 1.0477 | 1.0427 | 1.0399 | 1.0372 | 1.0340 | 1.0310 | 1.0244 | 79 | 1.0894 | 1.0798 | 1.0747 | 1.0700 | 1.0648 | 1.0597 | 1.0497 |
| 30 | 1.0491 | 1.0440 | 1.0411 | 1.0384 | 1.0350 | 1.0320 | 1.0253 | 80 | 1.0895 | 1.0798 | 1.0747 | 1.0700 | 1.0647 | 1.0596 | 1.0495 |
| 31 | 1.0505 | 1.0453 | 1.0423 | 1.0395 | 1.0361 | 1.0330 | 1.0262 | 81 | 1.0895 | 1.0797 | 1.0745 | 1.0699 | 1.0646 | 1.0594 | 1.0493 |
| 32 | 1.0519 | 1.0465 | 1.0435 | 1.0406 | 1.0372 | 1.0341 | 1.0272 | 82 | 1.0895 | 1.0796 | 1.0743 | 1.0698 | 1.0644 | 1.0592 | 1.0490 |
| 33 | 1.0532 | 1.0477 | 1.0446 | 1.0417 | 1.0382 | 1.0351 | 1.0281 | 83 | 1.0895 | 1.0795 | 1.0741 | 1.0696 | 1.0642 | 1.0589 | 1.0487 |
| 34 | 1.0545 | 1.0489 | 1.0458 | 1.0428 | 1.0392 | 1.0361 | 1.0289 | 84 | 1.0893 | 1.0793 | 1.0738 | 1.0693 | 1.0638 | 1.0585 | 1.0483 |
| 35 | 1.0558 | 1.0501 | 1.0469 | 1.0438 | 1.0402 | 1.0371 | 1.0298 | 85 | 1.0891 | 1.0790 | 1.0735 | 1.0689 | 1.0635 | 1.0582 | 1.0479 |
| 36 | 1.0571 | 1.0513 | 1.0480 | 1.0449 | 1.0412 | 1.0380 | 1.0306 | 86 | 1.0887 | 1.0787 | 1.0731 | 1.0685 | 1.0630 | 1.0576 | 1.0473 |
| 37 | 1.0584 | 1.0524 | 1.0491 | 1.0459 | 1.0422 | 1.0390 | 1.0314 | 87 | 1.0883 | 1.0783 | 1.0726 | 1.0680 | 1.0626 | 1.0571 | 1.0467 |
| 38 | 1.0596 | 1.0535 | 1.0501 | 1.0469 | 1.0432 | 1.0399 | 1.0322 | 88 | 1.0877 | 1.0778 | 1.0721 | 1.0675 | 1.0620 | 1.0564 | 1.0460 |
| 39 | 1.0608 | 1.0546 | 1.0512 | 1.0479 | 1.0441 | 1.0408 | 1.0330 | 89 | 1.0872 | 1.0773 | 1.0715 | 1.0668 | 1.0613 | 1.0557 | 1.0453 |
| 40 | 1.0621 | 1.0557 | 1.0522 | 1.0488 | 1.0450 | 1.0416 | 1.0338 | 90 | 1.0865 | 1.0766 | 1.0708 | 1.0661 | 1.0605 | 1.0549 | 1.0445 |
| 41 | 1.0633 | 1.0568 | 1.0532 | 1.0498 | 1.0460 | 1.0425 | 1.0346 | 91 | 1.0857 | 1.0758 | 1.0700 | 1.0652 | 1.0597 | 1.0541 | 1.0436 |
| 42 | 1.0644 | 1.0578 | 1.0542 | 1.0507 | 1.0469 | 1.0433 | 1.0353 | 92 | 1.0848 | 1.0749 | 1.0690 | 1.0643 | 1.0587 | 1.0530 | 1.0426 |
| 43 | 1.0656 | 1.0588 | 1.0551 | 1.0516 | 1.0477 | 1.0441 | 1.0361 | 93 | 1.0838 | 1.0739 | 1.0680 | 1.0632 | 1.0577 | 1.0518 | 1.0414 |
| 44 | 1.0667 | 1.0598 | 1.0561 | 1.0525 | 1.0486 | 1.0449 | 1.0368 | 94 | 1.0826 | 1.0727 | 1.0667 | 1.0619 | 1.0564 | 1.0506 | 1.0401 |
| 45 | 1.0679 | 1.0608 | 1.0570 | 1.0534 | 1.0495 | 1.0456 | 1.0375 | 95 | 1.0813 | 1.0714 | 1.0652 | 1.0605 | 1.0551 | 1.0491 | 1.0386 |
| 46 | 1.0689 | 1.0618 | 1.0579 | 1.0542 | 1.0503 | 1.0464 | 1.0382 | 96 | 1.0798 | | 1.0632 | 1.0588 | 1.0535 | 1.0473 | 1.0368 |
| 47 | 1.0699 | 1.0627 | 1.0588 | 1.0551 | 1.0511 | 1.0471 | 1.0389 | 97 | 1.0780 | | 1.0611 | 1.0570 | 1.0516 | 1.0454 | 1.0348 |
| 48 | 1.0709 | 1.0636 | 1.0597 | 1.0559 | 1.0518 | 1.0479 | 1.0395 | 98 | 1.0759 | | 1.0590 | 1.0549 | 1.0495 | 1.0431 | 1.0325 |
| 49 | 1.0720 | 1.0645 | 1.0605 | 1.0567 | 1.0526 | 1.0486 | 1.0402 | 99 | 1.0730 | | 1.0567 | 1.0524 | 1.0468 | 1.0407 | 1.0299 |
| | | | | | | | | 100 | 1.0697 | | 1.0545 | 1.0498 | 1.0440 | 1.0380 | 1.0271 |

**TABLE 2-108 Oxalic Acid ($H_2C_2O_4$)**

| % | $d_4^{17.5}$ | % | $d_4^{17.5}$ |
|---|---|---|---|
| 1 | 1.0035 | 8 | 1.0280 |
| 2 | 1.0070 | 10 | 1.0350 |
| 4 | 1.0140 | 12 | 1.0420 |

**TABLE 2-109 Methyl Alcohol ($CH_3OH$)***

| % | 0°C | 10°C | 15.56°C | 20°C | 15°C | % | 0°C | 10°C | 15.56°C | 20°C | 15°C | % | 0°C | 10°C | 15.56°C | 20°C | 15°C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.9999 | 0.9997 | 0.9990 | 0.9982 | 0.99913 | 35 | 0.9534 | 0.9484 | 0.9456 | 0.9433 | 0.94570 | 70 | 0.8869 | 0.8794 | 0.8748 | 0.8715 | 0.87507 |
| 1 | .9981 | .9980 | .9973 | .9965 | .99727 | 36 | .9520 | .9469 | .9440 | .9416 | .94404 | 71 | .8847 | .8770 | .8726 | .8690 | .87271 |
| 2 | .9963 | .9962 | .9955 | .9948 | .99543 | 37 | .9505 | .9453 | .9422 | .9398 | .94237 | 72 | .8824 | .8747 | .8702 | .8665 | .87033 |
| 3 | .9946 | .9945 | .9938 | .9931 | .99370 | 38 | .9490 | .9437 | .9405 | .9381 | .94067 | 73 | .8801 | .8724 | .8678 | .8641 | .86792 |
| 4 | .9930 | .9929 | .9921 | .9914 | .99198 | 39 | .9475 | .9420 | .9387 | .9363 | .93894 | 74 | .8778 | .8699 | .8653 | .8616 | .86546 |
| 5 | .9914 | .9912 | .9904 | .9896 | .99029 | 40 | .9459 | .9403 | .9369 | .9345 | .93720 | 75 | .8754 | .8676 | .8629 | .8592 | .86300 |
| 6 | .9899 | .9896 | .9889 | .9880 | .98864 | 41 | .9443 | .9387 | .9351 | .9327 | .93543 | 76 | .8729 | .8651 | .8604 | .8567 | .86051 |
| 7 | .9884 | .9881 | .9872 | .9863 | .98701 | 42 | .9427 | .9370 | .9333 | .9309 | .93365 | 77 | .8705 | .8626 | .8579 | .8542 | .85801 |
| 8 | .9870 | .9865 | .9857 | .9847 | .98547 | 43 | .9411 | .9352 | .9315 | .9290 | .93185 | 78 | .8680 | .8602 | .8554 | .8518 | .85551 |
| 9 | .9856 | .9849 | .9841 | .9831 | .98394 | 44 | .9395 | .9334 | .9297 | .9272 | .93001 | 79 | .8657 | .8577 | .8529 | .8494 | .85300 |
| 10 | .9842 | .9834 | .9826 | .9815 | .98241 | 45 | .9377 | .9316 | .9279 | .9252 | .92815 | 80 | .8634 | .8551 | .8503 | .8469 | .85048 |
| 11 | .9829 | .9820 | .9811 | .9799 | .98093 | 46 | .9360 | .9298 | .9261 | .9234 | .92627 | 81 | .8610 | .8527 | .8478 | .8446 | .84794 |
| 12 | .9816 | .9805 | .9796 | .9784 | .97945 | 47 | .9342 | .9279 | .9242 | .9214 | .92436 | 82 | .8585 | .8501 | .8452 | .8420 | .84536 |
| 13 | .9804 | .9791 | .9781 | .9768 | .97802 | 48 | .9324 | .9260 | .9223 | .9196 | .92242 | 83 | .8560 | .8475 | .8426 | .8394 | .84274 |
| 14 | .9792 | .9778 | .9766 | .9754 | .97660 | 49 | .9306 | .9240 | .9204 | .9176 | .92048 | 84 | .8535 | .8449 | .8400 | .8366 | .84009 |
| 15 | .9780 | .9764 | .9752 | .9740 | .97518 | 50 | .9287 | .9221 | .9185 | .9156 | .91852 | 85 | .8510 | .8422 | .8374 | .8340 | .83742 |
| 16 | .9769 | .9751 | .9738 | .9725 | .97377 | 51 | .9269 | .9202 | .9166 | .9135 | .91653 | 86 | .8483 | .8394 | .8347 | .8314 | .83475 |
| 17 | .9758 | .9739 | .9723 | .9710 | .97237 | 52 | .9250 | .9182 | .9146 | .9114 | .91451 | 87 | .8456 | .8367 | .8320 | .8286 | .83207 |
| 18 | .9747 | .9726 | .9709 | .9696 | .97096 | 53 | .9230 | .9162 | .9126 | .9094 | .91248 | 88 | .8428 | .8340 | .8294 | .8258 | .82937 |
| 19 | .9736 | .9713 | .9695 | .9681 | .96955 | 54 | .9211 | .9142 | .9106 | .9073 | .91044 | 89 | .8400 | .8314 | .8267 | .8230 | .82667 |
| 20 | .9725 | .9700 | .9680 | .9666 | .96814 | 55 | .9191 | .9122 | .9086 | .9052 | .90839 | 90 | .8374 | .8287 | .8239 | .8202 | .82396 |
| 21 | .9714 | .9687 | .9666 | .9651 | .96673 | 56 | .9172 | .9101 | .9065 | .9032 | .90631 | 91 | .8347 | .8261 | .8212 | .8174 | .82124 |
| 22 | .9702 | .9673 | .9652 | .9636 | .96533 | 57 | .9151 | .9080 | .9045 | .9010 | .90421 | 92 | .8320 | .8234 | .8185 | .8146 | .81849 |
| 23 | .9690 | .9660 | .9638 | .9622 | .96392 | 58 | .9131 | .9060 | .9024 | .8988 | .90210 | 93 | .8293 | .8208 | .8157 | .8118 | .81568 |
| 24 | .9678 | .9646 | .9624 | .9607 | .96251 | 59 | .9111 | .9039 | .9002 | .8968 | .89996 | 94 | .8266 | .8180 | .8129 | .8090 | .81285 |
| 25 | .9666 | .9632 | .9609 | .9592 | .96108 | 60 | .9090 | .9018 | .8980 | .8946 | .89781 | 95 | .8240 | .8152 | .8101 | .8062 | .80999 |
| 26 | .9654 | .9618 | .9595 | .9576 | .95963 | 61 | .9068 | .8998 | .8958 | .8924 | .89563 | 96 | .8212 | .8124 | .8073 | .8034 | .80713 |
| 27 | .9642 | .9604 | .9580 | .9562 | .95817 | 62 | .9046 | .8977 | .8936 | .8902 | .89341 | 97 | .8186 | .8096 | .8045 | .8005 | .80428 |
| 28 | .9629 | .9590 | .9565 | .9546 | .95668 | 63 | .9024 | .8955 | .8913 | .8879 | .89117 | 98 | .8158 | .8068 | .8016 | .7976 | .80143 |
| 29 | .9616 | .9575 | .9550 | .9531 | .95518 | 64 | .9002 | .8933 | .8890 | .8856 | .88890 | 99 | .8130 | .8040 | .7987 | .7948 | .79859 |
| 30 | .9604 | .9560 | .9535 | .9515 | .95366 | 65 | .8980 | .8911 | .8867 | .8834 | .88662 | 100 | .8102 | .8009 | .7959 | .7917 | .79577 |
| 31 | .9590 | .9546 | .9521 | .9499 | .95213 | 66 | .8958 | .8888 | .8844 | .8811 | .88433 | | | | | | |
| 32 | .9576 | .9531 | .9505 | .9483 | .95056 | 67 | .8935 | .8865 | .8820 | .8787 | .88203 | | | | | | |
| 33 | .9563 | .9516 | .9489 | .9466 | .94896 | 68 | .8913 | .8842 | .8797 | .8763 | .87971 | | | | | | |
| 34 | .9549 | .9500 | .9473 | .9450 | .94734 | 69 | .8891 | .8818 | .8771 | .8738 | .87739 | | | | | | |

*It should be noted that the values for 100 percent do not agree with some data available elsewhere, *e.g.*, *American Institute of Physics Handbook*, McGraw-Hill, New York, 1957. Also, see Atack, *Handbook of Chemical Data*, Reinhold, New York, 1957.

**TABLE 2-110 Ethyl Alcohol ($C_2H_5OH$)***

| % | 10°C | 15°C | 20°C | 25°C | 30°C | 35°C | 40°C | % | 10°C | 15°C | 20°C | 25°C | 30°C | 35°C | 40°C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.99973 | 0.99913 | 0.99823 | 0.99708 | 0.99568 | 0.99406 | 0.99225 | 50 | 0.92126 | 0.91776 | 0.91384 | 0.90985 | 0.90580 | 0.90168 | 0.89750 |
| 1 | 785 | 725 | 636 | 520 | 379 | 217 | 034 | 51 | .91943 | 555 | 160 | 760 | 353 | .89940 | 519 |
| 2 | 602 | 542 | 453 | 336 | 194 | 031 | .98846 | 52 | 723 | 333 | .90936 | 534 | 125 | 710 | 288 |
| 3 | 426 | 365 | 275 | 157 | 014 | .98849 | 663 | 53 | 502 | 110 | 711 | 307 | .89896 | 479 | 056 |
| 4 | 258 | 195 | 103 | .98984 | .98839 | 672 | 485 | 54 | 279 | .90885 | 485 | 079 | 667 | 248 | .88823 |
| 5 | 098 | 032 | .98938 | 817 | 670 | 501 | 311 | 55 | 055 | 659 | 258 | .89850 | 437 | 016 | 589 |
| 6 | .98946 | .98877 | 780 | 656 | 507 | 335 | 142 | 56 | .90831 | 433 | 031 | 621 | 206 | .88784 | 356 |
| 7 | 801 | 729 | 627 | 500 | 347 | 172 | .97975 | 57 | 607 | 207 | .89803 | 392 | .88975 | 552 | 122 |
| 8 | 660 | 584 | 478 | 346 | 189 | 009 | 808 | 58 | 381 | .89980 | 574 | 162 | 744 | 319 | .87888 |
| 9 | 524 | 442 | 331 | 193 | 031 | .97846 | 641 | 59 | 154 | 752 | 344 | .88931 | 512 | 085 | 653 |
| 10 | 393 | 304 | 187 | 043 | .97875 | 685 | 475 | 60 | .89927 | 523 | 113 | 699 | 278 | .87851 | 417 |
| 11 | 267 | 171 | 047 | .97897 | 723 | 527 | 312 | 61 | 698 | 293 | .88882 | 446 | 044 | 615 | 180 |
| 12 | 145 | 041 | .97910 | 753 | 573 | 371 | 150 | 62 | 468 | 062 | 650 | 233 | .87809 | 379 | .86943 |
| 13 | 026 | .97914 | 775 | 611 | 424 | 216 | .96989 | 63 | 237 | .88830 | 417 | .87998 | 574 | 142 | 705 |
| 14 | .97911 | 790 | 643 | 472 | 278 | 063 | 829 | 64 | 006 | 597 | 183 | 763 | 337 | .86905 | 466 |
| 15 | 800 | 669 | 514 | 334 | 133 | .96911 | 670 | 65 | .88774 | 364 | .87948 | 527 | 100 | 667 | 227 |
| 16 | 692 | 552 | 387 | 199 | .96990 | 760 | 512 | 66 | 541 | 130 | 713 | 291 | .86863 | 429 | .85987 |
| 17 | 583 | 433 | 259 | 062 | 844 | 607 | 352 | 67 | 308 | .87895 | 477 | 054 | 625 | 190 | 747 |
| 18 | 473 | 313 | 129 | .96923 | 697 | 452 | 189 | 68 | 074 | 660 | 241 | .86817 | 387 | .85950 | 407 |
| 19 | 363 | 191 | .96997 | 782 | 547 | 294 | 023 | 69 | .87839 | 424 | 004 | 579 | 148 | 710 | 266 |
| 20 | 252 | 068 | 864 | 639 | 395 | 134 | .95856 | 70 | 602 | 187 | .86766 | 340 | .85908 | 470 | 025 |
| 21 | 139 | .96944 | 729 | 495 | 242 | .95973 | 687 | 71 | 365 | .86949 | 527 | 100 | 667 | 228 | .84783 |
| 22 | 024 | 818 | 592 | 348 | 087 | 809 | 516 | 72 | 127 | 710 | 287 | .85859 | 426 | .84986 | 540 |
| 23 | .96907 | 689 | 453 | 199 | .95929 | 643 | 343 | 73 | .86888 | 470 | 047 | 618 | 184 | 743 | 297 |
| 24 | 787 | 558 | 312 | 048 | 769 | 476 | 168 | 74 | 648 | 229 | .85806 | 376 | .84941 | 500 | 053 |
| 25 | 665 | 424 | 168 | .95895 | 607 | 306 | .94991 | 75 | 408 | .85988 | 564 | 134 | 698 | 257 | .83809 |
| 26 | 539 | 287 | 020 | 738 | 442 | 133 | 810 | 76 | 168 | 747 | 322 | .84891 | 455 | 013 | 564 |
| 27 | 406 | 144 | .95867 | 576 | 272 | .94955 | 625 | 77 | .85927 | 505 | 079 | 647 | 211 | .83768 | 319 |
| 28 | 268 | .95996 | 710 | 410 | 098 | 774 | 438 | 78 | 685 | 262 | .84835 | 403 | .83966 | 523 | 074 |
| 29 | 125 | 844 | 548 | 241 | .94922 | 590 | 248 | 79 | 442 | 018 | 590 | 158 | 720 | 277 | .82827 |
| 30 | .95977 | 686 | 382 | 067 | 741 | 403 | 055 | 80 | 197 | .84772 | 344 | .83911 | 473 | 029 | 578 |
| 31 | 823 | 524 | 212 | .94890 | 557 | 214 | .93860 | 81 | .84950 | 525 | 096 | 664 | 224 | .82780 | 329 |
| 32 | 665 | 357 | 038 | 709 | 370 | 021 | 662 | 82 | 702 | 277 | .83848 | 415 | .82974 | 530 | 079 |
| 33 | 502 | 186 | .94860 | 525 | 180 | .93825 | 461 | 83 | 453 | 028 | 599 | 164 | 724 | 279 | .81828 |
| 34 | 334 | 011 | 679 | 337 | .93986 | 626 | 257 | 84 | 203 | .83777 | 348 | .82913 | 473 | 027 | 576 |
| 35 | 162 | .94832 | 494 | 146 | 790 | 425 | 051 | 85 | .83951 | 525 | 095 | 660 | 220 | .81774 | 322 |
| 36 | .94986 | 650 | 306 | .93952 | 591 | 221 | .92843 | 86 | 697 | 271 | .82840 | 405 | .81965 | 519 | 067 |
| 37 | 805 | 464 | 114 | 756 | 390 | 016 | 634 | 87 | 441 | 014 | 583 | 148 | 708 | 262 | .80811 |
| 38 | 620 | 273 | .93919 | 556 | 186 | .92808 | 422 | 88 | 181 | .82754 | 323 | .81888 | 448 | 003 | 552 |
| 39 | 431 | 079 | 720 | 353 | .92979 | 597 | 208 | 89 | .82919 | 492 | 062 | 626 | 186 | .80742 | 291 |
| 40 | 238 | .93882 | 518 | 148 | 770 | 385 | .91992 | 90 | 654 | 227 | .81797 | 362 | .80922 | 478 | 028 |
| 41 | 042 | 682 | 314 | .92940 | 558 | 170 | 774 | 91 | 386 | .81959 | 529 | 094 | 655 | 211 | .79761 |
| 42 | .93842 | 478 | 107 | 729 | 344 | .91952 | 554 | 92 | 114 | 688 | 257 | .80823 | 384 | .79941 | 491 |
| 43 | 639 | 271 | .92897 | 516 | 128 | 733 | 332 | 93 | .81839 | 413 | .80983 | 549 | 111 | 669 | 220 |
| 44 | 433 | 062 | 685 | 301 | .91910 | 513 | 108 | 94 | 561 | 134 | 705 | 272 | .79835 | 393 | .78947 |
| 45 | 226 | .92852 | 472 | 085 | 692 | 291 | .90884 | 95 | 278 | .80852 | 424 | .79991 | 555 | 114 | 670 |
| 46 | 017 | 640 | 257 | .91868 | 472 | 069 | 660 | 96 | .80991 | 566 | 138 | 706 | 271 | .78831 | 388 |
| 47 | .92806 | 426 | 041 | 649 | 250 | .90845 | 434 | 97 | 698 | 274 | .79846 | 415 | .78981 | 542 | 100 |
| 48 | 593 | 211 | .91823 | 429 | 028 | 621 | 207 | 98 | 399 | .79975 | 547 | 117 | 684 | 247 | .77806 |
| 49 | 379 | .91995 | 604 | 208 | .90805 | 396 | .89979 | 99 | 094 | 670 | 243 | .78814 | 382 | .77946 | 507 |
| | | | | | | | | 100 | .79784 | 360 | .78934 | 506 | 075 | 641 | 203 |

*For data from −78° to 78°C, see p. 2-142, Table 2N-5, *American Institute of Physics Handbook*, McGraw-Hill, New York, 1957.

**TABLE 2-111 Densities of Mixtures of $C_2H_5OH$ and $H_2O$ at 20°C**

g/mL

| % alcohol by weight | Tenths of % | | | | | | | | | | % alcohol by weight | Tenths of % | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 0 | 0.99823 | 804 | 785 | 766 | 748 | 729 | 710 | 692 | 673 | 655 | 50 | 0.91384 | 361 | 339 | 317 | 295 | 272 | 250 | 228 | 206 | 183 |
| 1 | 636 | 618 | 599 | 581 | 562 | 544 | 525 | 507 | 489 | 471 | 51 | 160 | 138 | 116 | 093 | 071 | 049 | 026 | 004 | °981 | °959 |
| 2 | 453 | 435 | 417 | 399 | 381 | 363 | 345 | 327 | 310 | 292 | 52 | .90936 | 914 | 891 | 869 | 846 | 824 | 801 | 779 | 756 | 734 |
| 3 | 275 | 257 | 240 | 222 | 205 | 188 | 171 | 154 | 137 | 120 | 53 | 711 | 689 | 666 | 644 | 621 | 598 | 576 | 553 | 531 | 508 |
| 4 | 103 | 087 | 070 | 053 | 037 | 020 | 003 | °987 | °971 | °954 | 54 | 485 | 463 | 440 | 417 | 395 | 372 | 349 | 327 | 304 | 281 |
| 5 | .98938 | 922 | 906 | 890 | 874 | 859 | 843 | 827 | 811 | 796 | 55 | 258 | 236 | 213 | 190 | 167 | 145 | 122 | 099 | 076 | 054 |
| 6 | 780 | 765 | 749 | 734 | 718 | 703 | 688 | 673 | 658 | 642 | 56 | 031 | 008 | °985 | °962 | °939 | °917 | °894 | °871 | °848 | °825 |
| 7 | 627 | 612 | 597 | 582 | 567 | 553 | 538 | 523 | 508 | 493 | 57 | .89803 | 780 | 757 | 734 | 711 | 688 | 665 | 643 | 620 | 597 |
| 8 | 478 | 463 | 449 | 434 | 419 | 404 | 389 | 374 | 360 | 345 | 58 | 574 | 551 | 528 | 505 | 482 | 459 | 436 | 413 | 390 | 367 |
| 9 | 331 | 316 | 301 | 287 | 273 | 258 | 244 | 229 | 215 | 201 | 59 | 344 | 321 | 298 | 275 | 252 | 229 | 206 | 183 | 160 | 137 |
| 10 | 187 | 172 | 158 | 144 | 130 | 117 | 103 | 089 | 075 | 061 | 60 | 113 | 090 | 067 | 044 | 021 | °998 | °975 | °951 | °928 | °905 |
| 11 | 047 | 033 | 019 | 006 | °992 | °978 | °964 | °951 | °937 | °923 | 61 | .88882 | 859 | 836 | 812 | 789 | 766 | 743 | 720 | 696 | 673 |
| 12 | .97910 | 896 | 883 | 869 | 855 | 842 | 828 | 815 | 801 | 788 | 62 | 650 | 626 | 603 | 580 | 557 | 533 | 510 | 487 | 463 | 440 |
| 13 | 775 | 761 | 748 | 735 | 722 | 709 | 696 | 683 | 670 | 657 | 63 | 417 | 393 | 370 | 347 | 323 | 300 | 277 | 253 | 230 | 206 |
| 14 | 643 | 630 | 617 | 604 | 591 | 578 | 565 | 552 | 539 | 526 | 64 | 183 | 160 | 136 | 113 | 089 | 066 | 042 | 019 | °995 | °972 |
| 15 | 514 | 501 | 488 | 475 | 462 | 450 | 438 | 425 | 412 | 400 | 65 | .87948 | 925 | 901 | 878 | 854 | 831 | 807 | 784 | 760 | 737 |
| 16 | 387 | 374 | 361 | 349 | 336 | 323 | 310 | 297 | 284 | 272 | 66 | 713 | 689 | 666 | 642 | 619 | 595 | 572 | 548 | 524 | 501 |
| 17 | 259 | 246 | 233 | 220 | 207 | 194 | 181 | 168 | 155 | 142 | 67 | 477 | 454 | 430 | 406 | 383 | 359 | 336 | 312 | 288 | 265 |
| 18 | 129 | 116 | 103 | 089 | 076 | 063 | 050 | 037 | 024 | 010 | 68 | 241 | 218 | 194 | 170 | 147 | 123 | 099 | 075 | 052 | 028 |
| 19 | .96997 | 984 | 971 | 957 | 944 | 931 | 917 | 904 | 891 | 877 | 69 | 004 | °981 | °957 | °933 | °909 | °885 | °862 | °838 | °814 | °790 |
| 20 | 864 | 850 | 837 | 823 | 810 | 796 | 783 | 769 | 756 | 742 | 70 | .86766 | 742 | 718 | 694 | 671 | 647 | 623 | 599 | 575 | 551 |
| 21 | 729 | 716 | 702 | 688 | 675 | 661 | 647 | 634 | 620 | 606 | 71 | 527 | 503 | 479 | 455 | 431 | 407 | 383 | 339 | 335 | 311 |
| 22 | 592 | 578 | 564 | 551 | 537 | 523 | 509 | 495 | 481 | 467 | 72 | 287 | 263 | 239 | 215 | 191 | 167 | 143 | 119 | 095 | 071 |
| 23 | 453 | 439 | 425 | 411 | 396 | 382 | 368 | 354 | 340 | 326 | 73 | 047 | 022 | °998 | °974 | °950 | °926 | °902 | °878 | °854 | °830 |
| 24 | 312 | 297 | 283 | 269 | 254 | 240 | 225 | 211 | 196 | 182 | 74 | .85806 | 781 | 757 | 733 | 709 | 685 | 661 | 636 | 612 | 588 |
| 25 | 168 | 153 | 139 | 124 | 109 | 094 | 080 | 065 | 050 | 035 | 75 | 564 | 540 | 515 | 491 | 467 | 443 | 419 | 394 | 370 | 346 |
| 26 | 020 | 005 | °990 | °975 | °959 | °944 | °929 | °914 | °898 | °883 | 76 | 322 | 297 | 273 | 249 | 225 | 200 | 176 | 152 | 128 | 103 |
| 27 | .95867 | 851 | 836 | 820 | 805 | 789 | 773 | 757 | 742 | 726 | 77 | 079 | 055 | 031 | 006 | °982 | °958 | °933 | °909 | °884 | °860 |
| 28 | 710 | 694 | 678 | 662 | 646 | 630 | 613 | 597 | 581 | 565 | 78 | .84835 | 811 | 787 | 762 | 738 | 713 | 689 | 664 | 640 | 615 |
| 29 | 548 | 532 | 516 | 499 | 483 | 466 | 450 | 433 | 416 | 400 | 79 | 590 | 566 | 541 | 517 | 492 | 467 | 443 | 418 | 393 | 369 |
| 30 | 382 | 365 | 349 | 332 | 315 | 298 | 281 | 264 | 247 | 230 | 80 | 344 | 319 | 294 | 270 | 245 | 220 | 196 | 171 | 146 | 121 |
| 31 | 212 | 195 | 178 | 161 | 143 | 126 | 108 | 091 | 074 | 056 | 81 | 096 | 072 | 047 | 022 | °997 | °972 | °947 | °923 | °898 | °873 |
| 32 | 038 | 020 | 003 | °985 | °967 | °950 | °932 | °914 | °896 | °878 | 82 | .83848 | 823 | 798 | 773 | 748 | 723 | 698 | 674 | 649 | 624 |
| 33 | .94860 | 842 | 824 | 806 | 788 | 770 | 752 | 734 | 715 | 697 | 83 | 599 | 574 | 549 | 523 | 498 | 473 | 448 | 423 | 398 | 373 |
| 34 | 679 | 660 | 642 | 624 | 605 | 587 | 568 | 550 | 531 | 512 | 84 | 348 | 323 | 297 | 272 | 247 | 222 | 196 | 171 | 146 | 120 |
| 35 | 494 | 475 | 456 | 438 | 419 | 400 | 382 | 363 | 344 | 325 | 85 | 095 | 070 | 044 | 019 | °994 | °968 | °943 | °917 | °892 | °866 |
| 36 | 306 | 287 | 268 | 249 | 230 | 211 | 192 | 172 | 153 | 134 | 86 | .82840 | 815 | 789 | 763 | 738 | 712 | 686 | 660 | 635 | 609 |
| 37 | 114 | 095 | 075 | 056 | 036 | 017 | °997 | °978 | °958 | °939 | 87 | 583 | 557 | 531 | 505 | 479 | 453 | 427 | 401 | 375 | 349 |
| 38 | .93919 | 899 | 879 | 859 | 840 | 820 | 800 | 780 | 760 | 740 | 88 | 323 | 297 | 271 | 245 | 219 | 193 | 167 | 140 | 114 | 088 |
| 39 | 720 | 700 | 680 | 660 | 640 | 620 | 599 | 579 | 559 | 539 | 89 | 062 | 035 | 009 | °983 | °956 | °930 | °903 | °877 | °850 | °824 |
| 40 | 518 | 498 | 478 | 458 | 437 | 417 | 396 | 376 | 356 | 335 | 90 | .81797 | 770 | 744 | 717 | 690 | 664 | 637 | 610 | 583 | 556 |
| 41 | 314 | 294 | 273 | 253 | 232 | 212 | 191 | 170 | 149 | 129 | 91 | 529 | 502 | 475 | 448 | 421 | 394 | 366 | 339 | 312 | 285 |
| 42 | 107 | 086 | 065 | 044 | 023 | 002 | °981 | °960 | °939 | °918 | 92 | 257 | 230 | 203 | 175 | 148 | 120 | 093 | 066 | 038 | 010 |
| 43 | .92897 | 876 | 855 | 834 | 812 | 791 | 770 | 749 | 728 | 707 | 93 | .80983 | 955 | 928 | 900 | 872 | 844 | 817 | 789 | 761 | 733 |
| 44 | 685 | 664 | 642 | 621 | 600 | 579 | 557 | 536 | 515 | 493 | 94 | 705 | 677 | 649 | 621 | 593 | 565 | 537 | 509 | 480 | 452 |
| 45 | 472 | 450 | 429 | 408 | 386 | 365 | 343 | 322 | 300 | 279 | 95 | 424 | 395 | 367 | 338 | 310 | 281 | 253 | 224 | 195 | 166 |
| 46 | 257 | 236 | 214 | 193 | 171 | 150 | 128 | 106 | 085 | 063 | 96 | 138 | 109 | 080 | 051 | 022 | °993 | °963 | °934 | °905 | °875 |
| 47 | 041 | 019 | °997 | °976 | °954 | °932 | °910 | °889 | °867 | °845 | 97 | .79846 | 816 | 787 | 757 | 727 | 698 | 668 | 638 | 608 | 578 |
| 48 | .91823 | 801 | 780 | 758 | 736 | 714 | 692 | 670 | 648 | 626 | 98 | 547 | 517 | 487 | 456 | 426 | 396 | 365 | 335 | 305 | 274 |
| 49 | 604 | 582 | 560 | 538 | 516 | 494 | 472 | 450 | 428 | 406 | 99 | 243 | 213 | 182 | 151 | 120 | 089 | 059 | 028 | °997 | °966 |
| | | | | | | | | | | | 100 | .78934 | | | | | | | | | |

°Indicates change in the first two decimal places.

**TABLE 2-112 Specific Gravity (60°/60°F [(15.56°/15.56°C)]) of Mixtures by Volume of $C_2H_5OH$ and $H_2O$**

| % alcohol by volume at 60°F | Tenths of % | | | | | | | | | | % alcohol by volume at 60°F | Tenths of % | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 0 | 1.00000 | °985 | °970 | °955 | °940 | °925 | °910 | °895 | °880 | 865 | 50 | 0.93426 | 407 | 387 | 368 | 348 | 328 | 309 | 289 | 270 | 250 |
| 1 | 0.99850 | 835 | 820 | 806 | 791 | 776 | 761 | 747 | 732 | 717 | 51 | 230 | 210 | 190 | 171 | 151 | 131 | 111 | 091 | 071 | 051 |
| 2 | 703 | 688 | 674 | 659 | 645 | 630 | 616 | 602 | 587 | 573 | 52 | 031 | 011 | °991 | °971 | °951 | °931 | °911 | °890 | °870 | °850 |
| 3 | 559 | 545 | 531 | 516 | 502 | 488 | 474 | 460 | 446 | 432 | 53 | .92830 | 810 | 789 | 769 | 749 | 728 | 708 | 688 | 667 | 647 |
| 4 | 419 | 405 | 391 | 378 | 364 | 350 | 336 | 323 | 309 | 296 | 54 | 626 | 605 | 585 | 564 | 544 | 523 | 502 | 482 | 461 | 440 |
| 5 | 282 | 269 | 255 | 242 | 228 | 215 | 202 | 189 | 176 | 163 | 55 | 419 | 398 | 377 | 357 | 336 | 315 | 294 | 273 | 252 | 231 |
| 6 | 150 | 137 | 124 | 111 | 098 | 085 | 073 | 060 | 047 | 035 | 56 | 210 | 189 | 168 | 147 | 126 | 105 | 084 | 062 | 041 | 020 |
| 7 | 022 | 009 | °997 | °984 | °972 | °960 | °947 | °935 | °923 | °911 | 57 | .91999 | 978 | 956 | 935 | 914 | 892 | 871 | 849 | 827 | 806 |
| 8 | .98899 | 887 | 875 | 863 | 851 | 838 | 826 | 814 | 803 | 791 | 58 | 784 | 762 | 741 | 719 | 697 | 675 | 653 | 631 | 610 | 588 |
| 9 | 779 | 767 | 755 | 743 | 731 | 720 | 708 | 696 | 684 | 672 | 59 | 565 | 543 | 521 | 499 | 477 | 455 | 433 | 410 | 388 | 366 |
| 10 | 661 | 649 | 637 | 625 | 614 | 602 | 590 | 579 | 567 | 556 | 60 | 344 | 322 | 299 | 277 | 255 | 232 | 210 | 188 | 165 | 143 |
| 11 | 544 | 532 | 521 | 509 | 498 | 487 | 475 | 464 | 452 | 441 | 61 | 120 | 097 | 075 | 052 | 030 | 007 | °984 | °962 | °939 | °916 |
| 12 | 430 | 419 | 408 | 396 | 385 | 374 | 363 | 352 | 341 | 330 | 62 | .90893 | 870 | 847 | 825 | 802 | 779 | 756 | 733 | 710 | 687 |
| 13 | 319 | 308 | 297 | 286 | 275 | 264 | 254 | 243 | 232 | 221 | 63 | 664 | 641 | 618 | 595 | 572 | 549 | 526 | 503 | 480 | 457 |
| 14 | 210 | 200 | 190 | 179 | 168 | 157 | 147 | 136 | 125 | 115 | 64 | 434 | 411 | 388 | 365 | 341 | 318 | 295 | 272 | 249 | 225 |
| 15 | 104 | 093 | 083 | 072 | 062 | 051 | 040 | 030 | 019 | 009 | 65 | 202 | 179 | 155 | 132 | 108 | 085 | 061 | 038 | 014 | °991 |
| 16 | .97998 | 988 | 977 | 967 | 956 | 946 | 936 | 925 | 915 | 905 | 66 | .89967 | 943 | 920 | 896 | 872 | 848 | 825 | 801 | 777 | 753 |
| 17 | 895 | 885 | 875 | 864 | 854 | 844 | 834 | 824 | 814 | 804 | 67 | 729 | 705 | 681 | 657 | 633 | 609 | 585 | 561 | 537 | 513 |
| 18 | 794 | 784 | 774 | 764 | 754 | 744 | 734 | 724 | 714 | 704 | 68 | 489 | 465 | 441 | 416 | 392 | 368 | 343 | 319 | 295 | 270 |
| 19 | 694 | 684 | 674 | 664 | 654 | 645 | 635 | 625 | 615 | 605 | 69 | 245 | 220 | 196 | 171 | 147 | 122 | 098 | 073 | 048 | 024 |
| 20 | 596 | 586 | 576 | 566 | 556 | 546 | 536 | 526 | 516 | 506 | 70 | .88999 | 974 | 950 | 925 | 900 | 875 | 850 | 825 | 801 | 776 |
| 21 | 496 | 486 | 476 | 466 | 456 | 446 | 436 | 425 | 415 | 405 | 71 | 751 | 725 | 700 | 675 | 650 | 625 | 600 | 574 | 549 | 524 |
| 22 | 395 | 385 | 375 | 365 | 354 | 344 | 334 | 324 | 313 | 303 | 72 | 499 | 474 | 448 | 423 | 397 | 372 | 346 | 321 | 296 | 270 |
| 23 | 293 | 283 | 272 | 262 | 252 | 241 | 231 | 221 | 210 | 200 | 73 | 244 | 218 | 193 | 167 | 141 | 116 | 090 | 064 | 039 | 013 |
| 24 | 189 | 179 | 168 | 158 | 147 | 137 | 126 | 116 | 105 | 095 | 74 | .87987 | 961 | 935 | 910 | 884 | 858 | 832 | 806 | 780 | 754 |
| 25 | 084 | 073 | 063 | 052 | 042 | 031 | 020 | 010 | °999 | °988 | 75 | 728 | 702 | 676 | 650 | 623 | 597 | 571 | 545 | 518 | 492 |
| 26 | .96978 | 967 | 957 | 946 | 935 | 924 | 914 | 903 | 892 | 881 | 76 | 465 | 439 | 412 | 386 | 359 | 332 | 306 | 279 | 252 | 226 |
| 27 | 870 | 859 | 848 | 837 | 826 | 815 | 804 | 793 | 782 | 771 | 77 | 199 | 172 | 145 | 118 | 092 | 065 | 038 | 011 | °984 | °957 |
| 28 | 760 | 749 | 738 | 727 | 715 | 704 | 693 | 682 | 671 | 659 | 78 | .86929 | 902 | 875 | 847 | 820 | 793 | 766 | 738 | 711 | 684 |
| 29 | 648 | 637 | 625 | 614 | 603 | 591 | 580 | 568 | 557 | 546 | 79 | 656 | 629 | 601 | 574 | 546 | 518 | 491 | 463 | 435 | 408 |
| 30 | 534 | 522 | 511 | 499 | 488 | 476 | 464 | 453 | 441 | 429 | 80 | 380 | 352 | 324 | 296 | 269 | 241 | 213 | 185 | 157 | 129 |
| 31 | 418 | 406 | 394 | 382 | 370 | 358 | 346 | 334 | 321 | 309 | 81 | 100 | 072 | 044 | 015 | °987 | °959 | °931 | °902 | °874 | °846 |
| 32 | 296 | 284 | 271 | 259 | 246 | 234 | 221 | 209 | 196 | 183 | 82 | .85817 | 789 | 760 | 732 | 703 | 674 | 646 | 617 | 588 | 560 |
| 33 | 170 | 157 | 144 | 132 | 119 | 106 | 093 | 080 | 067 | 054 | 83 | 531 | 502 | 473 | 444 | 415 | 386 | 357 | 328 | 299 | 270 |
| 34 | 041 | 028 | 015 | 002 | °988 | °975 | °962 | °948 | °935 | °921 | 84 | 240 | 211 | 181 | 152 | 122 | 093 | 063 | 033 | 004 | °974 |
| 35 | .95908 | 894 | 881 | 867 | 854 | 840 | 826 | 812 | 798 | 784 | 85 | .84944 | 914 | 884 | 854 | 824 | 794 | 764 | 734 | 703 | 673 |
| 36 | 770 | 756 | 742 | 728 | 714 | 700 | 685 | 671 | 657 | 643 | 86 | 642 | 612 | 581 | 551 | 520 | 490 | 459 | 428 | 398 | 367 |
| 37 | 628 | 614 | 599 | 585 | 570 | 556 | 541 | 526 | 512 | 497 | 87 | 336 | 305 | 274 | 243 | 212 | 181 | 150 | 119 | 088 | 056 |
| 38 | 482 | 467 | 452 | 437 | 423 | 408 | 393 | 378 | 362 | 347 | 88 | 025 | °994 | °962 | °930 | °899 | °867 | °835 | °803 | °771 | °739 |
| 39 | 332 | 317 | 302 | 286 | 271 | 256 | 240 | 225 | 209 | 194 | 89 | .83707 | 675 | 643 | 610 | 578 | 545 | 513 | 480 | 447 | 415 |
| 40 | 178 | 162 | 147 | 131 | 115 | 100 | 084 | 068 | 052 | 036 | 90 | 382 | 349 | 315 | 282 | 249 | 216 | 183 | 150 | 116 | 083 |
| 41 | 020 | 004 | °988 | °972 | °956 | °940 | °923 | °907 | °891 | °875 | 91 | 049 | 015 | °981 | °947 | °913 | °879 | °845 | °810 | °776 | °741 |
| 42 | .94858 | 842 | 825 | 809 | 792 | 776 | 759 | 743 | 726 | 710 | 92 | .82705 | 670 | 635 | 600 | 565 | 529 | 494 | 458 | 423 | 387 |
| 43 | 693 | 676 | 660 | 643 | 626 | 609 | 592 | 575 | 558 | 541 | 93 | 351 | 315 | 279 | 243 | 206 | 170 | 133 | 096 | 059 | 022 |
| 44 | 524 | 507 | 490 | 473 | 455 | 438 | 421 | 403 | 386 | 369 | 94 | .81984 | 947 | 909 | 871 | 834 | 796 | 757 | 719 | 681 | 642 |
| 45 | 351 | 334 | 316 | 298 | 281 | 263 | 245 | 228 | 210 | 192 | 95 | 603 | 564 | 525 | 486 | 446 | 407 | 367 | 327 | 287 | 247 |
| 46 | 174 | 156 | 138 | 120 | 102 | 084 | 066 | 048 | 030 | 011 | 96 | 206 | 165 | 125 | 084 | 042 | 001 | °960 | °918 | °876 | °834 |
| 47 | .93993 | 975 | 956 | 938 | 920 | 901 | 883 | 864 | 845 | 827 | 97 | .80792 | 750 | 707 | 664 | 620 | 577 | 533 | 489 | 445 | 401 |
| 48 | 808 | 789 | 771 | 752 | 733 | 714 | 695 | 676 | 657 | 638 | 98 | 356 | 311 | 265 | 219 | 173 | 127 | 080 | 033 | °985 | °937 |
| 49 | 619 | 600 | 581 | 562 | 543 | 523 | 504 | 485 | 465 | 446 | 99 | .79889 | 841 | 792 | 743 | 693 | 643 | 593 | 543 | 492 | 441 |
| | | | | | | | | | | | 100 | 389 | | | | | | | | | |

°Indicates change in first two decimal places.

**TABLE 2-113 *n*-Propyl Alcohol ($C_3H_7OH$)**

| % | 0°C | 15°C | 30°C | % | 0°C | 15°C | 30°C | % | 0°C | 15°C | 30°C | % | 0°C | 15°C | 30°C | % | 0°C | 15°C | 30°C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.9999 | 0.9991 | 0.9957 | 20 | 0.9789 | 0.9723 | 0.9643 | 40 | 0.9430 | 0.9331 | 0.9226 | 60 | 0.9033 | 0.8922 | 0.8807 | 80 | 0.8634 | 0.8516 | 0.8394 |
| 1 | .9982 | .9974 | .9940 | 21 | .9776 | .9705 | .9622 | 41 | .9411 | .9310 | .9205 | 61 | .9013 | .8902 | .8786 | 81 | .8614 | .8496 | .8373 |
| 2 | .9967 | .9960 | .9924 | 22 | .9763 | .9688 | .9602 | 42 | .9391 | .9290 | .9184 | 62 | .8994 | .8882 | .8766 | 82 | .8594 | .8475 | .8352 |
| 3 | .9952 | .9944 | .9908 | 23 | .9748 | .9670 | .9583 | 43 | .9371 | .9269 | .9164 | 63 | .8974 | .8861 | .8745 | 83 | .8574 | .8454 | .8332 |
| 4 | .9939 | .9929 | .9893 | 24 | .9733 | .9651 | .9563 | 44 | .9352 | .9248 | .9143 | 64 | .8954 | .8841 | .8724 | 84 | .8554 | .8434 | .8311 |
| 5 | .9926 | .9915 | .9877 | 25 | .9717 | .9633 | .9543 | 45 | .9332 | .9228 | .9122 | 65 | .8934 | .8820 | .8703 | 85 | .8534 | .8413 | .8290 |
| 6 | .9914 | .9902 | .9862 | 26 | .9700 | .9614 | .9522 | 46 | .9311 | .9207 | .9100 | 66 | .8913 | .8800 | .8682 | 86 | .8513 | .8393 | .8269 |
| 7 | .9904 | .9890 | .9848 | 27 | .9682 | .9594 | .9501 | 47 | .9291 | .9186 | .9079 | 67 | .8894 | .8779 | .8662 | 87 | .8492 | .8372 | .8248 |
| 8 | .9894 | .9877 | .9834 | 28 | .9664 | .9576 | .9481 | 48 | .9272 | .9165 | .9057 | 68 | .8874 | .8759 | .8641 | 88 | .8471 | .8351 | .8227 |
| 9 | .9883 | .9864 | .9819 | 29 | .9646 | .9556 | .9460 | 49 | .9252 | .9145 | .9036 | 69 | .8854 | .8739 | .8620 | 89 | .8450 | .8330 | .8206 |
| 10 | .9874 | .9852 | .9804 | 30 | .9627 | .9535 | .9439 | 50 | .9232 | .9124 | .9015 | 70 | .8835 | .8719 | .8600 | 90 | .8429 | .8308 | .8185 |
| 11 | .9865 | .9840 | .9790 | 31 | .9608 | .9516 | .9418 | 51 | .9213 | .9104 | .8994 | 71 | .8815 | .8700 | .8580 | 91 | .8408 | .8287 | .8164 |
| 12 | .9857 | .9828 | .9775 | 32 | .9589 | .9495 | .9396 | 52 | .9192 | .9084 | .8973 | 72 | .8795 | .8680 | .8559 | 92 | .8387 | .8266 | .8142 |
| 13 | .9849 | .9817 | .9760 | 33 | .9570 | .9474 | .9375 | 53 | .9173 | .9064 | .8952 | 73 | .8776 | .8659 | .8539 | 93 | .8364 | .8244 | .8120 |
| 14 | .9841 | .9806 | .9746 | 34 | .9550 | .9454 | .9354 | 54 | .9153 | .9044 | .8931 | 74 | .8756 | .8639 | .8518 | 94 | .8342 | .8221 | .8098 |
| 15 | .9833 | .9793 | .9730 | 35 | .9530 | .9434 | .9333 | 55 | .9132 | .9023 | .8911 | 75 | .8736 | .8618 | .8497 | 95 | .8320 | .8199 | .8077 |
| 16 | .9825 | .9780 | .9714 | 36 | .9511 | .9413 | .9312 | 56 | .9112 | .9003 | .8890 | 76 | .8716 | .8598 | .8477 | 96 | .8296 | .8176 | .8054 |
| 17 | .9817 | .9768 | .9698 | 37 | .9491 | .9392 | .9289 | 57 | .9093 | .8983 | .8869 | 77 | .8695 | .8577 | .8456 | 97 | .8272 | .8153 | .8031 |
| 18 | .9808 | .9752 | .9680 | 38 | .9471 | .9372 | .9269 | 58 | .9073 | .8963 | .8849 | 78 | .8675 | .8556 | .8435 | 98 | .8248 | .8128 | .8008 |
| 19 | .9800 | .9739 | .9661 | 39 | .9450 | .9351 | .9247 | 59 | .9053 | .8942 | .8828 | 79 | .8655 | .8536 | .8414 | 99 | .8222 | .8104 | .7984 |
| | | | | | | | | | | | | | | | | 100 | .8194 | .8077 | .7958 |

**TABLE 2-114 Isopropyl Alcohol ($C_3H_7OH$)**

| % | 0°C | 15°C* | 15°C* | 20°C | 30°C | % | 0°C | 15°C* | 15°C* | 20°C | 30°C | % | 0°C | 15°C* | 15°C* | 20°C | 30°C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.9999 | 0.9991 | 0.99913 | 0.9982 | 0.9957 | 35 | 0.9557 | | 0.9446 | 0.9419 | 0.9338 | 70 | 0.8761 | 0.8639 | 0.86346 | 0.8584 | 0.8511 |
| 1 | .9980 | .9973 | .9972 | .9962 | .9939 | 36 | .9536 | | .9424 | .9399 | .9315 | 71 | .8738 | .8615 | .8611 | .8560 | .8487 |
| 2 | .9962 | .9956 | .9954 | .9944 | .9921 | 37 | .9514 | | .9401 | .9377 | .9292 | 72 | .8714 | .8592 | .8588 | .8537 | .8464 |
| 3 | .9946 | .9938 | .9936 | .9926 | .9904 | 38 | .9493 | | .9379 | .9355 | .9269 | 73 | .8691 | .8568 | .8564 | .8513 | .8440 |
| 4 | .9930 | .9922 | .9920 | .9909 | .9887 | 39 | .9472 | | .9356 | .9333 | .9246 | 74 | .8668 | .8545 | .8541 | .8489 | .8416 |
| 5 | .9916 | .9906 | .9904 | .9893 | .9871 | 40 | .9450 | | .93333 | .9310 | .9224 | 75 | .8644 | .8521 | .8517 | .8464 | .8392 |
| 6 | .9902 | .9892 | .9890 | .9877 | .9855 | 41 | .9428 | | .9311 | .9287 | .9201 | 76 | .8621 | .8497 | .8493 | .8439 | .8368 |
| 7 | .9890 | .9878 | .9875 | .9862 | .9839 | 42 | .9406 | | .9288 | .9264 | .9177 | 77 | .8598 | .8474 | .8470 | .8415 | .8344 |
| 8 | .9878 | .9864 | .9862 | .9847 | .9824 | 43 | .9384 | | .9266 | .9239 | .9154 | 78 | .8575 | .8450 | .8446 | .8391 | .8321 |
| 9 | .9866 | .9851 | .9849 | .9833 | .9809 | 44 | .9361 | | .9243 | .9215 | .9130 | 79 | .8551 | .8426 | .8422 | .8366 | .8297 |
| 10 | .9856 | .9838 | .98362 | .9820 | .9794 | 45 | .9338 | | .9220 | .9191 | .9106 | 80 | .8528 | .8403 | .83979 | .8342 | .8273 |
| 11 | .9846 | .9826 | .9824 | .9808 | .9778 | 46 | .9315 | | .9197 | .9165 | .9082 | 81 | .8503 | .8379 | .8374 | .8317 | .8248 |
| 12 | .9838 | .9813 | .9812 | .9797 | .9764 | 47 | .9292 | | .9174 | .9141 | .9059 | 82 | .8479 | .8355 | .8350 | .8292 | .8224 |
| 13 | .9829 | .9802 | .9800 | .9876 | .9750 | 48 | .9270 | | .9150 | .9117 | .9036 | 83 | .8456 | .8331 | .8326 | .8268 | .8200 |
| 14 | .9821 | .9790 | .9788 | .9776 | .9735 | 49 | .9247 | | .9127 | .9093 | .9013 | 84 | .8432 | .8307 | .8302 | .8243 | .8175 |
| 15 | .9814 | .9779 | .9777 | .9765 | .9720 | 50 | .9224 | | .91043 | .9069 | .8990 | 85 | .8408 | .8282 | .8278 | .8219 | .8151 |
| 16 | .9806 | .9768 | .9765 | .9754 | .9705 | 51 | .9201 | | .9081 | .9044 | .8966 | 86 | .8384 | .8259 | .8254 | .8194 | .8127 |
| 17 | .9799 | .9756 | .9753 | .9743 | .9690 | 52 | .9178 | | .9058 | .9020 | .8943 | 87 | .8360 | .8234 | .8229 | .8169 | .8201 |
| 18 | .9792 | .9745 | .9741 | .9731 | .9675 | 53 | .9155 | | .9035 | .8996 | .8919 | 88 | .8336 | .8209 | .8205 | .8145 | .8078 |
| 19 | .9784 | .9730 | .9728 | .9717 | .9658 | 54 | .9132 | | .9011 | .8971 | .8895 | 89 | .8311 | .8184 | .8180 | .8120 | .8053 |
| 20 | .9777 | .9719 | .97158 | .9703 | .9642 | 55 | .9109 | | .8988 | .8946 | .8871 | 90 | .8287 | .8161 | .81553 | .8096 | .8029 |
| 21 | .9768 | .9704 | .9703 | .9688 | .9624 | 56 | .9086 | | .8964 | .8921 | .8847 | 91 | .8262 | .8136 | .8130 | .8072 | .8004 |
| 22 | .9759 | .9690 | .9689 | .9669 | .9606 | 57 | .9063 | | .8940 | .8896 | .8823 | 92 | .8237 | .8110 | .8104 | .8047 | .7979 |
| 23 | .9749 | .9675 | .9674 | .9651 | .9587 | 58 | .9040 | | .8917 | .8874 | .8800 | 93 | .8212 | .8085 | .8079 | .8023 | .7954 |
| 24 | .9739 | .9660 | .9659 | .9634 | .9569 | 59 | .9017 | | .8893 | .8850 | .8777 | 94 | .8186 | .8060 | .8052 | .7998 | .7929 |
| 25 | .9727 | .9643 | .9642 | .9615 | .9549 | 60 | .8994 | | .88690 | .8825 | .8752 | 95 | .8160 | .8034 | .8026 | .7973 | .7904 |
| 26 | .9714 | .9626 | .9624 | .9597 | .9529 | 61 | .8970 | | .8845 | .8800 | .8728 | 96 | .8133 | .8008 | .7999 | .7949 | .7878 |
| 27 | .9699 | .9608 | .9605 | .9577 | .9509 | 62 | .8947 | 0.8829 | .8821 | .8776 | .8704 | 97 | .8106 | .7981 | .7972 | .7925 | .7852 |
| 28 | .9684 | .9590 | .9586 | .9558 | .9488 | 63 | .8924 | .8805 | .8798 | .8751 | .8680 | 98 | .8078 | .7954 | .7945 | .7901 | .7826 |
| 29 | .9669 | .9570 | .9568 | .9540 | .9467 | 64 | .8901 | .8781 | .8775 | .8727 | .8656 | 99 | .8048 | .7926 | .7918 | .7877 | .7799 |
| 30 | .9652 | .9551 | .95493 | .9520 | .9446 | 65 | .8878 | .8757 | .8752 | .8702 | .8631 | 100 | .8016 | .7896 | .78913 | .7854 | .7770 |
| 31 | .9634 | | .9530 | .9500 | .9426 | 66 | .8854 | .8733 | .8728 | .8679 | .8607 | | | | | | |
| 32 | .9615 | | .9510 | .9481 | .9405 | 67 | .8831 | .8710 | .8705 | .8656 | .8583 | | | | | | |
| 33 | .9596 | | .9489 | .9460 | .9383 | 68 | .8807 | .8686 | .8682 | .8632 | .8559 | | | | | | |
| 34 | .9577 | | .9468 | .9440 | .9361 | 69 | .8784 | .8662 | .8658 | .8609 | .8535 | | | | | | |

*Two different observers; see *International Critical Tables*, vol. 3, p. 120.

**TABLE 2-115 Glycerol***

| Glycerol, % | Density 15°C | 15.5°C | 20°C | 25°C | 30°C | Glycerol, % | Density 15°C | 15.5°C | 20°C | 25°C | 30°C | Glycerol, % | Density 15°C | 15.5°C | 20°C | 25°C | 30°C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100 | 1.26415 | 1.26381 | 1.26108 | 1.15802 | 1.25495 | 65 | 1.17030 | 1.17000 | 1.16750 | 1.16475 | 1.16195 | 30 | 1.07455 | 1.07435 | 1.07270 | 1.07070 | 1.06855 |
| 99 | 1.26160 | 1.26125 | 1.25850 | 1.25545 | 1.25235 | 64 | 1.16755 | 1.16725 | 1.16475 | 1.16200 | 1.15925 | 29 | 1.07195 | 1.07175 | 1.07010 | 1.06815 | 1.06605 |
| 98 | 1.25900 | 1.25865 | 1.25590 | 1.25290 | 1.24975 | 63 | 1.16480 | 1.16445 | 1.16205 | 1.15925 | 1.15650 | 28 | 1.06935 | 1.06915 | 1.06755 | 1.06560 | 1.06355 |
| 97 | 1.25645 | 1.25610 | 1.25335 | 1.25030 | 1.24710 | 62 | 1.16200 | 1.16170 | 1.15930 | 1.15655 | 1.15375 | 27 | 1.06670 | 1.06655 | 1.06495 | 1.06305 | 1.06105 |
| 96 | 1.25385 | 1.25350 | 1.25080 | 1.24770 | 1.24450 | 61 | 1.15925 | 1.15895 | 1.15655 | 1.15380 | 1.15100 | 26 | 1.06410 | 1.06390 | 1.06240 | 1.06055 | 1.05855 |
| 95 | 1.25130 | 1.25095 | 1.24825 | 1.24515 | 1.24190 | 60 | 1.15650 | 1.15615 | 1.15380 | 1.15105 | 1.14830 | 25 | 1.06150 | 1.06130 | 1.05980 | 1.05800 | 1.05605 |
| 94 | 1.24865 | 1.24830 | 1.24560 | 1.24250 | 1.23930 | 59 | 1.15370 | 1.15340 | 1.15105 | 1.14835 | 1.14555 | 24 | 1.05885 | 1.05870 | 1.05720 | 1.05545 | 1.05350 |
| 93 | 1.24600 | 1.24565 | 1.24300 | 1.23985 | 1.23670 | 58 | 1.15095 | 1.15065 | 1.14830 | 1.14560 | 1.14285 | 23 | 1.05625 | 1.05610 | 1.05465 | 1.05290 | 1.05100 |
| 92 | 1.24340 | 1.24305 | 1.24035 | 1.23725 | 1.23410 | 57 | 1.14815 | 1.14785 | 1.14555 | 1.14285 | 1.14010 | 22 | 1.05365 | 1.05350 | 1.05205 | 1.05035 | 1.04850 |
| 91 | 1.24075 | 1.24040 | 1.23770 | 1.23460 | 1.23150 | 56 | 1.14535 | 1.14510 | 1.14280 | 1.14015 | 1.13740 | 21 | 1.05100 | 1.05090 | 1.04950 | 1.04780 | 1.04600 |
| 90 | 1.23810 | 1.23775 | 1.23510 | 1.23200 | 1.22890 | 55 | 1.14260 | 1.14230 | 1.14005 | 1.13740 | 1.13470 | 20 | 1.04840 | 1.04825 | 1.04690 | 1.04525 | 1.04350 |
| 89 | 1.23545 | 1.23510 | 1.23245 | 1.22935 | 1.22625 | 54 | 1.13980 | 1.13955 | 1.13730 | 1.13465 | 1.13195 | 19 | 1.04590 | 1.04575 | 1.04440 | 1.04280 | 1.04105 |
| 88 | 1.23280 | 1.23245 | 1.22975 | 1.22665 | 1.22360 | 53 | 1.13705 | 1.13680 | 1.13455 | 1.13195 | 1.12925 | 18 | 1.04335 | 1.04325 | 1.04195 | 1.04035 | 1.03860 |
| 87 | 1.23015 | 1.22980 | 1.22710 | 1.22400 | 1.22095 | 52 | 1.13425 | 1.13400 | 1.13180 | 1.12920 | 1.12650 | 17 | 1.04085 | 1.04075 | 1.03945 | 1.03790 | 1.03615 |
| 86 | 1.22750 | 1.22710 | 1.22445 | 1.22135 | 1.21830 | 51 | 1.13150 | 1.13125 | 1.12905 | 1.12650 | 1.12380 | 16 | 1.03835 | 1.03825 | 1.03695 | 1.03545 | 1.03370 |
| 85 | 1.22485 | 1.22445 | 1.22180 | 1.21870 | 1.21565 | 50 | 1.12870 | 1.12845 | 1.12630 | 1.12375 | 1.12110 | 15 | 1.03580 | 1.03570 | 1.03450 | 1.03300 | 1.03130 |
| 84 | 1.22220 | 1.22180 | 1.21915 | 1.21605 | 1.21300 | 49 | 1.12600 | 1.12575 | 1.12360 | 1.12110 | 1.11845 | 14 | 1.03330 | 1.03320 | 1.03200 | 1.03055 | 1.02885 |
| 83 | 1.21955 | 1.21915 | 1.21650 | 1.21340 | 1.21035 | 48 | 1.12325 | 1.12305 | 1.12090 | 1.11840 | 1.11580 | 13 | 1.03080 | 1.03070 | 1.02955 | 1.02805 | 1.02640 |
| 82 | 1.21690 | 1.21650 | 1.21380 | 1.21075 | 1.20770 | 47 | 1.12055 | 1.12030 | 1.11820 | 1.11575 | 1.11320 | 12 | 1.02830 | 1.02820 | 1.02705 | 1.02560 | 1.02395 |
| 81 | 1.21425 | 1.21385 | 1.21115 | 1.20810 | 1.20505 | 46 | 1.11780 | 1.11760 | 1.11550 | 1.11310 | 1.11055 | 11 | 1.02575 | 1.02565 | 1.02455 | 1.02315 | 1.02150 |
| 80 | 1.21160 | 1.21120 | 1.20850 | 1.20545 | 1.20240 | 45 | 1.11510 | 1.11490 | 1.11280 | 1.11040 | 1.10795 | 10 | 1.02325 | 1.02315 | 1.02210 | 1.02070 | 1.01905 |
| 79 | 1.20885 | 1.20845 | 1.20575 | 1.20275 | 1.19970 | 44 | 1.11235 | 1.11215 | 1.11010 | 1.10775 | 1.10530 | 9 | 1.02085 | 1.02075 | 1.01970 | 1.01835 | 1.01670 |
| 78 | 1.20610 | 1.20570 | 1.20305 | 1.20005 | 1.19705 | 43 | 1.10960 | 1.10945 | 1.10740 | 1.10510 | 1.10265 | 8 | 1.01840 | 1.01835 | 1.01730 | 1.01600 | 1.01440 |
| 77 | 1.20335 | 1.20300 | 1.20030 | 1.19735 | 1.19435 | 42 | 1.10690 | 1.10670 | 1.10470 | 1.10240 | 1.10005 | 7 | 1.01600 | 1.01590 | 1.01495 | 1.01360 | 1.01205 |
| 76 | 1.20060 | 1.20025 | 1.19760 | 1.19465 | 1.19170 | 41 | 1.10415 | 1.10400 | 1.10200 | 1.09975 | 1.09740 | 6 | 1.01360 | 1.01350 | 1.01255 | 1.01125 | 1.00970 |
| 75 | 1.19785 | 1.19750 | 1.19485 | 1.19195 | 1.18900 | 40 | 1.10145 | 1.10130 | 1.09930 | 1.09710 | 1.09475 | 5 | 1.01120 | 1.01110 | 1.01015 | 1.00890 | 1.00735 |
| 74 | 1.19510 | 1.19480 | 1.19215 | 1.18925 | 1.18635 | 39 | 1.09875 | 1.09860 | 1.09665 | 1.09445 | 1.09215 | 4 | 1.00875 | 1.00870 | 1.00780 | 1.00655 | 1.00505 |
| 73 | 1.19235 | 1.19205 | 1.18940 | 1.18650 | 1.18365 | 38 | 1.09605 | 1.09590 | 1.09400 | 1.09180 | 1.08955 | 3 | 1.00635 | 1.00630 | 1.00540 | 1.00415 | 1.00270 |
| 72 | 1.18965 | 1.18930 | 1.18670 | 1.18380 | 1.18100 | 37 | 1.09340 | 1.09320 | 1.09135 | 1.08915 | 1.08690 | 2 | 1.00395 | 1.00385 | 1.00300 | 1.00180 | 1.00035 |
| 71 | 1.18690 | 1.18655 | 1.18395 | 1.18110 | 1.17830 | 36 | 1.09070 | 1.09050 | 1.08865 | 1.08655 | 1.08430 | 1 | 1.00155 | 1.00145 | 1.00060 | 0.99945 | 0.99800 |
| 70 | 1.18415 | 1.18385 | 1.18125 | 1.17840 | 1.17565 | 35 | 1.08800 | 1.08780 | 1.08600 | 1.08390 | 1.08165 | 0 | 0.99913 | 0.99905 | 0.99823 | 0.99708 | 0.99568 |
| 69 | 1.18135 | 1.18105 | 1.17850 | 1.17565 | 1.17290 | 34 | 1.08530 | 1.08515 | 1.08335 | 1.08125 | 1.07905 | | | | | | |
| 68 | 1.17860 | 1.17830 | 1.17575 | 1.17295 | 1.17020 | 33 | 1.08265 | 1.08245 | 1.08070 | 1.07860 | 1.07645 | | | | | | |
| 67 | 1.17585 | 1.17555 | 1.17300 | 1.17020 | 1.16745 | 32 | 1.07995 | 1.07975 | 1.07800 | 1.07600 | 1.07380 | | | | | | |
| 66 | 1.17305 | 1.17275 | 1.17025 | 1.16745 | 1.16470 | 31 | 1.07725 | 1.07705 | 1.07535 | 1.07335 | 1.07120 | | | | | | |

*Bosart and Snoddy, *Ind. Eng. Chem.*, **20,** (1928): 1378.

**TABLE 2-116 Hydrazine ($N_2H_4$)**

| % | $d_4^{15}$ | % | $d_4^{15}$ |
|---|---|---|---|
| 1 | 1.0002 | 30 | 1.0305 |
| 2 | 1.0013 | 40 | 1.038 |
| 4 | 1.0034 | 50 | 1.044 |
| 8 | 1.0077 | 60 | 1.047 |
| 12 | 1.0121 | 70 | 1.046 |
| 16 | 1.0164 | 80 | 1.040 |
| 20 | 1.0207 | 90 | 1.030 |
| 24 | 1.0248 | 100 | 1.011 |
| 28 | 1.0286 | | |

**TABLE 2-117 Densities of Aqueous Solutions of Miscellaneous Organic Compounds***

$d$ (resp., $d_w$, $d_s$) = density of the solution (resp., water; resp., the pure liquid solute) in g/mL; $p_s$ (resp., $p_w$) = wt % of solute (resp., water) in the solution; range = range of applicability of the equation.

Section A $d = d_w + Ap_s + Bp_s^2 + Cp_s^3$

| Name | Formula | $t$, °C | Range, $p_s$ | $A$ | $B$ | $C$ |
|---|---|---|---|---|---|---|
| Acetaldehyde | $C_2H_4O$ | 18 | 0– 30 | $+0.0_2255$ | $-0.0_516$ | |
| Acetamide | $C_2H_5NO$ | 15 | 0– 6 | $+0.0_3639$ | $+0.0_4171$ | |
| Acetone | $C_3H_6O$ | 0 | 0–100 | $-0.0_3856$ | $-0.0_5449$ | $-0.0_7588$ |
| | | 4 | 0–100 | $-0.0_27648$ | $-0.0_41193$ | $+0.0_8272$ |
| | | 15 | 0–100 | $-0.0_21009$ | $-0.0_59682$ | $-0.0_8624$ |
| | | 20 | 0–100 | $-0.0_21233$ | $-0.0_53529$ | $-0.0_75327$ |
| | | 25 | 0–100 | $-0.0_21171$ | $-0.0_5904$ | $-0.0_856$ |
| Acetonitrile | $C_2H_3N$ | 15 | 0– 16 | $-0.0_21175$ | $-0.0_42024$ | |
| Allyl alcohol | $C_3H_6O$ | 0 | 0– 89 | $-0.0_33729$ | $-0.0_41232$ | $+0.0_72984$ |
| Benzenepentacarboxylic acid | $C_{11}H_6O_{10}$ | 25 | 0– 0.6 | $+0.0_25615$ | $-0.0_2117$ | |
| Butyl alcohol (*n*-) | $C_4H_{10}O$ | 20 | 0– 7.9 | $-0.0_21651$ | $+0.0_4285$ | |
| Butyric acid (*n*-) | $C_4H_8O_2$ | 18 | 0– 10 | $+0.0_3414$ | $+0.0_4131$ | |
| | | 25 | 0– 62 | $+0.0_35135$ | $-0.0_4166$ | $+0.0_611$ |
| Chloral hydrate | $C_2H_3Cl_3O_2$ | 0 | 0– 70 | $+0.0_24489$ | $+0.0_42802$ | $-0.0_71291$ |
| | | 15 | 0– 78 | $+0.0_24455$ | $+0.0_42198$ | $+0.0_74366$ |
| | | 30 | 0– 90 | $+0.0_24401$ | $+0.0_41887$ | $+0.0_76549$ |
| Chloroacetic acid | $C_2H_3ClO_2$ | 20 | 0– 32 | $+0.0_33648$ | $+0.0_5302$ | |
| | | 25 | 0– 86 | $+0.0_33602$ | $+0.0_5552$ | $+0.0_722$ |
| Citric acid (hydrate) | $C_6H_3O_7 + H_2O$ | 18 | 0– 50 | $+0.0_33824$ | $+0.0_41141$ | $+0.0_717$ |
| Dichloroacetic acid | $C_2H_2Cl_2O_2$ | 20 | 0– 30 | $+0.0_24427$ | $+0.0_5537$ | $+0.0_77534$ |
| | | 25 | 0– 97 | $+0.0_24427$ | $+0.0_5537$ | $+0.0_77534$ |
| Diethylamine hydrochloride | $C_4H_{12}ClN$ | 21 | 0– 36 | $+0.0_334$ | $+0.0_676$ | |
| Ethylamine hydrochloride | $C_2H_8ClN$ | 21 | 0– 65 | $+0.0_21193$ | $-0.0_5307$ | $-0.0_747$ |
| Ethylene glycol | $C_2H_6O_2$ | 0 | 0–100 | $+0.0_21483$ | $+0.0_52992$ | $-0.0_75248$ |
| | | 15 | 0– 6 | $+0.0_2133$ | $-0.0_5108$ | |
| Ethyl ether | $C_4H_{10}O$ | 20 | 0– 5 | $-0.0_2221$ | $+0.0_448$ | |
| | | 25 | 0– 4.5 | $-0.0_2221$ | $+0.0_435$ | |
| tartrate | $C_8H_{14}O_6$ | 15 | 0– 95 | $+0.0_32367$ | $+0.0_5358$ | $-0.0_76005$ |
| Formaldehyde | $CH_2O$ | 15 | 0– 40 | $+0.0_32518$ | $-0.0_5658$ | $+0.0_6542$ |
| Formamide | $CH_3NO$ | 25 | 22– 96 | $+0.0_21217$ | $+0.0_53199$ | $-0.0_72529$ |
| Furfural | $C_5H_4O_2$ | 20 | 0– 8 | $+0.0_21827$ | $+0.0_5366$ | |
| | | 25 | 0– 8 | $+0.0_21664$ | $+0.0_421$ | |
| Isoamyl alcohol | $C_5H_{12}O$ | 20 | 0– 2.5 | $+0.0_2155$ | $+0.0_43$ | |
| Isobutyl alcohol | $C_4H_{10}O$ | 15 | 0– 8 | $-0.0_2146$ | $+0.0_56$ | |
| | | 20 | 0– 8 | $-0.0_2169$ | $+0.0_438$ | |
| Isobutyric acid | $C_4H_8O_2$ | 15 | 0– 9 | $+0.0_352$ | | |
| | | 18 | 0– 9 | $+0.0_345$ | | |
| | | 25 | 0– 12 | $+0.0_337$ | | |
| Isovaleric acid | $C_5H_{10}O_2$ | 25 | 0– 5 | $+0.0_3253$ | $-0.0_4282$ | |
| Lactic acid | $C_3H_6O$ | 25 | 0– 9 | $+0.0_2231$ | $+0.0_5186$ | |
| Maleic acid | $C_4H_4O_4$ | 25 | 0– 40 | $+0.0_234$ | $+0.0_5575$ | |
| Malic acid | $C_4H_6O_5$ | 20 | 0– 40 | $+0.0_33933$ | $+0.0_5957$ | |
| | | 25 | 0– 40 | $+0.0_33736$ | $+0.0_4175$ | |
| Malonic acid | $C_3H_4O_4$ | 20 | 0– 40 | $+0.0_3389$ | $+0.0_41066$ | |
| Methyl acetate | $C_3H_6O_2$ | 20 | 0– 20 | $+0.0_340$ | $-0.0_574$ | |
| glucoside (α-) | $C_7H_{14}O_6$ | 0 | 26– 51 | $+0.0_33336$ | $+0.0_5996$ | $+0.01544$ |
| | | 30 | 26– 51 | $+0.0_33151$ | $+0.0_5975$ | $+0.0_8978$ |
| Nicotine | $C_{10}H_{14}N_2$ | 20 | 0– 60 | $+0.0_5642$ | $+0.0_5454$ | $-0.0_7687$ |
| Nitrophenol (*p*-) | $C_6H_5NO_3$ | 15 | 0– 1.5 | $+0.0_33216$ | $-0.0_455$ | |
| Oxalic acid | $C_2H_2O_4$ | 0 | 0– 4 | $+0.0_35898$ | $-0.0_53185$ | $+0.0_441$ |
| | | 15 | 0– 4 | $+0.0_2494$ | $-0.0_58$ | |
| | | 17.5 | 0– 9 | $+0.0_2494$ | $-0.0_58$ | |
| | | 20 | 0– 4 | $+0.0_25264$ | $-0.0_31996$ | $+0.0_4254$ |
| | | 25 | 0– 4 | $+0.0_25108$ | $-0.0_31607$ | $+0.0_4208$ |
| Phenol | $C_6H_6O$ | 15 | 0– 5 | $+0.0_2111$ | $-0.0_4283$ | |
| | | 80 | 0– 65 | $+0.0_3462$ | $-0.0_686$ | |
| Phenylglycolic acid | $C_8H_8O_3$ | 25 | 0– 11 | $+0.0_2207$ | $+0.0_423$ | |
| Picoline (α-) | $C_6H_7N$ | 25 | 0– 70 | $-0.0_4386$ | $-0.0_51405$ | $-0.0_74167$ |
| (β-) | $C_6H_7N$ | 25 | 0– 60 | $-0.0_4683$ | $-0.0_513$ | |
| Propionic acid | $C_3H_6O_2$ | 18 | 0– 10 | $+0.0_395$ | $-0.0_4172$ | |
| | | 25 | 0– 40 | $+0.0_39245$ | $-0.0_599$ | $+0.0_7361$ |
| Pyridine | $C_5H_5N$ | 25 | 0– 60 | $+0.0_3229$ | $-0.0_5204$ | $-0.0_828$ |
| Resorcinol | $C_6H_6O_2$ | 18 | 0– 52 | $+0.0_2201$ | $+0.0_5519$ | $-0.0_819$ |
| Succinic acid | $C_4H_6O_4$ | 25 | 0– 5.5 | $+0.0_3304$ | | |
| Tartaric acid (*d*, *l*, or *dl*) | $C_4H_6O_6$ | 15 | 0– 15 | $+0.0_24482$ | $+0.0_4185$ | |
| | | 17.5 | 0– 50 | $+0.0_24455$ | $+0.0_4185$ | |
| | | 20 | 0– 50 | $+0.0_24432$ | $+0.0_41837$ | |
| | | 30 | 0– 50 | $+0.0_24335$ | $+0.0_4185$ | |
| | | 40 | 0– 50 | $+0.0_24265$ | $+0.0_4185$ | |
| | | 50 | 0– 50 | $+0.0_24205$ | $+0.0_4185$ | |
| | | 60 | 0– 50 | $+0.0_24155$ | $+0.0_4185$ | |

*From "International Critical Tables," vol. 3, pp. 111–114.

**TABLE 2-117 Densities of Aqueous Solutions of Miscellaneous Organic Compounds** (*Concluded*)

Section A $d = d_w + Ap_s + Bp_s^2 + Cp_s^3$ (*Cont.*)

| Name | Formula | $t$, °C | Range, $p_s$ | $A$ | $B$ | $C$ |
|---|---|---|---|---|---|---|
| Tetraethyl ammonium chloride | $C_8H_{20}ClN$ | 21 | 0– 63 | $+0.0_31884$ | $+0.0_56$ | $+0.0_7122$ |
| Thiourea | $CH_4N_2S$ | 15 | 0– 7 | $+0.0_32995$ | $+0.0_5374$ | |
| Trichloroacetic acid | $C_2HCl_3O_2$ | 12.5 | 0– 61 | $+0.0_2499$ | $+0.0_41153$ | |
| | | 20 | 10– 30 | $+0.0_25053$ | $+0.0_41387$ | |
| | | 25 | 0– 94 | $+0.0_25051$ | $+0.0_56119$ | $+0.0_61038$ |
| Triethylamine hydrochloride | $C_6H_{16}ClN$ | 21 | 0– 54 | $+0.0_46$ | $+0.0_5558$ | $-0.0_869$ |
| Trimethyl carbinol | $C_4H_{10}O$ | 20 | 0–100 | $-0.0_2117$ | $-0.0_41908$ | $+0.0_7957$ |
| | | 25 | 0–100 | $-0.0_21286$ | $-0.0_4176$ | $+0.0_7887$ |
| Urea | $CH_4N_2O$ | 14.8 | 0– 12 | $+0.0_23213$ | $-0.0_44802$ | $+0.0_51216$ |
| | | 18 | 0– 51 | $+0.0_22718$ | $+0.0_51552$ | $+0.0_72573$ |
| | | 20 | 0– 35 | $+0.0_22702$ | $+0.0_53712$ | $-0.0_72285$ |
| | | 25 | 0– 10 | $+0.0_32728$ | $-0.0_41817$ | $+0.0_51379$ |
| Urethane | $C_3H_7NO_2$ | 20 | 0– 56 | $+0.0_21278$ | $-0.0_5245$ | $-0.0_73437$ |
| Valeric acid (*n*-) | $C_5H_{10}O_2$ | 25 | 0– 3 | $+0.0_334$ | $-0.0_427$ | |

Section B $d = d_s + Ap_w + Bp_w^2 + Cp_w^3$

| Name | Formula | $d_s$ | $t$, °C | Range, $p_w$ | $A$ | $B$ | $C$ |
|---|---|---|---|---|---|---|---|
| Butyl alcohol (*n*-) | $C_4H_{10}O$ | 0.8097 | 20 | 0–20 | $+0.0_32103$ | $-0.0_41113$ | |
| Butyric acid (*n*-) | $C_4H_8O_2$ | 0.9534 | 25 | 0–38 | $+0.0_21854$ | $-0.0_42314$ | |
| Ethyl ether | $C_4H_{10}O$ | 0.7077 | 25 | 0– 1.1 | $+0.0_534$ | $+0.0_336$ | |
| Isobutyl alcohol | $C_4H_{10}O$ | 0.8170 | 0 | 0–14 | $+0.0_32437$ | $-0.0_4285$ | |
| | | 0.8055 | 15 | 0–16 | $+0.0_5224$ | $-0.0_4129$ | |
| Isobutyric acid | $C_4H_8O_2$ | 0.9425 | 26 | 0–80 | $+0.0_21808$ | $-0.0_42358$ | $+0.0_61253$ |
| Nicotine | $C_{10}H_{14}N_2$ | 1.0093 | 20 | 0–40 | $+0.0_5199$ | $-0.0_4331$ | $+0.0_7315$ |
| Picoline (α-) | $C_6H_7N$ | 0.9404 | 25 | 0–30 | $+0.0_52715$ | $-0.0_4393$ | |
| (β-) | $C_6H_7N$ | 0.9515 | 25 | 0–40 | $+0.0_21925$ | $-0.0_4352$ | $+0.0_625$ |
| Pyridine | $C_5H_5N$ | 0.9776 | 25 | 0–40 | $+0.0_51157$ | $-0.0_5536$ | $-0.0_62$ |
| Trimethyl carbinol | $C_4H_{10}O$ | 0.7856 | 20 | 0–20 | $+0.0_52287$ | $+0.0_5275$ | |

Section C $d_t = d_o + At + Bt^2$

| Name | Formula | $p_s$ | $d_o$ | Range, °C | $A$ | $B$ |
|---|---|---|---|---|---|---|
| Allyl alcohol | $C_3H_6O$ | 76.60 | 0.9122 | 0–45 | $-0.0_38$ | $-0.0_527$ |
| Butyl alcohol (*n*-) | $C_4H_{10}O$ | 80.95 | 0.8614 | 0–43 | $-0.0_37292$ | $-0.0_675$ |
| Chloral hydrate | $C_2H_3Cl_3O_2$ | 2.00 | 1.0094 | 7–80 | $-0.0_42597$ | $-0.0_54313$ |
| | | 10.00 | 1.0476 | 7–80 | $-0.0_47955$ | $-0.0_54253$ |
| Ethyl tartrate | $C_7H_{14}O_6$ | 5.00 | 1.0150 | 15–80 | $-0.0_32103$ | $-0.0_52544$ |
| | | 10.00 | 1.0270 | 15–80 | $-0.0_32116$ | $-0.0_62929$ |
| | | 25.00 | 1.0665 | 15–80 | $-0.0_3401$ | $-0.0_523$ |
| Furfural | $C_5H_4O_2$ | 4.62 | 1.0125 | 22–74 | $-0.0_3232$ | $-0.0_5254$ |
| | | 5.69 | 1.0140 | 22–74 | $-0.0_3221$ | $-0.0_5268$ |
| | | 6.56 | 1.0155 | 22–74 | $-0.0_3211$ | $-0.0_5290$ |
| Pyridine | $C_5H_5N$ | 9.34 | 1.0055 | 11–73 | $-0.0_3171$ | $-0.0_53615$ |
| | | 21.20 | 1.0115 | 14–73 | $-0.0_3378$ | $-0.0_5248$ |
| | | 29.50 | 1.0145 | 12–72 | $-0.0_3463$ | $-0.0_5235$ |
| | | 40.40 | 1.0182 | 9–74 | $-0.0_3605$ | $-0.0_5167$ |

# DENSITIES OF MISCELLANEOUS MATERIALS

## TABLE 2-118 Approximate Specific Gravities and Densities of Miscellaneous Solids and Liquids*

Water at 4°C and normal atmospheric pressure taken as unity. For more detailed data on any material, see the section dealing with the properties of that material.

| Substance | Sp. gr. | Aver. weight lb/ft³ |
|---|---|---|
| **Metals, Alloys, Ores** | | |
| Aluminum, cast-hammered | 2.55–2.80 | 165 |
| bronze | 7.7 | 481 |
| Brass, cast-rolled | 8.4–8.7 | 534 |
| Bronze, 7.9 to 14% Sn | 7.4–8.9 | 509 |
| phosphor | 8.88 | 554 |
| Copper, cast-rolled | 8.8–8.95 | 556 |
| ore, pyrites | 4.1–4.3 | 262 |
| German silver | 8.58 | 536 |
| Gold, cast-hammered | 19.25–19.35 | 1205 |
| coin (U.S.) | 17.18–17.2 | 1073 |
| Iridium | 21.78–22.42 | 1383 |
| Iron, gray cast | 7.03–7.13 | 442 |
| cast, pig | 7.2 | 450 |
| wrought | 7.6–7.9 | 485 |
| spiegeleisen | 7.5 | 468 |
| ferro-silicon | 6.7–7.3 | 437 |
| ore, hematite | 5.2 | 325 |
| ore, limonite | 3.6–4.0 | 237 |
| ore, magnetite | 4.9–5.2 | 315 |
| slag | 2.5–3.0 | 172 |
| Lead | 11.34 | 710 |
| ore, galena | 7.3–7.6 | 465 |
| Manganese | 7.42 | 475 |
| ore, pyrolusite | 3.7–4.6 | 259 |
| Mercury | 13.6 | 849 |
| Monel metal, rolled | 8.97 | 555 |
| Nickel | 8.9 | 537 |
| Platinum, cast-hammered | 21.5 | 1330 |
| Silver, cast-hammered | 10.4–10.6 | 656 |
| Steel, cold-drawn | 7.83 | 489 |
| machine | 7.80 | 487 |
| tool | 7.70–7.73 | 481 |
| Tin, cast-hammered | 7.2–7.5 | 459 |
| cassiterite | 6.4–7.0 | 418 |
| Tungsten | 19.22 | 1200 |
| Zinc, cast-rolled | 6.9–7.2 | 440 |
| blende | 3.9–4.2 | 253 |
| **Various Solids** | | |
| Cereals, oats, bulk | 0.51 | 26 |
| barley, bulk | 0.62 | 39 |
| corn, rye, bulk | 0.73 | 45 |
| wheat, bulk | 0.77 | 48 |
| Cork | 0.22–0.26 | 15 |
| Cotton, flax, hemp | 1.47–1.50 | 93 |
| Fats | 0.90–0.97 | 58 |
| Flour, loose | 0.40–0.50 | 28 |
| pressed | 0.70–0.80 | 47 |
| Glass, common | 2.40–2.80 | 162 |
| plate or crown | 2.45–2.72 | 161 |
| crystal | 2.90–3.00 | 184 |
| dint | 3.2–4.7 | 247 |
| Hay and straw, bales | 0.32 | 20 |
| Leather | 0.86–1.02 | 59 |
| Paper | 0.70–1.15 | 58 |
| Potatoes, piled | 0.67 | 44 |
| Rubber, caoutchouc | 0.92–0.96 | 59 |
| goods | 1.0–2.0 | 94 |
| Salt, granulated, piled | 0.77 | 48 |
| Saltpeter | 1.07 | 67 |
| Starch | 1.53 | 96 |
| Sulfur | 1.93–2.07 | 125 |
| Wool | 1.32 | 82 |

| Substance | Sp. gr. | Aver. weight lb/ft³ |
|---|---|---|
| **Timber, Air-dry** | | |
| Apple | 0.66–0.74 | 44 |
| Ash, black | 0.55 | 34 |
| white | 0.64–0.71 | 42 |
| Birch, sweet, yellow | 0.71–0.72 | 44 |
| Cedar, white, red | 0.35 | 22 |
| Cherry, wild red | 0.43 | 27 |
| Chestnut | 0.48 | 30 |
| Cypress | 0.45–0.48 | 29 |
| Elm, white | 0.56 | 35 |
| Fir, Douglas | 0.48–0.55 | 32 |
| balsam | 0.40 | 25 |
| Hemlock | 0.45–0.50 | 29 |
| Hickory | 0.74–0.80 | 48 |
| Locust | 0.67–0.77 | 45 |
| Mahogany | 0.56–0.85 | 44 |
| Maple, sugar | 0.68 | 43 |
| white | 0.53 | 33 |
| Oak, chestnut | 0.74 | 46 |
| live | 0.87 | 54 |
| red, black | 0.64–0.71 | 42 |
| white | 0.77 | 48 |
| Pine, Norway | 0.55 | 34 |
| Oregon | 0.51 | 32 |
| red | 0.48 | 30 |
| Southern | 0.61–0.67 | 38–42 |
| white | 0.43 | 27 |
| Poplar | 0.43 | 27 |
| Redwood, California | 0.42 | 26 |
| Spruce, white, red | 0.45 | 28 |
| Teak, African | 0.99 | 62 |
| Indian | 0.66–0.88 | 48 |
| Walnut, black | 0.59 | 37 |
| Willow | 0.42–0.50 | 28 |
| **Various Liquids** | | |
| Alcohol, ethyl (100%) | 0.789 | 49 |
| methyl (100%) | 0.796 | 50 |
| Acid, muriatic, 40% | 1.20 | 75 |
| nitric, 91% | 1.50 | 94 |
| sulfuric, 87% | 1.80 | 112 |
| Chloroform | 1.500 | 95 |
| Ether | 0.736 | 46 |
| Lye, soda, 66% | 1.70 | 106 |
| Oils, vegetable | 0.91–0.94 | 58 |
| mineral, lubricants | 0.88–0.94 | 57 |
| Turpentine | 0.861–0.867 | 54 |
| Water, 4°C max. density | 1.0 | 62.428 |
| 100°C | 0.9584 | 59.830 |
| ice | 0.88–0.92 | 56 |
| snow, fresh fallen | 0.125 | 8 |
| sea water | 1.02–1.03 | 64 |
| **Ashlar Masonry** | | |
| Bluestone | 2.3–2.6 | 153 |
| Granite, syenite, gneiss | 2.4–2.7 | 159 |
| Limestone | 2.1–2.8 | 153 |
| Marble | 2.4–2.8 | 162 |
| Sandstone | 2.0–2.6 | 143 |
| **Rubble Masonry** | | |
| Bluestone | 2.2–2.5 | 147 |
| Granite, syenite, gneiss | 2.3–2.6 | 153 |
| Limestone | 2.0–2.7 | 147 |
| Marble | 2.3–2.7 | 156 |
| Sandstone | 1.9–2.5 | 137 |

| Substance | Sp. gr. | Aver. weight lb/ft³ |
|---|---|---|
| **Dry Rubble Masonry** | | |
| Granite, syenite, gneiss | 1.9–2.3 | 130 |
| Limestone, marble | 1.9–2.1 | 125 |
| Sandstone, bluestone | 1.8–1.9 | 110 |
| **Brick Masonry** | | |
| Hard brick | 1.8–2.3 | 128 |
| Medium brick | 1.6–2.0 | 112 |
| Soft brick | 1.4–1.9 | 103 |
| Sand-lime brick | 1.4–2.2 | 112 |
| **Concrete Masonry** | | |
| Cement, stone, sand | 2.2–2.4 | 144 |
| slag, etc. | 1.9–2.3 | 130 |
| cinder, etc. | 1.5–1.7 | 100 |
| **Various Building Materials** | | |
| Ashes, cinders | 0.64–0.72 | 40–45 |
| Cement, Portland, loose | 1.5 | 94 |
| Lime, gypsum, loose | 0.85–1.00 | 53–64 |
| Mortar, lime, set | 1.4–1.9 | 103 |
| Portland cement | 2.08–2.25 | 94–135 |
| Portland cement | 3.1–3.2 | 196 |
| Slags, bank slag | 1.1–1.2 | 67–72 |
| bank screenings | 1.5–1.9 | 98–117 |
| machine slag | 1.5 | 96 |
| slag sand | 0.8–0.9 | 49–55 |
| **Earth, etc., Excavated** | | |
| Clay, dry | 1.0 | 63 |
| damp plastic | 1.76 | 110 |
| and gravel, dry | 1.6 | 100 |
| Earth, dry, loose | 1.2 | 76 |
| dry, packed | 1.5 | 95 |
| moist, loose | 1.3 | 78 |
| moist, packed | 1.6 | 96 |
| mud, flowing | 1.7 | 108 |
| mud, packed | 1.8 | 115 |
| Riprap, limestone | 1.3–1.4 | 80–85 |
| Riprap, sandstone | 1.4 | 90 |
| Riprap, shale | 1.7 | 105 |
| Sand, gravel, dry, loose | 1.4–1.7 | 90–105 |
| gravel, dry, packed | 1.6–1.9 | 100–120 |
| gravel, wet | 1.89–2.16 | 126 |
| **Excavations in Water** | | |
| Clay | 1.28 | 80 |
| River mud | 1.44 | 90 |
| Sand or gravel | 0.96 | 60 |
| and clay | 1.00 | 65 |
| Soil | 1.12 | 70 |
| Stone riprap | 1.00 | 65 |
| **Minerals** | | |
| Asbestos | 2.1–2.8 | 153 |
| Barytes | 4.50 | 281 |
| Basalt | 2.7–3.2 | 184 |
| Bauxite | 2.55 | 159 |
| Bluestone | 2.5–2.6 | 159 |
| Borax | 1.7–1.8 | 109 |
| Chalk | 1.8–2.8 | 143 |
| Clay, marl | 1.8–2.6 | 137 |
| Dolomite | 2.9 | 181 |
| Feldspar, orthoclase | 2.5–2.7 | 162 |
| Gneiss | 2.7–2.9 | 175 |
| Granite | 2.6–2.7 | 165 |
| Greenstone, trap | 2.8–3.2 | 187 |
| Gypsum, alabaster | 2.3–2.8 | 159 |
| Hornblende | 3.0 | 187 |
| Limestone | 2.1–2.86 | 155 |
| Marble | 2.6–2.86 | 170 |
| Magnesite | 3.0 | 187 |
| Phosphate rock, apatite | 3.2 | 200 |
| Porphyry | 2.6–2.9 | 172 |

*From Marks, *Mechanical Engineers' Handbook,* McGraw-Hill.

**TABLE 2-118 Approximate Specific Gravities and Densities of Miscellaneous Solids and Liquids** (*Concluded*)

Water at 4°C and normal atmospheric pressure taken as unity. For more detailed data on any material, see the section dealing with the properties of that material.

| Substance | Sp. gr. | Aver. weight lb/ft³ | Substance | Sp. gr. | Aver. weight lb/ft³ | Substance | Sp. gr. | Aver. weight lb/ft³ |
|---|---|---|---|---|---|---|---|---|
| Minerals (*Cont.*) | | | Bituminous Substances | | | Bituminous Substances (*Cont.*) | | |
| Pumice, natural | 0.37–0.90 | 40 | Asphaltum | 1.1–1.5 | 81 | Petroleum | 0.87 | 54 |
| Quartz, flint | 2.5–2.8 | 165 | Coal, anthracite | 1.4–1.8 | 97 | refined (kerosene) | 0.78–0.82 | 50 |
| Sandstone | 2.0–2.6 | 143 | bituminous | 1.2–1.5 | 84 | benzine | 0.73–0.75 | 46 |
| Serpentine | 2.7–2.8 | 171 | lignite | 1.1–1.4 | 78 | gasoline | 0.70–0.75 | 45 |
| Shale, slate | 2.6–2.9 | 172 | peat, turf, dry | 0.65–0.85 | 47 | Pitch | 1.07–1.15 | 69 |
| | | | | | | Tar, bituminous | 1.20 | 75 |
| Soapstone, talc | 2.6–2.8 | 169 | charcoal, pine | 0.28–0.44 | 23 | | | |
| Syenite | 2.6–2.7 | 165 | charcoal, oak | 0.47–0.57 | 33 | Coal and Coke, Piled | | |
| | | | coke | 1.0–1.4 | 75 | Coal, anthracite | 0.75–0.93 | 47–58 |
| Stone, Quarried, Piled | | | Graphite | 1.64–2.7 | 135 | bituminous, lignite | 0.64–0.87 | 40–54 |
| Basalt, granite, gneiss | 1.5 | 96 | Paraffin | 0.87–0.91 | 56 | peat, turf | 0.32–0.42 | 20–26 |
| Greenstone, hornblende | 1.7 | 107 | | | | charcoal | 0.16–0.23 | 10–14 |
| Limestone, marble, quartz | 1.5 | 95 | | | | coke | 0.37–0.51 | 23–32 |
| Sandstone | 1.3 | 82 | | | | | | |
| Shale | 1.5 | 92 | | | | | | |

NOTE: To convert pounds per cubic foot to kilograms per cubic meter, multiply by 16.02. °F = ⅘ °C + 32.

**TABLE 2-119 Density (kg/m³) of Selected Elements as a Function of Temperature**

| Temperature, K° | Element symbol | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Al | Be† | Cr | Cu | Au | Ir | Fe | Pb | Mo | Ni | Pt | Ag | Zn† |
| 50 | 2736 | 3650 | 7160 | 9019 | 19,490 | 22,600 | 7910 | 11,570 | 10,260 | 8960 | 21,570 | 10,620 | 7280 |
| 100 | 2732 | 3640 | 7155 | 9009 | 19,460 | 22,580 | 7900 | 11,520 | 10,260 | 8950 | 21,550 | 10,600 | 7260 |
| 150 | 2726 | 3630 | 7150 | 8992 | 19,420 | 22,560 | 7890 | 11,470 | 10,250 | 8940 | 21,530 | 10,575 | 7230 |
| 200 | 2719 | 3620 | 7145 | 8973 | 19,380 | 22,540 | 7880 | 11,430 | 10,250 | 8930 | 21,500 | 10,550 | 7200 |
| 250 | 2710 | 3610 | 7140 | 8951 | 19,340 | 22,520 | 7870 | 11,380 | 10,250 | 8910 | 21,470 | 10,520 | 7170 |
| 300 | 2701 | 3600 | 7135 | 8930 | 19,300 | 22,500 | 7860 | 11,330 | 10,240 | 8900 | 21,450 | 10,490 | 7135 |
| 400 | 2681 | 3580 | 7120 | 8885 | 19,210 | 22,450 | 7830 | 11,230 | 10,220 | 8860 | 21,380 | 10,430 | 7070 |
| 500 | 2661 | 3555 | 7110 | 8837 | 19,130 | 22,410 | 7800 | 11,130 | 10,210 | 8820 | 21,330 | 10,360 | 7000 |
| 600 | 2639 | 3530 | 7080 | 8787 | 19,040 | 22,360 | 7760 | 11,010 | 10,190 | 8780 | 21,270 | 10,300 | 6935 |
| 800 | 2591 | | 7040 | 8686 | 18,860 | 22,250 | 7690 | 10,430 | 10,160 | 8690 | 21,140 | 10,160 | 6430 |
| 1000 | 2365 | ____ | 7000 | 8568 | 18,660 | 22,140 | 7650 | 10,190 | 10,120 | 8610 | 21,010 | 10,010 | 6260 |
| 1200 | 2305 | | 6945 | 8458 | 18,440 | 22,030 | 7620 | 9,940 | 10,080 | 8510 | 20,870 | 9,850 | |
| 1400 | 2255 | | 6890 | 7920 | 17,230 | 21,920 | 7520 | | 10,040 | 8410 | 20,720 | 9,170 | |
| 1600 | | | 6760 | 7750 | 16,950 | 21,790 | 7420 | | 10,000 | 8320 | 20,570 | 8,980 | |
| 1800 | | | 6700 | 7600 | | 21,660 | 7320 | | 9,950 | 7690 | 20,400 | | |
| 2000 | | | | 7460 | | 21,510 | 7030 | | 9,900 | 7450 | 20,220 | | |

NOTE: Above the horizontal line the condensed phase is solid; below the line, it is liquid.
°°R = ⅘ K.
†Polycrystalline form tabulated. Similar tables for an additional 45 elements appear in the *Handbook of Heat Transfer*, 2d ed., McGraw-Hill, New York, 1984.

# SOLUBILITIES

## UNITS CONVERSIONS

For this subsection, the following units conversions are applicable:

$$°F = \tfrac{9}{5}\,°C + 32.$$

To convert cubic centimeters to cubic feet, multiply by $3.532 \times 10^{-5}$.

To convert millimeters of mercury to pounds-force per square inch, multiply by 0.01934.

To convert grams per liter to pounds per cubic foot, multiply by $6.243 \times 10^{-2}$.

## TABLE 2-120 Solubilities of Inorganic Compounds in Water at Various Temperatures*

This table shows the amount of anhydrous substance that is soluble in 100 g of water at the temperature in degrees Celsius as indicated; when the name is followed by †, the value is expressed in grams of substance in 100 $cm^3$ of saturated solution. Solid phase gives the hydrated form in equilibrium with the saturated solution.

| | Substance | Formula | Solid phase | 0°C | 10°C | 20°C | 30°C | 40°C | 50°C | 60°C | 70°C | 80°C | 90°C | 100°C | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Aluminum chloride | $AlCl_3$ | $6H_2O$ | | | 69.86[15°] | | | | | | | | | 1 |
| 2 | sulfate | $Al_2(SO_4)_3$ | $18H_2O$ | 31.2 | 33.5 | 36.4 | 40.4 | 46.1 | 52.2 | 59.2 | 66.1 | 73.0 | 80.8 | 89.0 | 2 |
| 3 | Ammonium aluminum sulfate | $(NH_4)_2Al_2(SO_4)_4$ | $24H_2O$ | 2.1 | 4.99 | 7.74 | 10.94 | 14.88 | 20.10 | 26.70 | | | | 109.7[96°] | 3 |
| 4 | bicarbonate | $NH_4HCO_3$ | | 11.9 | 15.8 | 21 | 27 | | | | | | | | 4 |
| 5 | bromide | $NH_4Br$ | | 60.6 | 68 | 75.5 | 83.2 | 91.1 | 99.2 | 107.8 | 116.8 | 126 | 135.6 | 145.6 | 5 |
| 6 | chloride | $NH_4Cl$ | | 29.4 | 33.3 | 37.2 | 41.4 | 45.8 | 50.4 | 55.2 | 60.2 | 65.6 | 71.3 | 77.3 | 6 |
| 7 | chloroplatinate | $(NH_4)_2PtCl_6$ | | | 0.7 | | | | | | | | | 1.25 | 7 |
| 8 | chromate | $(NH_4)_2CrO_4$ | | | | | 40.4 | | | | | | | | 8 |
| 9 | chromium sulfate | $(NH_4)_2Cr_2(SO_4)_4$ | $24H_2O$ | | | 10.78[25°] | | | | | | | | | 9 |
| 10 | dichromate | $(NH_4)_2Cr_2O_7$ | | | | | 47.17 | | | | | | | | 10 |
| 11 | dihydrogen phosphite | $NH_4H_2PO_3$ | | 171 | | 190[14.5°] | 260[31°] | | | | | | | | 11 |
| 12 | hydrogen phosphate | $(NH_4)_2HPO_4$ | | | | 131[15] | | | | | | | | | 12 |
| 13 | iodide | $NH_4I$ | | 154.2 | 163.2 | 172.3 | 181.4 | 190.5 | 199.6 | 208.9 | 218.7 | 228.8 | | 250.3 | 13 |
| 14 | magnesium phosphate | $NH_4MgPO_4$ | $6H_2O$ | 0.023 | | 0.052 | | 0.036 | 0.030 | 0.040 | 0.016 | 0.019 | | | 14 |
| 15 | manganese phosphate | $NH_4MnPO_4$ | $7H_2O$ | | | 0 | | 0 | | 0 | 0.005 | 0.007 | | | 15 |
| 16 | nitrate | $NH_4NO_3$ | | 118.3 | | 192 | 241.8 | 297.0 | 344.0 | 421.0 | 499.0 | 580.0 | 740.0 | 871.0 | 16 |
| 17 | oxalate | $(NH_4)_2C_2O_4$ | $1H_2O$ | 2.2 | 3.1 | 4.4 | 5.9 | 8.0 | 10.3 | | | | | | 17 |
| 18 | perchlorate† | $NH_4ClO_4$† | | 11.56 | | 20.85 | | 30.58 | | 39.05 | | 48.19 | | 57.01 | 18 |
| 19 | persulfate | $(NH_4)_2S_2O_8$ | | 58.2 | | | | | | | | | | | 19 |
| 20 | sulfate | $(NH_4)_2SO_4$ | | 70.6 | 73.0 | 75.4 | 78.0 | 81.0 | | 88.0 | | 95.3 | | 103.3 | 20 |
| 21 | thiocyanate | $NH_4CNS$ | | 119.8 | 144 | 170 | 207.7 | | | | | | | | 21 |
| 22 | vanadate (meta) | $NH_4VO_3$ | | | | 0.48 | 0.84 | 1.32 | 1.78 | | 3.05 | | | | 22 |
| 23 | Antimonious fluoride | $SbF_3$ | | 384.7 | | 444.7 | 563.6 | | | | | | | | 23 |
| 24 | sulfide | $Sb_2S_3$ | | | | 0.000175[18°] | | | | | | | | | 24 |
| 25 | Arsenic oxide | $As_2O_5$ | | 59.5 | 62.1 | 65.8 | 69.5 | 71.2 | | 73.0 | | 75.1 | | 76.7 | 25 |
| 26 | Arsenious sulfide | $As_2S_3$ | | $5.17\times10^{-5}$ at 18° | | | | | | | | | | | 26 |
| 27 | Barium acetate | $Ba(C_2H_3O_2)_2$ | $3H_2O$ | 59 | 63 | 71 | | | | | | | | | 27 |
| 28 | acetate | $Ba(C_2H_3O_2)_2$ | $1H_2O$ | | | | 75 | 79 | 77 | 74 | 74 | | | 75 | 28 |
| 29 | carbonate | $BaCO_3$ | | | 0.0016[8°] | 0.0022[18°] | 0.0024 at 24.2° | | | | | | | | 29 |
| 30 | chlorate | $Ba(ClO_3)_2$ | $1H_2O$ | 20.34 | 26.95 | 33.80 | 41.70 | 49.61 | | 66.81 | | 84.84 | | 104.9 | 30 |
| 31 | chloride | $BaCl_2$ | $2H_2O$ | 31.6 | 33.3 | 35.7 | 38.2 | 40.7 | 43.6 | 46.4 | 49.4 | 52.4 | | 58.8 | 31 |
| 32 | chromate | $BaCrO_4$ | | 0.0002 | 0.00028 | 0.00037 | 0.00046 | | | | | | | | 32 |
| 33 | hydroxide | $Ba(OH)_2$ | $8H_2O$ | 1.67 | 2.48 | 3.89 | 5.59 | 8.22 | 13.12 | 20.94 | | 101.4 | | | 33 |
| 34 | iodide | $BaI_2$ | $6H_2O$ | 170.2 | 185.7 | 203.1 | 219.6 | | | | | | | | 34 |
| 35 | iodide | $BaI_2$ | $2H_2O$ | | | | | 231.9 | | 247.3 | | 261.0 | | 271.7 | 35 |
| 36 | nitrate | $Ba(NO_3)_2$ | | 5.0 | 7.0 | 9.2 | 11.6 | 14.2 | 17.1 | 20.3 | | 27.0 | | 34.2 | 36 |
| 37 | nitrite | $Ba(NO_2)_2$ | $1H_2O$ | | | 67.5 | | | | | | 205.8 | | 300 | 37 |
| 38 | oxalate | $BaC_2O_4$ | | | 0.0016[8°] | 0.0022[18°] | 0.0024 at 24.2° | | | | | | | | 38 |
| 39 | perchlorate | $Ba(ClO_4)_2$ | $3H_2O$ | 205.8 | | 289.1 | | 358.7 | 426.3 | | 495.2 | | 562.3 | | 39 |
| 40 | sulfate | $BaSO_4$ | | $1.15\times10^{-4}$ | $2.0\times10^{-4}$ | $2.4\times10^{-4}$ | $2.85\times10^{-4}$ | | | | | | | | 40 |
| 41 | Beryllium sulfate | $BeSO_4$ | $6H_2O$ | | | | 52 | | 60.67 | | | | | | 41 |
| 42 | sulfate | $BeSO_4$ | $4H_2O$ | | | | 43.78 | 46.74 | | | 62 | | 83 | 100 | 42 |
| 43 | sulfate | $BeSO_4$ | $2H_2O$ | | | | | | | | | 84.76 | 98 | 110 | 43 |
| 44 | Boric acid | $H_3BO_3$ | | 2.66 | 3.57 | 5.04 | 6.60 | 8.72 | 11.54 | 14.81 | 16.73 | 23.75 | 30.38 | 40.25 | 44 |
| 45 | Boron oxide | $B_2O_3$ | | 1.1 | 1.5 | 2.2 | | 4.0 | | 6.2 | | 9.5 | | 15.7 | 45 |
| 46 | Bromine | $Br_2$ | | 4.22 | 3.4 | 3.20 | 3.13 | | | | | | | | 46 |
| 47 | Cadmium chloride | $CdCl_2$ | $4H_2O$ | 97.59 | 125.1 | | | | | | | | | | 47 |
| 48 | chloride | $CdCl_2$ | $2½H_2O$ | 90.01 | | | 132.1 | | | | | | | | 48 |
| 49 | chloride | $CdCl_2$ | $1H_2O$ | | 135.1 | 134.5 | | 135.3 | | 136.5 | | 140.4 | | 147.0 | 49 |
| 50 | cyanide | $Cd(CN)_2$ | | | | 1.7[15°] | | | | | | | | | 50 |
| 51 | hydroxide | $Cd(OH)_2$ | | | | | $2.6\times10^{-4}$ at 25° | | | | | | | | 51 |
| 52 | sulfate | $CdSO_4$ | | 76.48 | 76.00 | 76.60 | | 78.54 | | 83.68 | | | 63.13 | 60.77 | 52 |
| 53 | Calcium acetate | $Ca(C_2H_3O_2)_2$ | $2H_2O$ | 37.4 | 36.0 | 34.7 | 33.8 | 33.2 | | 32.7 | | 33.5 | | | 53 |
| 54 | acetate | $Ca(C_2H_3O_2)_2$ | $1H_2O$ | | | | | | | | | | 31.1 | 29.7 | 54 |

*By N. A. Lange. Abridged from "Table of Solubilities of Inorganic Compounds in Water at Various Temperatures" in Lange, *Handbook of Chemistry,* 10th ed., McGraw-Hill, New York, 1961. For tables of the solubility of gases in water at various temperatures, Atack (*Handbook of Chemical Data*, Reinhold, New York, 1957) gives values at closer temperature intervals, usually 1 or 5°C, than are tabulated here. For materials marked by ‡, additional data are given in tables subsequent to this one. For the solubility of various hydrocarbons in water at high pressures see *J. Chem. Eng. Data,* **4,** 212 (1959).

**TABLE 2-120 Solubilities of Inorganic Compounds in Water at Various Temperatures** (*Continued*)

| | Substance | Formula | Solid phase | 0°C | 10°C | 20°C | 30°C | 40°C | 50°C | 60°C | 70°C | 80°C | 90°C | 100°C | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Calcium bicarbonate | $Ca(HCO_3)_2$ | | 16.15 | | 16.60 | | 17.05 | | 17.50 | | 17.95 | | 18.40 | 1 |
| 2 | chloride | $CaCl_2$ | $6H_2O$ | 59.5 | 65.0 | 74.5 | 102 | | | | | | | | 2 |
| 3 | chloride | $CaCl_2$ | $2H_2O$ | | | | | | | 136.8 | 141.7 | 147.0 | 152.7 | 159 | 3 |
| 4 | fluoride | $CaF_2$ | | | | $0.0016^{18o}$ | $0.0017^{26o}$ | | | | | | | | 4 |
| 5 | hydroxide | $Ca(OH)_2$ | | 0.185 | 0.176 | 0.165 | 0.153 | 0.141 | 0.128 | 0.116 | 0.106 | 0.094 | 0.085 | 0.077 | 5 |
| 6 | nitrate | $Ca(NO_3)_2$ | $4H_2O$ | 102.0 | 115.3 | 129.3 | 152.6 | 195.9 | | | | | | | 6 |
| 7 | nitrate | $Ca(NO_3)_2$ | $3H_2O$ | | | | | 237.5 | 281.5 | | | | | | 7 |
| 8 | nitrate | $Ca(NO_3)_2$ | | | | | | | | | | 358.7 | | 363.6 | 8 |
| 9 | nitrite | $Ca(NO_2)_2$ | $4H_2O$ | 62.07 | | 76.68 | | | | | | | | | 9 |
| 10 | nitrite | $Ca(NO_2)_2$ | $2H_2O$ | | | | | | | 132.6 | 151.9 | | 244.8 | | 10 |
| 11 | oxalate | $CaC_2O_4$ | | | $6.7 \times 10^{-4}$ at 13° | $6.8 \times 10^{-4}$ at 25° | $9.5 \times 10^{-4}$ at 50° | $14 \times 10^{-4}$ at 95° | | | | | | | 11 |
| 12 | sulfate | $CaSO_4$ | $2H_2O$ | 0.1759 | 0.1928 | | 0.2090 | 0.2097 | | 0.2047 | 0.1966 | | | 0.1619 | 12 |
| 13 | Carbon dioxide, 760 mm ‡ | $CO_2$ | | 0.3346 | 0.2318 | 0.1688 | 0.1257 | 0.0973 | 0.0761 | 0.0576 | | | | 0 | 13 |
| 14 | monoxide, 760 mm ‡ | CO | | 0.0044 | 0.0035 | 0.0028 | 0.0024 | 0.0021 | 0.0018 | 0.0015 | 0.0013 | 0.0010 | 0.0006 | 0 | 14 |
| 15 | Cesium chloride | CsCl | | 161.4 | 174.7 | 186.5 | 197.3 | 208.0 | 218.5 | 229.7 | 239.5 | 250.0 | 260.1 | 270.5 | 15 |
| 16 | nitrate | $CsNO_3$ | | 9.33 | 14.9 | 23.0 | 33.9 | 47.2 | 64.4 | 83.8 | 107.0 | 134.0 | 163.0 | 197.0 | 16 |
| 17 | sulfate | $Cs_2SO_4$ | | 167.1 | 173.1 | 178.7 | 184.1 | 189.9 | 194.9 | 199.9 | 205.0 | 210.3 | 214.9 | 220.3 | 17 |
| 18 | Chlorine, 760 mm ‡ | $Cl_2$ | | 1.46 | 0.980 | 0.716 | 0.562 | 0.451 | 0.386 | 0.324 | 0.274 | 0.219 | 0.125 | 0 | 18 |
| 19 | Chromic anhydride | $CrO_3$ | | 164.9 | | | | 174.0 | 182.1 | | | | 217.5 | 206.8 | 19 |
| 20 | Cuprio chloride | $CuCl_2$ | $2H_2O$ | 70.7 | 73.76 | 77.0 | 80.34 | 83.8 | 87.44 | 91.2 | | 99.2 | | 107.9 | 20 |
| 21 | nitrate | $Cu(NO_3)_2$ | $6H_2O$ | 81.8 | 95.28 | 125.1 | | | | | | | | | 21 |
| 22 | nitrate | $Cu(NO_3)_2$ | $3H_2O$ | | | | | 159.8 | | 178.8 | | 207.8 | | | 22 |
| 23 | sulfate | $CuSO_4$ | $5H_2O$ | 14.3 | 17.4 | 20.7 | 25 | 28.5 | 33.3 | 40 | | 55 | | 75.4 | 23 |
| 24 | sulfide | CuS | | | | $3.3 \times 10^{-5}$ at 18° | | | | | | | | | 24 |
| 25 | Cuprous chloride | CuCl | | | | $1.52^{25o}$ | | | | | | | | | 25 |
| 26 | Ferric chloride | $FeCl_3$ | | 74.4 | 81.9 | 91.8 | | | 315.1 | | | 525.8 | | 535.7 | 26 |
| 27 | Ferrous chloride | $FeCl_2$ | $4H_2O$ | | 64.5 | | 73.0 | 77.3 | 82.5 | 88.7 | | 100 | | | 27 |
| 28 | chloride | $FeCl_2$ | | | | | | | | | | | 105.3 | 105.8 | 28 |
| 29 | nitrate | $Fe(NO_3)_2$ | $6H_2O$ | 71.02 | | 83.8 | | | | 165.6 | | | | | 29 |
| 30 | sulfate | $FeSO_4$ | $7H_2O$ | 15.65 | 20.51 | 26.5 | 32.9 | 40.2 | 48.6 | | | | | | 30 |
| 31 | sulfate | $FeSO_4$ | $1H_2O$ | | | | | | | | 50.9 | 43.6 | 37.3 | | 31 |
| 32 | Hydrobromic acid, 760 mm | HBr | | 221.2 | 210.3 | 198 | | | 171.5 | | | | | 130 | 32 |
| 33 | Hydrochloric acid, 760 mm | HCl | | 82.3 | | | 67.3 | 63.3 | 59.6 | 56.1 | | | | | 33 |
| 34 | Iodine | $I_2$ | | | | 0.029 | 0.04 | 0.056 | 0.078 | | | | | | 34 |
| 35 | Lead acetate | $Pb(C_2H_3O_2)_2$ | $3H_2O$ | | | | $55.04^{25o}$ | | | | | | | | 35 |
| 36 | bromide | $PbBr_2$ | | 0.4554 | | 0.85 | 1.15 | 1.53 | 1.94 | 2.36 | | 3.34 | | 4.75 | 36 |
| 37 | carbonate | $PbCO_3$ | | | | 0.00011 | | | | | | | | | 37 |
| 38 | chloride | $PbCl_2$ | | 0.6728 | | 0.99 | 1.20 | 1.45 | 1.70 | 1.98 | | 2.62 | | 3.34 | 38 |
| 39 | chromate | $PbCrO_4$ | | | | $7 \times 10^{-6}$ | | | | | | | | | 39 |
| 40 | fluoride | $PbF_2$ | | | 0.060 | 0.064 | 0.068 | | | | | | | | 40 |
| 41 | nitrate | $Pb(NO_3)_2$ | | 38.8 | 48.3 | 56.5 | 66 | 75 | 85 | 95 | | 115 | | 38.8 | 41 |
| 42 | sulfate | $PbSO_4$ | | 0.0028 | 0.0035 | 0.0041 | 0.0049 | 0.0056 | | | | | | | 42 |
| 43 | Magnesium bromide | $MgBr_2$ | $6H_2O$ | 91.0 | 94.5 | 96.5 | 99.2 | 101.6 | 104.1 | 107.5 | | 113.7 | | 120.2 | 43 |
| 44 | chloride | $MgCl_2$ | $6H_2O$ | 52.8 | 53.5 | 54.5 | | 57.5 | | 61.0 | | 66.0 | | 73.0 | 44 |
| 45 | hydroxide | $Mg(OH)_2$ | | | | $0.0009^{18o}$ | | | | | | | | | 45 |
| 46 | nitrate | $Mg(NO_3)_2$ | $6H_2O$ | 66.55 | | | | 84.74 | | | | | 137.0 | | 46 |
| 47 | sulfate | $MgSO_4$ | $7H_2O$ | | 30.9 | 35.5 | 40.8 | 45.6 | | | | | | | 47 |
| 48 | sulfate | $MgSO_4$ | $6H_2O$ | 40.8 | 42.2 | 44.5 | 45.3 | | 50.4 | 53.5 | 59.5 | 64.2 | 69.0 | 74.0 | 48 |
| 49 | sulfate | $MgSO_4$ | $1H_2O$ | | | | | | | | | 62.9 | | 68.3 | 49 |
| 50 | Manganous sulfate | $MnSO_4$ | $7H_2O$ | 53.23 | 60.01 | | | | | | | | | | 50 |
| 51 | sulfate | $MnSO_4$ | $5H_2O$ | | 59.5 | 62.9 | 67.76 | | | | | | | | 51 |
| 52 | sulfate | $MnSO_4$ | $4H_2O$ | | | 64.5 | 66.44 | 68.8 | 72.6 | | | | | | 52 |
| 53 | sulfate | $MnSO_4$ | $1H_2O$ | | | | | | 58.17 | 55.0 | 52.0 | 48.0 | 42.5 | 34.0 | 53 |
| 54 | Mercurous chloride | HgCl | | 0.00014 | | 0.0002 | | 0.0007 | | | | | | | 54 |
| 55 | Molybdic oxide | $MoO_3$ | $2H_2O$ | | | 0.138 | 0.264 | 0.476 | 0.687 | 1.206 | 2.055 | 2.106 | | | 55 |
| 56 | Nickel chloride | $NiCl_2$ | $6H_2O$ | 53.9 | 59.5 | 64.2 | 68.9 | 73.3 | 78.3 | 82.2 | 85.2 | | | 87.6 | 56 |
| 57 | nitrate | $Ni(NO_3)_2$ | $6H_2O$ | 79.58 | | 96.31 | | 122.2 | | | | | | | 57 |
| 58 | nitrate | $Ni(NO_3)_2$ | $3H_2O$ | | | | | | | 163.1 | 169.1 | | 235.1 | | 58 |
| 59 | sulfate | $NiSO_4$ | $7H_2O$ | 27.22 | 32 | | 42.46 | | | | | | | | 59 |
| 60 | sulfate | $NiSO_4$ | $6H_2O$ | | | | | | 50.15 | 54.80 | 59.44 | 63.17 | | 76.7 | 60 |
| 61 | Nitric oxide, 760 mm | NO | | 0.00984 | 0.00757 | 0.00618 | 0.00517 | 0.00440 | 0.00376 | 0.00324 | 0.00267 | 0.00199 | 0.00114 | 0 | 61 |
| 62 | Nitrous oxide | $N_2O$ | | | 0.1705 | 0.1211 | | | | | | | | | 62 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Potassium acetate | $KC_2H_3O_2$ | $1\frac{1}{2}H_2O$ | 216.7 | 233.9 | 255.6 | 283.8 | 323.3 | | | | | | | 1 |
| 2 | acetate | $KC_2H_3O_2$ | $\frac{1}{2}H_2O$ | | | | | | 337.3 | 350 | 364.8 | 380.1 | 396.3 | | 2 |
| 3 | alum | $K_2SO_4{\cdot}Al_2(SO_4)_3$ | $24H_2O$ | 3.0 | 4.0 | 5.9 | 8.39 | 11.70 | 17.00 | 24.75 | 40.0 | 71.0 | 109.0 | | 3 |
| 4 | bicarbonate | $KHCO_3$ | | 22.4 | 27.7 | 33.2 | 39.1 | 45.4 | | 60.0 | | | | | 4 |
| 5 | bisulfate | $KHSO_4$ | | 36.3 | | 51.4 | | 67.3 | | | | | | 121.6 | 5 |
| 6 | bitartrate | $KHC_4H_4O_6$ | | 0.32 | 0.40 | 0.53 | 0.90 | 1.32 | 1.83 | 2.46 | | 4.6 | | 6.95 | 6 |
| 7 | carbonate | $K_2CO_3$ | $2H_2O$ | 105.5 | 108 | 110.5 | 113.7 | 116.9 | 121.2 | 126.8 | 133.1 | 139.8 | 147.5 | 155.7 | 7 |
| 8 | chlorate | $KClO_3$ | | 3.3 | 5 | 7.4 | 10.5 | 14 | 19.3 | 24.5 | | 38.5 | | 57 | 8 |
| 9 | chloride | KCl | | 27.6 | 31.0 | 34.0 | 37.0 | 40.0 | 42.6 | 45.5 | 48.3 | 51.1 | 54.0 | 56.7 | 9 |
| 10 | chromate | $K_2CrO_4$ | | 58.2 | 60.0 | 61.7 | 63.4 | 65.2 | 66.8 | 68.6 | 70.4 | 72.1 | 73.9 | 75.6 | 10 |
| 11 | dichromate | $K_2Cr_2O_7$ | | 5 | 7 | 12 | 20 | 26 | 34 | 43 | 52 | 61 | 70 | 80 | 11 |
| 12 | ferricyanide | $K_3Fe(CN)_6$ | | 31 | 36 | 43 | 50 | 60 | | 66 | | | | 82.6[104] | 12 |
| 13 | hydroxide | KOH | $2H_2O$ | 97 | 103 | 112 | 126 | | | | | | | | 13 |
| 14 | hydroxide | KOH | $1H_2O$ | | | | | | 140 | | | | | 178 | 14 |
| 15 | nitrate | $KNO_3$ | | 13.3 | 20.9 | 31.6 | 45.8 | 63.9 | 85.5 | 110.0 | 138 | 169 | 202 | 246 | 15 |
| 16 | nitrite | $KNO_2$ | | 278.8 | | 298.4 | | 334.9 | | | | | | 412.8 | 16 |
| 17 | perchlorate | $KClO_4$ | | 0.75 | 1.05 | 1.80 | 2.6 | 4.4 | 6.5 | 9 | 11.8 | 14.8 | 18 | 21.8 | 17 |
| 18 | permanganate | $KMnO_4$ | | 2.83 | 4.4 | 6.4 | 9.0 | 12.56 | 16.89 | 22.2 | | | | | 18 |
| 19 | persulfate† | $K_2S_2O_8$† | † | 1.62 | 2.60 | 4.49 | 7.19 | 9.89 | | | | | | | 19 |
| 20 | sulfate | $K_2SO_4$ | | 7.35 | 9.22 | 11.11 | 12.97 | 14.76 | 16.50 | 18.17 | 19.75 | 21.4 | 22.8 | 24.1 | 20 |
| 21 | thiocyanate | KCNS | | 177.0 | | 217.5 | | | | | | | | | 21 |
| 22 | Silver cyanide | AgCN | | | | $2.2 \times 10^{-5}$ | | | | | | | | | 22 |
| 23 | nitrate | $AgNO_3$ | | 122 | 170 | 222 | 300 | 376 | 455 | 525 | | 669 | | 952 | 23 |
| 24 | sulfate | $Ag_2SO_4$ | | 0.573 | 0.695 | 0.796 | 0.888 | 0.979 | 1.08 | 1.15 | 1.22 | 1.30 | 1.36 | 1.41 | 24 |
| 25 | Sodium acetate | $NaC_2H_3O_2$ | $3H_2O$ | 36.3 | 40.8 | 46.5 | 54.5 | 65.5 | 83 | 139 | | | | | 25 |
| 26 | acetate | $NaC_2H_3O_2$ | | 119 | 121 | 123.5 | 126 | 129.5 | 134 | 139.5 | 146 | 153 | 161 | 170 | 26 |
| 27 | bicarbonate | $NaHCO_3$ | | 6.9 | 8.15 | 9.6 | 11.1 | 12.7 | 14.45 | 16.4 | | | | | 27 |
| 28 | carbonate | $Na_2CO_3$ | $10H_2O$ | 7 | 12.5 | 21.5 | 38.8 | | | | | | | | 28 |
| 29 | carbonate | $Na_2CO_3$ | $1H_2O$ | | | | 50.5 | 48.5 | | 46.4 | | 45.8 | | 45.5 | 29 |
| 30 | chlorate | $NaClO_8$ | | 79 | 89 | 101 | 113 | 126 | 140 | 155 | 172 | 189 | | 230 | 30 |
| 31 | chloride | NaCl | | 35.7 | 35.8 | 36.0 | 36.3 | 36.6 | 37.0 | 37.3 | 37.8 | 38.4 | 39.0 | 39.8 | 31 |
| 32 | chromate | $Na_2CrO_4$ | $10H_2O$ | 31.70 | 50.17 | 88.7 | | | | | | | | | 32 |
| 33 | chromate | $Na_2CrO_4$ | $4H_2O$ | | | | 88.7 | 95.96 | 104 | 114.6 | | | | | 33 |
| 34 | chromate | $Na_2CrO_4$ | | | | | | | | | 123.0 | 124.8 | | 125.9 | 34 |
| 35 | dichromate | $Na_2Cr_2O_7$ | $2H_2O$ | 163.0 | | 177.8 | | | 244.8 | | 316.7 | 376.2 | | | 35 |
| 36 | dichromate | $Na_2Cr_2O_7$ | | | | | | | | | | | | 426.3 | 36 |
| 37 | dihydrogen phosphate | $NaH_2PO_4$ | $2H_2O$ | 57.9 | 69.9 | 85.2 | 106.5 | 138.2 | | | | | | | 37 |
| 38 | dihydrogen phosphate | $NaH_2PO_4$ | $1H_2O$ | | | | | | 158.6 | | | | | | 38 |
| 39 | dihydrogen phosphate | $NaH_2PO_4$ | | | | | | | | 179.3 | 190.3 | 207.3 | 225.3 | 246.6 | 39 |
| 40 | hydrogen arsenate | $Na_2HAsO_4$ | $12H_2O$ | 7.3 | 15.5 | 26.5 | 37 | 47 | | 65 | | 85 | | | 40 |
| 41 | hydrogen phosphate | $Na_2HPO_4$ | $12H_2O$ | 1.67 | 3.6 | 7.7 | 20.8 | | | | | | | | 41 |
| 42 | hydrogen phosphate | $Na_2HPO_4$ | $7H_2O$ | | | | | 51.8 | | | | | | | 42 |
| 43 | hydrogen phosphate | $Na_2HPO_4$ | $2H_2O$ | | | | | | 80.2 | 82.9 | 88.1 | 92.4 | 102.9 | | 43 |
| 44 | hydrogen phosphate | $Na_2HPO_4$ | | | | | | | | | | | | 102.2 | 44 |
| 45 | hydroxide | NaOH | $4H_2O$ | 42 | | | | | | | | | | | 45 |
| 46 | hydroxide | NaOH | $3\frac{1}{2}H_2O$ | | 51.5 | | | | | | | | | | 46 |
| 47 | hydroxide | NaOH | $1H_2O$ | | | 109 | 119 | 129 | 145 | 174 | | | | | 47 |
| 48 | hydroxide | NaOH | | | | | | | | | | | 313 | 347 | 48 |
| 49 | nitrate | $NaNO_3$ | | 73 | 80 | 88 | 96 | 104 | 114 | 124 | | 148 | | 180 | 49 |
| 50 | nitrite | $NaNO_2$ | | 72.1 | 78.0 | 84.5 | 91.6 | 98.4 | 104.1 | | | 132.6 | | 163.2 | 50 |
| 51 | oxalate | $Na_2C_2O_4$ | | | | 3.7 | | | | | | | | 6.33 | 51 |
| 52 | phosphate, tri- | $Na_3PO_4$ | $12H_2O$ | 1.5 | 4.1 | 11 | 20 | 31 | 43 | 55 | | 81 | | 108 | 52 |
| 53 | pyrophosphate | $Na_4P_2O_7$ | $10H_2O$ | 3.16 | 3.95 | 6.23 | 9.95 | 13.50 | 17.45 | 21.83 | | 30.04 | | 40.26 | 53 |
| 54 | sulfate | $Na_2SO_4$ | $10H_2O$ | 5.0 | 9.0 | 19.4 | 40.8 | | | | | | | | 54 |
| 55 | sulfate | $Na_2SO_4$ | $7H_2O$ | 19.5 | 30 | 44 | | | | | | | | | 55 |
| 56 | sulfate | $Na_2SO_4$ | | | | | | 48.8 | 46.7 | 45.3 | | 43.7 | | 42.5 | 56 |
| 57 | sulfide | $Na_2S$ | $9H_2O$ | | 15.42 | 18.8 | 22.5 | 28.5 | | | | | | | 57 |
| 58 | sulfide | $Na_2S$ | $5\frac{1}{2}H_2O$ | | | | | | 39.82 | 42.69 | 45.73 | 51.40 | 59.23 | | 58 |
| 59 | sulfide | $Na_2S$ | $6H_2O$ | | | | | | 36.4 | 39.1 | 43.31 | 49.14 | 57.28 | | 59 |
| 60 | sulfite | $Na_2SO_3$ | $7H_2O$ | 13.9 | 20 | 26.9 | 36 | | | | | | | | 60 |
| 61 | sulfite | $Na_2SO_3$ | | | | | | 28 | 28.2 | 28.8 | | 28.3 | | | 61 |
| 62 | tetraborate | $Na_2B_4O_7$ | $10H_2O$ | 1.3 | 1.6 | 2.7 | 3.9 | | 10.5 | 20.3 | | | | | 62 |
| 63 | tetraborate | $Na_2B_4O_7$ | $5H_2O$ | | | | | | | | 24.4 | 31.5 | 41 | 52.5 | 63 |
| 64 | vanadate (meta) | $NaVO_8$ | $2H_2O$ | | | $15.3^{25o}$ | | 30.2 | | 68.4 | | | | | 64 |

**TABLE 2-120 Solubilities of Inorganic Compounds in Water at Various Temperatures** (*Concluded*)

| | Substance | Formula | Solid phase | 0°C | 10°C | 20°C | 30°C | 40°C | 50°C | 60°C | 70°C | 80°C | 90°C | 100°C | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Sodium vanadate (meta) | $NaVO_3$ | | | | 21.10[25°] | | 26.23 | | 32.97 | 36.9 | 38.8[75°] | | | 1 |
| 2 | Stannous chloride | $SnCl_2$ | | 83.9 | | 269.8[15°] | | | | | | | | | 2 |
| 3 | sulfate | $SnSO_4$ | | | | 19 | | | | | | | | 18 | 3 |
| 4 | Strontium acetate | $Sr(C_2H_3O_2)_2$ | $4H_2O$ | 36.9 | 43.61 | | | | | | | | | | 4 |
| 5 | acetate | $Sr(C_2H_3O_2)_2$ | $½H_2O$ | | 42.95 | 41.6 | 39.5 | | 37.35 | | 36.24 | 36.10 | | 36.4 | 5 |
| 6 | chloride | $SrCl_2$ | $6H_2O$ | 43.5 | 47.7 | 52.9 | 58.7 | 65.3 | 72.4 | 81.8 | | | | | 6 |
| 7 | chloride | $SrCl_2$ | $2H_2O$ | | | | | | | | 85.9 | 90.5 | | 100.8 | 7 |
| 8 | nitrate | $Sr(NO_3)_2$ | $1H_2O$ | 52.7 | | 64.0 | | | 83.8 | 97.2 | | | 130.4 | 139 | 8 |
| 9 | nitrate | $Sr(NO_3)_2$ | $4H_2O$ | 40.1 | | 70.5 | | | | | | | | | 9 |
| 10 | nitrate | $Sr(NO_3)_2$ | | | | | 88.6 | 90.1 | | 93.8 | 96 | 98 | 100 | | 10 |
| 11 | sulfate | $SrSO_4$ | | 0.0113 | | 0.0114 | 0.0114 | | | | | | | | 11 |
| 12 | Sulfur dioxide, 760 mm † | $SO_2$ | | 22.83 | 16.21 | 11.29 | 7.81 | 5.41 | 4.5 | | | | | | 12 |
| 13 | Thallium sulfate | $Tl_2SO_4$ | | 2.70 | 3.70 | 4.87 | 6.16 | | 9.21 | 10.92 | 12.74 | 14.61 | 16.53 | 18.45 | 13 |
| 14 | Thorium sulfate | $Th(SO_4)_2$ | $9H_2O$ | 0.74 | 0.98 | 1.38 | 1.995 | 2.998 | 5.22 | | | | | | 14 |
| 15 | sulfate | $Th(SO_4)_2$ | $8H_2O$ | 1.0 | 1.25 | 1.62 | | | | | | | | | 15 |
| 16 | sulfate | $Th(SO_4)_2$ | $6H_2O$ | 1.50 | | 1.90 | 2.45 | | | 6.64 | | | | | 16 |
| 17 | sulfate | $Th(SO_4)_2$ | $4H_2O$ | | | | | 4.04 | 2.54 | 1.63 | 1.09 | | | | 17 |
| 18 | Zinc chlorate | $ZnClO_3$ | $6H_2O$ | 145.0 | 152.5 | | | | | | | | | | 18 |
| 19 | chlorate | $ZnClO_3$ | $4H_2O$ | | | 200.3 | 209.2 | 223.2 | 273.1 | | | | | | 19 |
| 20 | nitrate | $Zn(NO_3)_2$ | $6H_2O$ | 94.78 | | 118.3 | | | | | | | | | 20 |
| 21 | nitrate | $Zn(NO_3)_2$ | $3H_2O$ | | | | | 206.9 | | | | | | | 21 |
| 22 | sulfate | $ZnSO_4$ | $7H_2O$ | 41.9 | 47 | 54.4 | | | | | | | | | 22 |
| 23 | sulfate | $ZnSO_4$ | $6H_2O$ | | | | | 70.1 | 76.8 | | | | | | 23 |
| 24 | sulfate | $ZnSO_4$ | $1H_2O$ | | | | | | | | | 86.6 | 83.7 | 80.8 | 24 |

The $H$ in solubility tables (2-121 to 2-144) is the proportionality constant for the expression of Henry's law, $p = Hx$, where $x$ = mole fraction of the solute in the liquid phase; $p$ = partial pressure of the solute in the gas phase, expressed in atmospheres; and $H$ = a proportionality constant expressed in units of atmospheres of solute pressure in the gas phase per unit concentration of the solute in the liquid phase. (The unit of concentration of the solute in the liquid phase is moles solute per mole solution.)

**TABLE 2-121 Acetylene ($C_2H_2$)**

| $t$, °C | 0 | 5 | 10 | 15 | 20 | 25 | 30 |
|---|---|---|---|---|---|---|---|
| $10^{-3} \times H$* | 0.72 | 0.84 | 0.96 | 1.08 | 1.21 | 1.33 | 1.46 |

*International Critical Tables*, vol. 3, p. 260, McGraw-Hill, 1928.
*$H$. See footnote for Table 2-122.

**TABLE 2-122 Air**

| $t$, °C | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 |
|---|---|---|---|---|---|---|---|---|
| $10^{-4} \times H$* | 4.32 | 4.88 | 5.49 | 6.07 | 6.64 | 7.20 | 7.71 | 8.23 |
| $t$, °C | 40 | 45 | 50 | 60 | 70 | 80 | 90 | 100 |
| $10^{-4} \times H$* | 8.70 | 9.11 | 9.46 | 10.1 | 10.5 | 10.7 | 10.8 | 10.7 |

*International Critical Tables*, vol. 3, p. 257.
*$H$ is calculated from the absorption coefficients of $O_2$ and $N_2$, taking into consideration the correction for constant argon content.

**TABLE 2-123 Ammonia ($NH_3$)**

| Weight $NH_3$ per 100 weights $H_2O$ | Partial pressure of $NH_3$, mm. Hg | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0°C | 10°C | 20°C | 25°C | 30°C | 40°C | 50°C | 60°C |
| 100 | 947 | | | | | | | |
| 90 | 785 | | | | | | | |
| 80 | 636 | 987 | 1450 | | | 3300 | | |
| 70 | 500 | 780 | 1170 | | | 2760 | | |
| 60 | 380 | 600 | 945 | | | 2130 | | |
| 50 | 275 | 439 | 686 | | | 1520 | | |
| 40 | 190 | 301 | 470 | | 719 | 1065 | | |
| 30 | 119 | 190 | 298 | | 454 | 692 | | |
| 25 | 89.5 | 144 | 227 | | 352 | 534 | 825 | |
| 20 | 64 | 103.5 | 166 | | 260 | 395 | 596 | 834 |
| 15 | 42.7 | 70.1 | 114 | | 179 | 273 | 405 | 583 |
| 10 | 25.1 | 41.8 | 69.6 | | 110 | 167 | 247 | 361 |
| 7.5 | 17.7 | 29.9 | 50.0 | | 79.7 | 120 | 179 | 261 |
| 5 | 11.2 | 19.1 | 31.7 | | 51.0 | 76.5 | 115 | 165 |
| 4 | | 16.1 | 24.9 | | 40.1 | 60.8 | 91.1 | 129.2 |
| 3 | | 11.3 | 18.2 | 23.5 | 29.6 | 45 | 67.1 | 94.3 |
| 2.5 | | | 15.0 | 19.4 | 24.4 | (37.6)* | (55.7) | 77.0 |
| 2 | | | 12.0 | 15.3 | 19.3 | (30.0) | (44.5) | 61.0 |
| 1.6 | | | | 12.0 | 15.3 | (24.1) | (35.5) | 48.7 |
| 1.2 | | | | 9.1 | 11.5 | (18.3) | (26.7) | 36.3 |
| 1.0 | | | | 7.4 | | (15.4) | (22.2) | 30.2 |
| 0.5 | | | | 3.4 | | | | |

*Extrapolated values.

**TABLE 2-124 Ammonia ($NH_3$)—Low Pressures**

| Weight $NH_3$ per 100 weights $H_2O$ | 0.105 | 0.244 | 0.32 | 0.38 | 0.576 | 0.751 | 1.02 |
|---|---|---|---|---|---|---|---|
| Partial pressure $NH_3$, mm. Hg, at 25°C | 0.791 | 1.83 | 2.41 | 2.89 | 4.41 | 5.80 | 7.96 |
| Weight $NH_3$ per 100 weights $H_2O$ | 1.31 | 1.53 | 1.71 | 1.98 | 2.11 | 2.58 | 2.75 |
| Partial pressure $NH_3$, mm. Hg, at 25°C | 10.31 | 11.91 | 13.46 | 15.75 | 16.94 | 20.86 | 22.38 |

"Landolt-Börnstein Physikalische-chemische Tabellen," Eg. I, p. 303, 1927. Phase-equilibrium data for the binary system $NH_3$-$H_2O$ are given by Clifford and Hunter, *J. Phys. Chem.*, **37,** 101 (1933).

**TABLE 2-125 Carbon Dioxide ($CO_2$)**

| Total pressure, atm | Weight of $CO_2$ per 100 weights of $H_2O$* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 12°C | 18°C | 25°C | 31.04°C | 35°C | 40°C | 50°C | 75°C | 100°C |
| 25 | | 3.86 | | 2.80 | 2.56 | 2.30 | 1.92 | 1.35 | 1.06 |
| 50 | 7.03 | 6.33 | 5.38 | 4.77 | 4.39 | 4.02 | 3.41 | 2.49 | 2.01 |
| 75 | 7.18 | 6.69 | 6.17 | 5.80 | 5.51 | 5.10 | 4.45 | 3.37 | 2.82 |
| 100 | 7.27 | 6.72 | 6.28 | 5.97 | 5.76 | 5.50 | 5.07 | 4.07 | 3.49 |
| 150 | 7.59 | 7.07 | | 6.25 | 6.03 | 5.81 | 5.47 | 4.86 | 4.49 |
| 200 | | | | 6.48 | 6.29 | 6.28 | 5.76 | 5.27 | 5.08 |
| 300 | 7.86 | 7.35 | | | | | 6.20 | 5.83 | 5.84 |
| 400 | 8.12 | 7.77 | 7.54 | 7.27 | 7.06 | 6.89 | 6.58 | 6.30 | 6.40 |
| 500 | | | | 7.65 | 7.51 | 7.26 | | | |
| 700 | | | | | | | 7.58 | 7.43 | 7.61 |

*In the original, concentration is expressed in cubic centimeters of $CO_2$ (reduced to 0°C and 1 atm) dissolved in 1 g of water.

**TABLE 2-126 Carbon Monoxide (CO)**

| Partial pressure of CO, mm Hg | $10^{-4} \times H$ | |
|---|---|---|
| | 17.7°C | 19.0°C |
| 900 | 4.77 | 4.88 |
| 2000 | 4.77 | 4.91 |
| 3000 | 4.77 | 4.93 |
| 4000 | 4.78 | 4.95 |
| 5000 | 4.80 | 4.97 |
| 6000 | 4.82 | 4.98 |
| 7000 | 4.86 | 5.02 |
| 8000 | 4.88 | 5.08 |

*International Critical Tables*, vol. 3, p. 260.

**TABLE 2-127 Carbonyl Sulfide (COS)**

| $t$ °C | 0 | 5 | 10 | 15 | 20 | 25 | 30 |
|---|---|---|---|---|---|---|---|
| $10^{-3} \times H$ | 0.92 | 1.17 | 1.48 | 1.82 | 2.19 | 2.59 | 3.04 |

*International Critical Tables*, vol. 3, p. 261.

**TABLE 2-128 Chlorine ($Cl_2$)**

| Partial pressure of $Cl_2$, mm Hg | Solubility, g of $Cl_2$ per liter | | | | | |
|---|---|---|---|---|---|---|
| | 0°C | 10°C | 20°C | 30°C | 40°C | 50°C |
| 5 | 0.488 | 0.451 | 0.438 | 0.424 | 0.412 | 0.398 |
| 10 | .679 | .603 | .575 | .553 | .532 | .512 |
| 30 | 1.221 | 1.024 | .937 | .873 | .821 | .781 |
| 50 | 1.717 | 1.354 | 1.210 | 1.106 | 1.025 | .962 |
| 100 | 2.79 | 2.08 | 1.773 | 1.573 | 1.424 | 1.313 |
| 150 | 3.81 | 2.73 | 2.27 | 1.966 | 1.754 | 1.599 |
| 200 | 4.78 | 3.35 | 2.74 | 2.34 | 2.05 | 1.856 |
| 250 | 5.71 | 3.95 | 3.19 | 2.69 | 2.34 | 2.09 |
| 300 | | 4.54 | 3.63 | 3.03 | 2.61 | 2.31 |
| 350 | | 5.13 | 4.06 | 3.35 | 2.86 | 2.53 |
| 400 | | 5.71 | 4.48 | 3.69 | 3.11 | 2.74 |
| 450 | | 6.26 | 4.88 | 3.98 | 3.36 | 2.94 |
| 500 | | 6.85 | 5.29 | 4.30 | 3.61 | 3.14 |
| 550 | | 7.39 | 5.71 | 4.60 | 3.84 | 3.33 |
| 600 | | 7.97 | 6.12 | 4.91 | 4.08 | 3.52 |
| 650 | | 8.52 | 6.52 | 5.21 | 4.32 | 3.71 |
| 700 | | 9.09 | 6.90 | 5.50 | 4.54 | 3.89 |
| 750 | | 9.65 | 7.29 | 5.80 | 4.77 | 4.07 |
| 800 | | 10.21 | 7.69 | 6.08 | 4.99 | 4.27 |
| 900 | | | 8.46 | 6.68 | 5.44 | 4.62 |
| 1000 | | | 9.27 | 7.27 | 5.89 | 4.97 |
| 1200 | $Cl_2.8H_2O_2$ separates | | 10.84 | 8.42 | 6.81 | 5.67 |
| 1500 | | | 13.23 | 10.14 | 8.05 | 6.70 |
| 2000 | | | 17.07 | 13.02 | 10.22 | 8.38 |
| 2500 | | | 21.0 | 15.84 | 12.32 | 10.03 |
| 3000 | | | | 18.73 | 14.47 | 11.70 |
| 3500 | | | | 21.7 | 16.62 | 13.38 |
| 4000 | | | | 24.7 | 18.84 | 15.04 |
| 4500 | | | | 27.7 | 20.7 | 16.75 |
| 5000 | | | | 30.8 | 23.3 | 18.46 |

| Partial pressure of $Cl_2$, mm Hg | Solubility, g of $Cl_2$ per liter | | | | | |
|---|---|---|---|---|---|---|
| | 60°C | 70°C | 80°C | 90°C | 100°C | 110°C |
| 5 | 0.383 | 0.369 | 0.351 | 0.339 | 0.326 | 0.316 |
| 10 | .492 | .470 | .447 | .431 | .415 | .402 |
| 30 | .743 | .704 | .671 | .642 | .627 | .598 |
| 50 | .912 | .863 | .815 | .781 | .747 | .722 |
| 100 | 1.228 | 1.149 | 1.085 | 1.034 | .987 | .950 |
| 150 | 1.482 | 1.382 | 1.294 | 1.227 | 1.174 | 1.137 |
| 200 | 1.706 | 1.580 | 1.479 | 1.396 | 1.333 | 1.276 |
| 250 | 1.914 | 1.764 | 1.642 | 1.553 | 1.480 | 1.413 |
| 300 | 2.10 | 1.932 | 1.793 | 1.700 | 1.610 | 1.542 |
| 350 | 2.28 | 2.10 | 1.940 | 1.831 | 1.736 | 1.661 |
| 400 | 2.47 | 2.25 | 2.08 | 1.965 | 1.854 | 1.773 |
| 450 | 2.64 | 2.41 | 2.22 | 2.09 | 1.972 | 1.880 |
| 500 | 2.80 | 2.55 | 2.35 | 2.21 | 2.08 | 1.986 |
| 550 | 2.97 | 2.69 | 2.47 | 2.32 | 2.19 | 2.09 |
| 600 | 3.13 | 2.83 | 2.59 | 2.43 | 2.29 | 2.19 |
| 650 | 3.29 | 2.97 | 2.72 | 2.55 | 2.41 | 2.28 |
| 700 | 3.44 | 3.10 | 2.84 | 2.66 | 2.50 | 2.37 |
| 750 | 3.59 | 3.23 | 2.96 | 2.76 | 2.60 | 2.47 |
| 800 | 3.75 | 3.37 | 3.08 | 2.87 | 2.69 | 2.56 |
| 900 | 4.04 | 3.63 | 3.30 | 3.08 | 2.89 | 2.74 |
| 1000 | 4.36 | 3.88 | 3.53 | 3.28 | 3.07 | 2.91 |
| 1200 | 4.92 | 4.37 | 3.95 | 3.67 | 3.43 | 3.25 |
| 1500 | 5.76 | 5.09 | 4.58 | 4.23 | 3.95 | 3.74 |
| 2000 | 7.14 | 6.26 | 5.63 | 5.17 | 4.78 | 4.49 |
| 2500 | 8.48 | 7.40 | 6.61 | 6.05 | 5.59 | 5.25 |
| 3000 | 9.83 | 8.52 | 7.54 | 6.92 | 6.38 | 5.97 |
| 3500 | 11.22 | 9.65 | 8.53 | 7.79 | 7.16 | 6.72 |
| 4000 | 12.54 | 10.76 | 9.52 | 8.65 | 7.94 | 7.42 |
| 4500 | 13.88 | 11.91 | 10.46 | 9.49 | 8.72 | 8.13 |
| 5000 | 15.26 | 13.01 | 11.42 | 10.35 | 9.48 | 8.84 |

**TABLE 2-129 Chlorine Dioxide ($ClO_2$)**

| Vol % of $ClO_2$ in gas phase | Weight of $ClO_2$, grams per liter of solution | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0°C | 5°C | 10°C | 15°C | 20°C | 30°C | 40°C |
| 1 | 2.00 | 1.50 | 1.25 | 1.00 | 0.90 | 0.60 | 0.46 |
| 3 | 6.00 | 4.7 | 3.85 | 3.20 | 2.70 | 1.95 | 1.30 |
| 5 | 10.0 | 7.8 | 6.30 | 5.25 | 4.30 | 3.20 | 2.25 |
| 7 | 14.0 | 10.9 | 8.95 | 7.35 | 6.15 | 4.40 | 3.20 |
| 10 | 20.0 | 15.5 | 12.8 | 10.5 | 8.80 | 6.30 | 4.50 |
| 11 | | 17.0 | 14.0 | 11.7 | 9.70 | 7.00 | 5.00 |
| 12 | | 18.6 | 15.3 | 12.8 | 10.55 | 7.50 | 5.45 |
| 13 | | 20.3 | 16.6 | 13.8 | 11.5 | 8.20 | 5.85 |
| 14 | | | 18.0 | 14.9 | 12.3 | 8.80 | 6.35 |
| 15 | | | 19.2 | 16.0 | 13.2 | 9.50 | 6.80 |
| 16 | | | 20.3 | 17.0 | 14.2 | 10.1 | 7.20 |

Ishi, *Chem. Eng. (Japan)*, **22,** 153 (1958).

**TABLE 2-130 Ethane ($C_2H_6$)**

| $t$, °C | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 |
|---|---|---|---|---|---|---|---|---|
| $10^{-4} \times H$ | 1.26 | 1.55 | 1.89 | 2.26 | 2.63 | 3.02 | 3.42 | 3.83 |
| $t$, °C | 40 | 45 | 50 | 60 | 70 | 80 | 90 | 100 |
| $10^{-4} \times H$ | 4.23 | 4.63 | 5.00 | 5.65 | 6.23 | 6.61 | 6.87 | 6.92 |

*International Critical Tables,* vol. 3, p. 261.

**TABLE 2-131 Ethylene ($C_2H_4$)**

| $t$, °C | 0 | 5 | 10 | 15 | 20 | 25 | 30 |
|---|---|---|---|---|---|---|---|
| $10^{-3} \times H$ | 5.52 | 6.53 | 7.68 | 8.95 | 10.2 | 11.4 | 12.7 |

*International Critical Tables,* vol. 3, p. 260.

**TABLE 2-132 Helium (He)**

| $t$, °C | 0 | 10 | 20 | 30 | 40 | 50 |
|---|---|---|---|---|---|---|
| $10^{-4} \times H$ | 12.9 | 12.6 | 12.5 | 12.4 | 12.1 | 11.5 |

See also Pray, Schweickert, and Minnich, *Ind. Eng. Chem.,* **44,** 1146 (1952).

**TABLE 2-133 Hydrogen ($H_2$)—Temperature**

| $t$, °C | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 |
|---|---|---|---|---|---|---|---|---|
| $10^{-4} \times H$ | 5.79 | 6.08 | 6.36 | 6.61 | 6.83 | 7.07 | 7.29 | 7.42 |
| $t$, °C | 40 | 45 | 50 | 60 | 70 | 80 | 90 | 100 |
| $10^{-4} \times H$ | 7.51 | 7.60 | 7.65 | 7.65 | 7.61 | 7.55 | 7.51 | 7.45 |

"International Critical Tables," vol. 3, p. 256.
See also Pray, Schweickert, and Minnich, *Ind. Eng. Chem.,* **44,** 1146 (1952).

**TABLE 2-134 Hydrogen ($H_2$)—Pressure**

| Partial pressure $H_2$, mm Hg | $10^{-4} \times H$ | |
|---|---|---|
| | 19.5°C | 23°C |
| 900 | 7.42 | |
| 1100 | | 7.75 |
| 2000 | 7.42 | 7.76 |
| 3000 | 7.43 | 7.77 |
| 4000 | 7.47 | 7.81 |
| 5000 | 7.56 | 7.89 |
| 6000 | 7.70 | 8.00 |
| 7000 | 7.87 | 8.16 |
| 8200 | | 8.41 |
| 8250 | 8.17 | |

*International Critical Tables,* vol. 3, p. 256.

**TABLE 2-135 Hydrogen Chloride (HCl)**

| Weights of HCl per 100 weights of $H_2O$ | Partial pressure of HCl, mm Hg | | | |
|---|---|---|---|---|
| | 0°C | 10°C | 20°C | 30°C |
| 78.6 | 510 | 840 | | |
| 66.7 | 130 | 233 | 399 | 627 |
| 56.3 | 29.0 | 56.4 | 105.5 | 188 |
| 47.0 | 5.7 | 11.8 | 23.5 | 44.5 |
| 38.9 | 1.0 | 2.27 | 4.90 | 9.90 |
| 31.6 | 0.175 | 0.43 | 1.00 | 2.17 |
| 25.0 | .0316 | .084 | 0.205 | 0.48 |
| 19.05 | .0056 | .016 | .0428 | .106 |
| 13.64 | .00099 | .00305 | .0088 | .0234 |
| 8.70 | .000118 | .000583 | .00178 | .00515 |
| 4.17 | .000018 | .000069 | .00024 | .00077 |
| 2.04 | | .0000117 | .000044 | .000151 |

| Weights of HCl per 100 weights of $H_2O$ | Partial pressure of HCl, mm Hg | | |
|---|---|---|---|
| | 50°C | 80°C | 110°C |
| 78.6 | | | |
| 66.7 | | | |
| 56.3 | 535 | | |
| 47.0 | 141 | 623 | |
| 38.9 | 35.7 | 188 | 760 |
| 31.6 | 8.9 | 54.5 | 253 |
| 25.0 | 2.21 | 15.6 | 83 |
| 19.05 | 0.55 | 4.66 | 28 |
| 13.64 | .136 | 1.34 | 9.3 |
| 8.70 | .0344 | 0.39 | 3.10 |
| 4.17 | .0064 | .095 | 0.93 |
| 2.04 | .00140 | .0245 | .280 |

Enthalpy and phase-equilibrium data for the binary system HCl-$H_2O$ are given by Van Nuys, *Trans. Am. Inst. Chem. Engrs.*, **39,** 663 (1943).

**TABLE 2-136 Hydrogen Sulfide ($H_2S$)**

| $t$, °C | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 |
|---|---|---|---|---|---|---|---|---|
| $10^{-2} \times H$ | 2.68 | 3.15 | 3.67 | 4.23 | 4.83 | 5.45 | 6.09 | 6.76 |
| $t$, °C | 40 | 45 | 50 | 60 | 70 | 80 | 90 | 100 |
| $10^{-2} \times H$ | 7.45 | 8.14 | 8.84 | 10.3 | 11.9 | 13.5 | 14.4 | 14.8 |

*International Critical Tables,* vol. 3, p. 259.

**TABLE 2-137 Methane ($CH_4$)**

| $t$, °C | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 |
|---|---|---|---|---|---|---|---|---|
| $10^{-4} \times H$ | 2.24 | 2.59 | 2.97 | 3.37 | 3.76 | 4.13 | 4.49 | 4.86 |
| $t$, °C | 40 | 45 | 50 | 60 | 70 | 80 | 90 | 100 |
| $10^{-4} \times H$ | 5.20 | 5.51 | 5.77 | 6.26 | 6.66 | 6.82 | 6.92 | 7.01 |

*International Critical Tables,* vol. 3, p. 260.

**TABLE 2-138 Nitrogen ($N_2$)—Temperature***

| $t$, °C | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 |
|---|---|---|---|---|---|---|---|---|
| $10^{-4} \times H$ | 5.29 | 5.97 | 6.68 | 7.38 | 8.04 | 8.65 | 9.24 | 9.85 |
| $t$, °C | 40 | 45 | 50 | 60 | 70 | 80 | 90 | 100 |
| $10^{-4} \times H$ | 10.4 | 10.9 | 11.3 | 12.0 | 12.5 | 12.6 | 12.6 | 12.6 |

"International Critical Tables," vol. 3, p. 256. See also Pray, Schweickert, and Minnich, *Ind. Eng. Chem.*, **44,** 1146 (1952).

*Atmospheric nitrogen = 98.815 vol. % $N_2$ + 1.185 vol. % A.

**TABLE 2-139 Nitrogen ($N_2$)—Pressure**

| Partial pressure of $N_2$, mm Hg | $10^{-4} \times H$ | |
|---|---|---|
| | 19.4°C | 24.9°C |
| 900 | 8.24 | 9.08 |
| 2000 | 8.32 | 9.15 |
| 3000 | 8.41 | 9.25 |
| 4000 | 8.49 | 9.38 |
| 5000 | 8.59 | 9.49 |
| 6000 | 8.74 | 9.62 |
| 7000 | 8.86 | 9.75 |
| 8100 | 9.04 | |
| 8200 | | 9.91 |

See also Goodman and Krase [*Ind. Eng. Chem.*, **23,** 401 (1931)] for values up to 169°C and 300 atm.

**TABLE 2-140 Oxygen ($O_2$)—Temperature**

| $t$, °C | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 |
|---|---|---|---|---|---|---|---|---|
| $10^{-4} \times H$ | 2.55 | 2.91 | 3.27 | 3.64 | 4.01 | 4.38 | 4.75 | 5.07 |
| $t$, °C | 40 | 45 | 50 | 60 | 70 | 80 | 90 | 100 |
| $10^{-4} \times H$ | 5.35 | 5.63 | 5.88 | 6.29 | 6.63 | 6.87 | 6.99 | 7.01 |

*International Critical Tables,* vol. 3, p. 257. Pray, Schweickert, and Minnich [*Ind. Eng. Chem.*, **44,** 1146 (1952)] give $H = 4.46 \times 10^{-4}$ at 25°C and other values up to 343°C.

**TABLE 2-141 Oxygen ($O_2$)—Pressure**

| Partial pressure of $O_2$, mm Hg | $10^{-4} \times H$ | |
|---|---|---|
| | 23°C | 25.9°C |
| 800 | | 4.79 |
| 900 | 4.58 | |
| 2000 | 4.59 | 4.80 |
| 3000 | 4.60 | 4.83 |
| 4000 | 4.68 | 4.88 |
| 5000 | 4.73 | 4.92 |
| 6000 | 4.80 | 4.98 |
| 7000 | 4.88 | 5.05 |
| 8150 | 4.98 | |
| 8200 | | 5.16 |

*International Critical Tables,* vol. 3, p. 257. See also *Trans. Am. Soc. Mech. Engrs.*, **76,** 69 (1954) for solubility of $O_2$ for 100°F < $T$ < 650°F, 300 < $P$ < 2000 lb/in$^2$.

**TABLE 2-142 Ozone ($O_3$)**

| $t$, °C | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 50 |
|---|---|---|---|---|---|---|---|---|---|---|
| $10^{-3} \times H$ | 1.94 | 2.18 | 2.48 | 2.88 | 3.76 | 4.57 | 5.98 | 8.18 | 12.0 | 27.4 |

*International Critical Tables,* vol. 3, p. 257.

**TABLE 2-143 Propylene ($C_3H_6$)**

| $t$, °C | 2 | 6 | 10 | 14 | 18 |
|---|---|---|---|---|---|
| $10^{-3} \times H$ | 3.04 | 3.84 | 4.46 | 5.06 | 5.69 |

*International Critical Tables,* vol. 3, p. 260.

**TABLE 2-144 Partial Vapor Pressure of Sulfur Dioxide over Water, mm Hg**

| g $SO_2$/ 100 g $H_2O$ | Temperature, °C | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 90 | 120 |
| 0.01 | 0.02 | 0.04 | 0.07 | 0.12 | 0.19 | 0.29 | 0.43 | 1.21 | 2.82 |
| 0.05 | 0.38 | 0.66 | 1.07 | 1.68 | 2.53 | 3.69 | 5.24 | 12.9 | 27.0 |
| 0.10 | 1.15 | 1.91 | 3.03 | 4.62 | 6.80 | 9.71 | 13.5 | 31.7 | 63.9 |
| 0.15 | 2.10 | 3.44 | 5.37 | 8.07 | 11.7 | 16.5 | 22.7 | 52.2 | 104 |
| 0.20 | 3.17 | 5.13 | 7.93 | 11.8 | 17.0 | 23.8 | 32.6 | 73.7 | 145 |
| 0.25 | 4.34 | 6.93 | 10.6 | 15.7 | 22.5 | 31.4 | 42.8 | 95.8 | 186 |
| 0.30 | 5.57 | 8.84 | 13.5 | 19.8 | 28.2 | 39.2 | 53.3 | 118 | 229 |
| 0.40 | 8.17 | 12.8 | 19.4 | 28.3 | 40.1 | 55.3 | 74.7 | 164 | 316 |
| 0.50 | 10.9 | 17.0 | 25.6 | 37.1 | 52.3 | 72.0 | 96.8 | 211 | 404 |
| 1.00 | 25.8 | 39.5 | 58.4 | 83.7 | 117 | 159 | 212 | 454 | 856 |
| 2.00 | 58.6 | 88.5 | 129 | 183 | 253 | 342 | 453 | 955 | |
| 3.00 | 93.2 | 139 | 202 | 285 | 393 | 530 | 700 | | |
| 4.00 | 129 | 192 | 277 | 389 | 535 | 720 | | | |
| 5.00 | 165 | 245 | 353 | 496 | 679 | | | | |
| 6.00 | 202 | 299 | 430 | 602 | 824 | | | | |
| 8.00 | 275 | 407 | 585 | 818 | | | | | |
| 10.00 | 351 | 517 | 741 | | | | | | |
| 15.00 | 542 | 796 | | | | | | | |
| 20.00 | 735 | | | | | | | | |

Condensed from Rabe, A. E. and Harris, J. F., *J. Chem. Eng. Data,* **8** (3), 333–336, 1963. 

# THERMAL EXPANSION

## UNITS CONVERSIONS

For this subsection, the following units conversion is applicable:

$$°F = \tfrac{9}{5}\,°C + 32.$$

## ADDITIONAL REFERENCES

The tables given under this subject are reprinted by permission from the *Smithsonian Tables.* For more detailed data on thermal expansion, see *International Critical Tables:* tabular index, vol. 3, p. 1; abrasives, vol. 2, p. 87; alloys, vol. 2, p. 463; building stones, vol. 2, p. 54; carbons, vol. 2, p. 303; elements, vol. 1, p. 102; enamels, vol. 2, p. 115; glass, vol. 2, p. 93; metals, vol. 2, p. 459; petroleums, vol. 2, p. 145; porcelains, vol. 2, pp. 70, 78; refractory materials, vol. 2, p. 83; solid insulators, vol. 2, p. 310.

## THERMAL EXPANSION OF GASES

No tables of the coefficients of thermal expansion of gases are given in this edition. The coefficient at constant pressure, $1/\upsilon(\partial\upsilon/\partial T)_p$, for an ideal gas is merely the reciprocal of the absolute temperature. For a real gas or liquid, both it and the coefficient at constant volume, $1/p\ (\partial p/\partial T)_v$, should be calculated either from the equation of state or from tabulated *PVT* data.

**TABLE 2-145 Linear Expansion of the Solid Elements***

*C* is the true expansion coefficient at the given temperature; *M* is the mean coefficient between given temperatures; where one temperature is given, the true coefficient at that temperature is indicated; $\alpha$ and $\beta$ are coefficients in formula $l_t = l_0(1 + \alpha t + \beta t^2)$; $l_0$ is length at 0°C (unless otherwise indicated, when, if $x$ is the reference temperature, $l_t = l_x[1 + \alpha(t - t_x) + \beta(t - t_x)^2]$; $l_t$ is length at $t$°C).

| Element | Temp. °C | $C \times 10^4$ | Temp. range, °C | $M \times 10^4$ | Temp. range, °C | $\alpha \times 10^4$ | $\beta \times 10^6$ |
|---|---|---|---|---|---|---|---|
| Aluminum | 20 | 0.224 | 100 | 0.235 | 0, 500 | 0.22 | 0.009 |
| Aluminum | 300 | 0.284 | 500 | 0.311 | | | |
| Antimony | 20 | 0.136‖ | 20 | 0.080⊥ | | | |
| Arsenic | 20 | 0.05 | | | | | |
| Bismuth | 20 | 0.014‖ | 20 | 0.103⊥ | | | |
| Cadmium | 0 | 0.54‖ | −180, −140 | 0.59‖ | 20, 100 | 0.526‖ | |
| Cadmium | 0 | 0.20⊥ | −180, −140 | 0.117⊥ | 20, 100 | 0.214⊥ | |
| Carbon, diamond | 50 | 0.012 | | | | | |
| graphite | 50 | 0.06 | | | | | |
| Chromium | | | 20, 100 | 0.068 | 20, 500 | 0.086 | |
| Cobalt | 20 | 0.123 | | | 6, 121 | 0.121 | 0.0064 |
| Copper | 20 | 0.162 | 100 | 0.166 | 0, 625 | 0.161 | 0.0040 |
| Copper | 200 | 0.170 | 300 | 0.175 | | | |
| Gold | 20 | 0.140 | 17, 100 | 0.143 | 0, 520 | 0.142 | 0.0022 |
| Gold | | | −191, 17 | 0.132 | | | |
| Indium | 40 | 0.417 | | | | | |
| Iodine | | | −190, 17 | 0.837 | | | |
| Iridium | 20 | 0.065 | | | 0, 80 | 0.0636 | 0.0032 |
| Iridium | | | | | 1070, 1720 | 0.0679 | 0.0011 |
| Iron, soft | 40 | 0.1210 | 0, 100 | 0.11 | | | |
| cast | 20 | 0.118 | | | 0, 750 | 0.1158 | 0.0053 |
| wrought | 20 | 0.119 | | | 0, 750 | 0.1170 | 0.0053 |
| steel | 20 | 0.114 | | | 0, 750 | 0.1118 | 0.0053 |
| Lead (99.9) | | | 20, 100 | 0.291 | 100, 240 | 0.269 | 0.011 |
| | 100 | 0.291 | 20, 200 | 0.300 | | | |
| | 280 | 0.343 | | | | | |
| Magnesium | 20 | 0.254 | −100, +20 | 0.240 | +20, 500 | 0.2480 | 0.0096 |
| | | | 20, 100 | 0.260 | | | |
| Manganese | 20 | 0.233 | 0, 100 | 0.228 | | | |
| | | | −190, 0 | 0.159 | 20, 300 | 0.216 | 0.0121 |
| Molybdenum† | 20 | 0.053 | 0, 100 | 0.052 | −142, 19 | 0.0515 | 0.0057 |
| | | | 25, 100 | 0.049 | 19, +305 | 0.0501 | 0.0014 |
| | | | 25, 500 | 0.055 | | | |
| Nickel | 20 | 0.126 | 0, 100 | 0.130 | −190, +20 | 0.1308 | 0.0166 |
| | | | | | +20, +300 | 0.1236 | 0.0066 |
| | | | | | 500, 1000 | 0.1346 | 0.0033 |
| Osmium | 40 | 0.066 | | | | | |
| Palladium | 20 | 0.1173 | | | −190, +100 | 0.1152 | 0.00517 |
| | | | | | 0, 1000 | 0.1167 | 0.0022 |
| Platinum | 20 | 0.0887 | | | −190, −100 | 0.0875 | 0.00314 |
| | 20 | 0.0893 | | | 0, +80 | 0.0890 | 0.00121 |
| | | | | | 0, 1000 | 0.0887 | 0.00132 |
| Potassium | | | 0, 50 | 0.83 | | | |
| Rhodium | 40 | 0.0850 | 6, 21 | 0.0876 | −75, −112 | 0.0746 | |
| Ruthenium | 40 | 0.0963 | | | | | |
| Selenium | 0 | 0.439 | 0, 100 | 0.660 | | | |
| Silicon | 40 | 0.0763 | −3, +18 | 0.0249 | −75, −67 | 0.0182 | |
| Silver | 20 | 0.1846 | 0, 100 | 0.197 | 0, 875 | 0.1827 | 0.00479 |
| | 20 | 0.195 | | | 20, 500 | 0.1939 | 0.00295 |
| Sodium | | | −190, −17 | 0.622 | 0, 50 | 0.72 | |
| Steel, 36.4Ni | | | 20, 260 | 0.031 | 260, 500 | 0.144 | |
| | | | 20, 340 | 0.055 | 340, 500 | 0.136 | |
| Tantalum† | 20 | 0.065 | −78, 0 | 0.059 | 20, 400 | 0.0646 | 0.0009 |
| | | | 0, 100 | 0.0655 | | | |
| Tellurium | 20 | 0.016‖ | 20 | 0.272⊥ | | | |
| Thallium | 40 | 0.302 | | | | | |
| Tin | 20 | 0.214 | | | 8, 95 | 0.2033 | 0.0263 |
| | 20 | 0.305‖ | 20 | 0.154⊥ | | | |
| Tungsten† | 27 | 0.0444 | 0, 100 | 0.045 | −105, +502 | 0.0428 | 0.00058 |
| Zinc | 20‡ | 0.643‖ | −140, −100 | 0.656‖ | +0, 400 | 0.354 | 0.010 |
| | 20‡ | 0.125⊥ | +20, 100 | 0.639‖ | | | |
| | 20 | 0.358 | +20, 100 | 0.141⊥ | | | |

**Smithsonian Tables.* For more complete tabulations see Table 142, *Smithsonian Physical Tables,* 9th ed., 1954; *Handbook of Chemistry and Physics,* 40th ed., pp. 2239–2245. Chemical Rubber Publishing Co.; Goldsmith, and Waterman, WADC-TR-58-476, 1959; Johnson (ed.), WADD-TR-60-56, 1960, etc.

†Molybdenum, 300° to 2500°C; $l_t = l_{300}[1 + 5.00 \times 10^{-6}(t - 300) + 10.5 \times 10^{-10}(t - 300)^2]$

Tantalum, 300° to 2800°C; $l_t = l_{300}[1 + 6.60 \times 10^{-6}(t - 300) + 5.2 \times 10^{-10}(t - 300)^2]$

Tungsten, 300° to 2700°C; $l_t = l_{300}[1 + 4.44 \times 10^{-6}(t - 300) + 4.5 \times 10^{-10}(t - 300)^2]$

Beryllium, 20° to 100°C; $12.3 \times 10^{-6}$ per °C.

Columbium, 0° to 100°C; $7.2 \times 10^{-6}$ per °C.

Tantalum, 20° to 100°C; $6.6 \times 10^{-6}$ per °C.

‡Two errors in the data of zinc have been corrected. These values were taken from Grüneisen and Goens, *Z. Physik.,* **29,** 141 (1924).

## TABLE 2-146 Linear Expansion of Miscellaneous Substances*

The coefficient of cubical expansion may be taken as three times the linear coefficient. In the following table, $t$ is the temperature or range of temperature, and $C$, the coefficient of expansion.

| Substance | $t$°C | $C \times 10^4$ |
|---|---|---|
| Amber | 0–30 | 0.50 |
| | 0–09 | 0.61 |
| Bakelite, bleached | 20–60 | 0.22 |
| Brass: | | |
| Cast | 0–100 | 0.1875 |
| Wire | 0–100 | 0.1930 |
| Wire | 0–100 | 0.1783 to 0.193 |
| 71.5 Cu + 27.7 Zn + 0.3 Sn + 0.5 Pb | 40 | 0.1859 |
| 71 Cu + 29 Zn | 0–100 | 0.1906 |
| Bronze: | | |
| 3 Cu + 1 Sn | 16.6–100 | 0.1844 |
| 3 Cu + 1 Sn | 16.6–350 | 0.2116 |
| 3 Cu + 1 Sn | 16.6–957 | 0.1737 |
| 86.3 Cu + 9.7 Sn + 4 Zn | 40 | 0.1782 |
| 97.6 Cu + 2.2 Sn + 0.2 P (hard) | 0–80 | 0.1713 |
| 97.6 Cu + 2.2 Sn + 0.2 P (soft) | 0–80 | 0.1708 |
| Caoutchouc | | 0.657 to 0.686 |
| Caoutchouc | 16.7–25.3 | 0.770 |
| Celluloid | 20–70 | 1.00 |
| Constantan | 4–29 | 0.1523 |
| Duralumin, 94Al | 20–100 | 0.23 |
| | 20–300 | 0.25 |
| Ebonite | 25.3–35.4 | 0.842 |
| Fluorspar, $CaF_2$ | 0–100 | 0.1950 |
| German silver | 0–100 | 0.1836 |
| Gold-platinum, 2 Au + 1 Pt | 0–100 | 0.1523 |
| Gold-copper, 2 Au + 1 Cu | 0–100 | 0.1552 |
| Glass: | | |
| Tube | 0–100 | 0.0833 |
| Tube | 0–100 | 0.0828 |
| Plate | 0–100 | 0.0891 |
| Crown (mean) | 0–100 | 0.0897 |
| Crown (mean) | 50–60 | 0.0954 |
| Flint | 50–60 | 0.0788 |
| Jena thermometer 16III normal | 0–100 | 0.081 |
| Jena thermometer 59III | 0–100 | 0.058 |
| Jena thermometer 59III | −191 to +16 | 0.424 |
| Gutta percha | 20 | 1.983 |
| Ice | −20 to −1 | 0.51 |
| Iceland spar: | | |
| Parallel to axis | 0–80 | 0.2631 |
| Perpendicular to axis | 0–80 | 0.0544 |
| Lead tin (solder) 2 Pb + 1 Sn | 0–100 | 0.2508 |
| Limestone | 25–100 | 0.09 |
| Magnalium | 12–39 | 0.238 |
| Manganin | | 0.181 |
| Marble | 15–100 | 0.117 |
| Monel metal | 25–100 | 0.14 |
| | 25–600 | 0.16 |
| Paraffin | 0–16 | 1.0662 |
| Paraffin | 16–38 | 1.3030 |
| Paraffin | 38–49 | 4.7707 |
| Platinum-iridium, 10 Pt + 1 Ir | 40 | 0.0884 |
| Platinum-silver, 1 Pt + 2 Ag | 0–100 | 0.1523 |
| Porcelain | 20–790 | 0.0413 |
| Porcelain Bayeux | 1000–1400 | 0.0553 |
| Quartz: | | |
| Parallel to axis | 0–80 | 0.0797 |
| Parallel to axis | −190 to + 16 | 0.0521 |
| Perpend. to axis | 0–80 | 0.1337 |
| Quartz glass | −190 to + 16 | −0.0026 |
| Quartz glass | 16 to 500 | 0.0057 |
| Quartz glass | 16 to 1000 | 0.0058 |
| Rock salt | 40 | 0.4040 |
| Rubber, hard | 0 | 0.691 |
| Rubber, hard | −160 | 0.300 |
| Speculum metal | 0–100 | 0.1933 |
| Steel, 0.14 C, 34.5 Ni | 25–100 | 0.037 |
| | 25–600 | 0.136 |
| Topas: | | |
| Parallel to lesser horizontal axis | 0–100 | 0.0832 |
| Parallel to greater horizontal axis | 0–100 | 0.0836 |
| Parallel to vertical axis | 0–100 | 0.0472 |
| Tourmaline: | | |
| Parallel to longitudinal axis | 0–100 | 0.0937 |
| Parallel to horizontal axis | 0–100 | 0.0773 |
| Type metal | 16.6–254 | 0.1952 |
| Vulcanite | 0–18 | 0.6360 |
| Wedgwood ware | 0–100 | 0.0890 |
| Wood: | | |
| Parallel to fiber: | | |
| Ash | 0–100 | 0.0951 |
| Beech | 2.34 | 0.0257 |
| Chestnut | 2.34 | 0.0649 |
| Elm | 2.34 | 0.0565 |
| Mahogany | 2.34 | 0.0361 |
| Maple | 2.34 | 0.0638 |
| Oak | 2.34 | 0.0492 |
| Pine | 2.34 | 0.0541 |
| Walnut | 2.34 | 0.0658 |
| Across the fiber: | | |
| Beech | 2.34 | 0.614 |
| Chestnut | 2.34 | 0.325 |
| Elm | 2.34 | 0.443 |
| Mahogany | 2.34 | 0.404 |
| Maple | 2.34 | 0.484 |
| Oak | 2.34 | 0.544 |
| Pine | 2.34 | 0.341 |
| Walnut | 2.34 | 0.484 |
| Wax white | 10–26 | 2.300 |
| Wax white | 26–31 | 3.120 |
| Wax white | 31–43 | 4.860 |
| Wax white | 43–57 | 15.227 |

**Smithsonian Tables.* For a more complete tabulation see Tables 143, 144. *Smithsonian Physical Tables.* 9th ed., 1954, also reprinted in *American Institute of Physics Handbook,* McGraw-Hill, New York, 1957; *Handbook of Chemistry and Physics,* 40th ed., pp. 2239–2245, Chemical Rubber Publishing Co. For data on many solids prior to 1926, see Gruneisen, *Handbuch der Physik,* vol. 10, pp. 1–52, 1926, translation available as *N.A.S.A.* RE 2-18-59W, 1959. For eight plastic solids below 300 K, see Scott, *Cryogenic Engineering,* p. 331, Van Nostrand, Princeton, NJ, 1959. For 11 other materials to 300 K, see Scott, *loc. cit.,* p. 333. For quartz and silica, see Cook, *Brit. J. Appl. Phys.,* **7,** 285 (1956).

## TABLE 2-147 Cubical Expansion of Liquids*

If $V_0$ is the volume at 0°, then at $t$° the expansion formula is $V_t = V_0(1 + \alpha t + \beta t^2 + \gamma t^3)$. The table gives values of α, β, and γ, and of $C$, the true coefficient of cubical expansion at 20° for some liquids and solutions. The temperature range of the observation is $\Delta t$. Values for the coefficient of cubical expansion of liquids can be derived from the tables of specific volumes of the saturated liquid given as a function of temperature later in this section.

| Liquid | Range | $\alpha \times 10^3$ | $\beta \times 10^6$ | $\gamma \times 10^8$ | $C \times 10^8$ at 20° |
|---|---|---|---|---|---|
| Acetic acid | 16–107 | 1.0630 | 0.12636 | 1.0876 | 1.071 |
| Acetone | 0–54 | 1.3240 | 3.8090 | − 0.87983 | 1.487 |
| Alcohol: | | | | | |
| Amyl | − 15–80 | 0.9001 | 0.6573 | 1.18458 | 0.902 |
| Ethyl, 30% by volume | 18–39 | 0.2928 | 10.790 | −11.87 | |
| Ethyl, 50% by volume | 0–39 | 0.7450 | 1.85 | 0.730 | |
| Ethyl, 99.3% by volume | 27–46 | 1.012 | 2.20 | | 1.12 |
| Ethyl, 500 atm. pressure | 0–40 | 0.866 | | | |
| Ethyl, 3000 atm. pressure | 0–40 | 0.524 | | | |
| Methyl | 0–61 | 1.1342 | 1.3635 | 0.8741 | 1.199 |
| Benzene | 11–81 | 1.17626 | 1.27776 | 0.80648 | 1.237 |
| Bromine | 0–59 | 1.06218 | 1.87714 | −0.30854 | 1.132 |
| Calcium chloride: | | | | | |
| 5.8% solution | 18–25 | 0.07878 | 4.2742 | | 0.250 |
| 40.9% solution | 17–24 | 0.42383 | 0.8571 | | 0.458 |
| Carbon disulfide | −34–60 | 1.13980 | 1.37065 | 1.91225 | 1.218 |
| 500 atm. pressure | 0–50 | 0.940 | | | |
| 3000 atm. pressure | 0–50 | 0.581 | | | |
| Carbon tetrachloride | 0–76 | 1.18384 | 0.89881 | 1.35135 | 1.236 |
| Chloroform | 0–63 | 1.10715 | 4.66473 | − 1.74328 | 1.273 |
| Ether | −15–38 | 1.51324 | 2.35918 | 4.00512 | 1.656 |
| Glycerin | | 0.4853 | 0.4895 | | 0.505 |
| Hydrochloric acid, 33.2% solution | 0–33 | 0.4460 | 0.215 | | 0.455 |
| Mercury | 0–100 | 0.18182 | 0.0078 | | 0.18186 |
| Olive oil | | 0.6821 | 1.1405 | − 0.539 | 0.721 |
| Pentane | 0–33 | 1.4646 | 3.09319 | 1.6084 | 1.608 |
| Potassium chloride, 24.3% solution | 16–25 | 0.2695 | 2.080 | | 0.353 |
| Phenol | 36–157 | 0.8340 | 0.10732 | 0.4446 | 1.090 |
| Petroleum, 0.8467 density | 24–120 | 0.8994 | 1.396 | | 0.955 |
| Sodium chloride, 20.6% solution | 0–29 | 0.3640 | 1.237 | | 0.414 |
| Sodium sulfate, 24% solution | 11–40 | 0.3599 | 1.258 | | 0.410 |
| Sulfuric acid: | | | | | |
| 10.9% solution | 0–30 | 0.2835 | 2.580 | | 0.387 |
| 100.0% | 0–30 | 0.5758 | −0.432 | | 0.558 |
| Turpentine | − 9–106 | 0.9003 | 1.9595 | − 0.44998 | 0.973 |
| Water | 0–33 | −0.06427 | 8.5053 | − 6.7900 | 0.207 |

**Smithsonian Tables*, Table 269. For a detailed discussion of mercury data, see Cook, *Brit. J. Appl. Phys.*, **7,** 285 (1956). For data on nitrogen and argon, see Johnson (ed.), WADD-TR-60-56, 1960.

Bromoform[1] 7.7 – 50°C.
$V_t = 0.34204[1 + 0.00090411(t - 7.7) + 0.0000006766(t - 7.7)^2]$
0.34204 in the specific volume of bromoform at 7.7°C.

Glycerin[2] −62 to 0°C.
$V_t = V_0(1 + 4.83 \times 10^{-4}t - 0.49 \times 10^{-6}t^2)$
0 – 80°C.
$V_t = V_0(1 + 4.83 \times 10^{-4}t + 0.49 \times 10^{-6}t^2)$

Mercury[3] 0 – 300°C.
$V_t - V_0[1 + 10^{-8}(18153.8t + 0.7548t^2 + 0.001533t^3 + 0.00000536t^4)]$

[1] Sherman and Sherman, *J. Am. Chem. Soc.*, **50,** 1119 (1928). (An obvious error in their equation has been corrected.)
[2] Samsoen, *Ann. phys.*, (10) **9,** 91 (1928).
[3] Harlow, *Phil. Mag.*, (7) **7,** 674 (1929).

## TABLE 2-148 Cubical Expansion of Solids*

If $v_2$ and $v_1$ are the volumes at $t_2$ and $t_1$, respectively, then $v_2 = v_1(1 + C\Delta t)$, $C$ being the coefficient of cubical expansion and $\Delta t$ the temperature interval. Where only a single temperature is stated, $C$ represents the true coefficient of cubical expansion at that temperature.

| Substance | $t$ or $\Delta t$ | $C \times 10^4$ |
|---|---|---|
| Antimony | 0–100 | 0.3167 |
| Beryl | 0–100 | 0.0105 |
| Bismuth | 0–100 | 0.3948 |
| Copper† | 0–100 | 0.4998 |
| Diamond | 40 | 0.0354 |
| Emerald | 40 | 0.0168 |
| Galena | 0–100 | 0.558 |
| Glass, common tube | 0–100 | 0.276 |
| hard | 0–100 | 0.214 |
| Jena, borosilicate 59 III | 20–100 | 0.156 |
| pure silica | 0–80 | 0.0129 |
| Gold | 0–100 | 0.4411 |
| Ice | −20 to −1 | 1.1250 |
| Iron | 0–100 | 0.3550 |
| Lead† | 0–100 | 0.8399 |
| Paraffin | 20 | 5.88 |
| Platinum | 0–100 | 0.265 |
| Porcelain, Berlin | 20 | 0.0814 |
| chloride | 0–100 | 1.094 |
| nitrate | 0–100 | 1.967 |
| sulfate | 20 | 1.0754 |
| Quartz | 0–100 | 0.3840 |
| Rock salt | 50–60 | 1.2120 |
| Rubber | 20 | 4.87 |
| Silver | 0–100 | 0.5831 |
| Sodium | 20 | 2.13 |
| Stearic acid | 33.8–45.4 | 8.1 |
| Sulfur, native | 13.2–50.3 | 2.23 |
| Tin | 0–100 | 0.6889 |
| Zinc† | 0–100 | 0.8928 |

**Smithsonian Tables*, Table 268.
†See additional data below.

Aluminum[1] 100 – 530°C.
$V = V_0(1 + 2.16 \times 10^{-5}t + 0.95 \times 10^{-8}t^2)$

Cadmium[1] 130 – 270°C.
$V = V_0(1 + 8.04 \times 10^{-5}t + 5.9 \times 10^{-8}t^2)$

Copper[1] 110 – 300°C.
$V = V_0(1 + 1.62 \times 10^{-5}t + 0.20 \times 10^{-8}t^2)$

Colophony[2] 0 – 34°C.
$V = V_0(1 + 2.21 \times 10^{-4}t + 0.31 \times 10^{-6}t^2)$
34 – 150°C.
$V = V_{34}[1 + 7.40 \times 10^{-4}(t - 34) + 5.91 \times 10^{-6}(t - 34)^2]$

Lead[1] 100 – 280°C.
$V = V_0(1 + 1.60 \times 10^{-5}t + 3.2 \times 10^{-8}t^2)$

Shellac[2] 0 – 46°C.
$V = V_0(1 + 2.73 \times 10^{-4}t + 0.39 \times 10^{-6}t^2)$
46 – 100°C.
$V = V_{46}[1 + 13.10 \times 10^{-4}(t - 46) + 0.62 \times 10^{-6}(t - 46)^2]$

Silica (vitreous)[3] 0 – 300°C.
$V_t = V_0[1 + 10^{-8}(93.6t + 0.7776t^2 - 0.003315t^3 + 0.00000524t^4)$

Sugar (cane, amorphous)[2] 0 – 67°C.
$V_t = V_0(1 + 2.34 \times 10^{-4}t + 0.14 \times 10^{-6}t^2)$
67 – 160°C.
$V_t = V_{67}[1 + 5.02 \times 10^{-4}(t - 67) + 0.43 \times 10^{-6}(t - 67)^2]$

Zinc[1] 120 – 360°C.
$V_t = V_0(1 + 8.50 \times 10^{-5}t + 3.9 \times 10^{-8}t^2)$

[1] Uffelmann, *Phil. Mag.*, (7) **10,** 633 (1930).
[2] Samsoen, *Ann. phys.*, (10) **9,** 83 (1928).
[3] Harlow, *Phil. Mag.*, (7) **7,** 674 (1929).

# JOULE-THOMSON EFFECT

## UNITS CONVERSIONS

For this subsection, the following units conversions are applicable:

To convert the Joule-Thomson coefficient, $\mu$, in degrees Celsius per atmosphere to degrees Fahrenheit per atmosphere, multiply by 1.8.

$°F = \frac{9}{5}\,°C + 32$; $°R = \frac{9}{5}\,K$

To convert bars to pounds-force per square inch, multiply by 14.504; to convert bars to kilopascals, multiply by $1 \times 10^2$.

**TABLE 2-149 Additional References Available for the Joule-Thomson Coefficient**

| Gas | Pressure range, atm | | | | Temp. range, °C | | | Unclassified |
|---|---|---|---|---|---|---|---|---|
| | 0–10 | 10–50 | 50–200 | >200 | <0 | 0–300 | >300 | |
| Air | 12, 15, 16 19, 35 | 12, 15, 19 35 | 15, 19, 35 | | 19, 35 | 12, 15, 16 19, 35 | | 3, 4, 18 |
| Ammonia | 28 | | | | | 28 | | 2, 3 |
| Argon | 39 | 39 | 39 | | 39 | 39 | | |
| Benzene | 31 | 31 | 31 | | | 31 | 31 | |
| Butane | 26 | 26 | | | | 26 | | |
| Carbon dioxide | 7, 8, 28 37 | 7, 8, 37 | 7, 8, 37 | | 7, 8, 37 | 7, 8, 9, 10 37 | | |
| Carbon monoxide | 17 | 17 | | | 17 | 17 | | |
| Deuterium | | 22, 24, 25 1* | 1,* 22, 24 25 | | 1,* 22, 24, 25 | | | |
| Dowtherm A | 46 | 46 | | | | 46 | 46 | |
| Ethane | 45 | 45 | | | | 45 | | |
| Ethylene | | | | | | 9, 10 | | |
| Helium | 1, 38 | 1, 38 | 38 | | 1, 38 | 38 | | 48 |
| Hydrogen | 24, 30 | 22, 24, 25 30 | 24, 30 | | 22, 24, 25 30 | 24 | | |
| Methane | | 6 | 6 | | | 6 | | |
| Mixtures | | | | | | 9, 11 | | |
| Natural gas | | | 33 | 33 | 33 | 33 | | |
| Nitrogen | 13, 28, 40 | 13, 40 | 13, 40 | 13 | 13, 40 | 9, 10, 13 28, 40 | 13 | 19 |
| Nitrous oxide | | | | | | 9, 10 | | |
| Pentane | 26, 34, 44 | 34 | 34 | | | 26, 34, 44 | | |
| Propane | 41 | 43 | | | | 43 | | |
| Steam | 28, 29, 42 | 29, 42, 47 | 42, 47 | | | 28, 29, 42 45 | 29, 42, 47 | 29, 47 |

*See also 14 (generalized chart); 18 (review, to 1919); 20–22; 23 (review, to 1948); 27 (review, to 1905); 32, 36, 41, 50.

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**TABLE 2-150 Approximate Inversion-Curve Locus in Reduced Coordinates ($T_r = T/T_c$; $P_r = P/P_c$)***

| $P_r$ | 0 | 0.5 | 1 | 1.5 | 2 | 2.5 | 3 | 4 |
|---|---|---|---|---|---|---|---|---|
| $T_{rL}$ | 0.782 | 0.800 | 0.818 | 0.838 | 0.859 | 0.880 | 0.903 | 0.953 |
| $T_{rU}$ | 4.984 | 4.916 | 4.847 | 4.777 | 4.706 | 4.633 | 4.550 | 4.401 |
| $P_r$ | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 11.79 |
| $T_{rL}$ | 1.01 | 1.08 | 1.16 | 1.25 | 1.35 | 1.50 | 1.73 | 2.24 |
| $T_{rU}$ | 4.23 | 4.06 | 3.88 | 3.68 | 3.45 | 3.18 | 2.86 | 2.24 |

*Calculated from the best three-constant equation recommended by Miller, *Ind. Eng. Chem. Fundam.*, **9,** 585 (1970). $T_{rL}$ refers to the lower curve, and $T_{rU}$, to the upper curve.

**TABLE 2-151 Joule-Thomson Data for Air***

| | $t$, °C | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $P$, atm | −150 | −100 | −75 | −50 | −25 | 0 | 25 | 50 | 75 | 100 | 150 | 200 | 250 |
| 1 | | 0.5895 | 0.4795 | 0.3910 | 0.3225 | 0.2745 | 0.2320 | 0.1956 | 0.1614 | 0.1355 | 0.0961 | 0.0645 | 0.0409 |
| 20 | | .5700 | .4555 | .3690 | .3010 | .2580 | .2173 | .1830 | .1508 | .1258 | .0883 | .0580 | .0356 |
| 60 | 0.0450 | .4820 | .3835 | .3195 | .2610 | .2200 | .1852 | .1571 | .1293 | .1062 | .0732 | .0453 | .0254 |
| 100 | .0185 | .2775 | .2880 | .2505 | .2130 | .1820 | .1550 | .1310 | .1087 | .0884 | .0600 | .0343 | .0165 |
| 140 | − .0070 | .1360 | .1855 | .1825 | .1650 | .1450 | .1249 | .1070 | .0889 | .0726 | .0482 | .0250 | .0092 |
| 180 | − .0255 | .0655 | .1136 | .1270 | .1240 | .1100 | .0959 | .0829 | .0707 | .0580 | .0376 | .0174 | .0027 |
| 200 | − .0330 | .0440 | .0855 | .1065 | .1090 | .0950 | | | | | | | |

*Free of water and $CO_2$. Extracted from Table 261, *Smithsonian Physical Tables,* 9th rev. ed., Washington, DC, 1954. These data are corrected from earlier publications. μ in °C/atm.

**TABLE 2-152 Approximate Inversion-Curve Locus for Air**

| $P$, bar | 0 | 25 | 50 | 75 | 100 | 125 | 150 | 175 | 200 | 225 |
|---|---|---|---|---|---|---|---|---|---|---|
| $T_L$, K | (112)* | 114 | 117 | 120 | 124 | 128 | 132 | 137 | 143 | 149 |
| $T_U$, K | 653 | 641 | 629 | 617 | 606 | 594 | 582 | 568 | 555 | 541 |
| $P$, bar | 250 | 275 | 300 | 325 | 350 | 375 | 400 | 425 | 432 | |
| $T_L$, K | 156 | 164 | 173 | 184 | 197 | 212 | 230 | 265 | 300 | |
| $T_U$, K | 526 | 509 | 491 | 470 | 445 | 417 | 386 | 345 | 300 | |

*Hypothetical low-pressure limit.

**TABLE 2-153 Joule-Thomson Data for Argon***

| | Pressure, atm | | | | | | |
|---|---|---|---|---|---|---|---|
| $t$, °C | 1 | 20 | 60 | 100 | 140 | 180 | 200 |
| −150 | 1.812 | | −0.0025 | −0.0277 | −0.0403 | −0.0595 | −0.0640 |
| −125 | 1.112 | 1.102 | .1250 | .0415 | .0090 | −.0100 | − .0165 |
| −100 | 0.8605 | 0.8485 | .6900 | .2820 | .1137 | .0560 | .0395 |
| −75 | .7100 | .6895 | .5910 | .4225 | .2480 | .1537 | .1215 |
| −50 | .5960 | .5720 | .4963 | .3970 | .2840 | .2037 | .1860 |
| −25 | .5045 | .4805 | .4210 | .3460 | .2763 | .2140 | .1950 |
| 0 | .4307 | .4080 | .3600 | .3010 | .2505 | .2050 | .1883 |
| 25 | .3720 | .3490 | .3077 | .2628 | .2213 | .1890 | .1745 |
| 50 | .3220 | .3015 | .2650 | .2297 | .1947 | .1700 | .1580 |
| 75 | .2695 | .2557 | .2285 | .1993 | .1710 | .1505 | .1415 |
| 100 | .2413 | .2277 | .1975 | .1715 | .1490 | .1320 | .1255 |
| 125 | .2105 | .1980 | .1707 | .1480 | .1300 | .1153 | .1100 |
| 150 | .1845 | .1720 | .1485 | .1285 | .1123 | .0998 | .0945 |
| 200 | .1377 | .1280 | .1102 | .0950 | .0823 | .0715 | .0675 |
| 250 | .0980 | .0910 | .0785 | .0665 | .0555 | .0485 | .0468 |
| 300 | .0643 | .0607 | .0530 | .0445 | .0370 | .0370 | .0276 |

*Extracted from Table 263, *Smithsonian Physical Tables,* 9th rev. ed., Washington, DC, 1954. These data are corrected from an earlier publication. μ in °C/atm.

**TABLE 2-154 Approximate Inversion-Curve Locus for Argon**

| $P$, bar | 0 | 25 | 50 | 75 | 100 | 125 | 150 | 175 | 200 | 225 |
|---|---|---|---|---|---|---|---|---|---|---|
| $T_L$, K | 94 | 97 | 101 | 105 | 109 | 113 | 118 | 123 | 128 | 134 |
| $T_U$, K | 765 | 755 | 744 | 736 | 726 | 716 | 705 | 694 | 683 | 671 |
| $P$, bar | 250 | 275 | 300 | 325 | 350 | 375 | 400 | 425 | 450 | 475 |
| $T_L$, K | 141 | 148 | 158 | 170 | 183 | 201 | 222 | 248 | 288 | 375 |
| $T_U$, K | 657 | 643 | 627 | 610 | 591 | 569 | 544 | 515 | 478 | 375 |

**TABLE 2-155 Joule-Thomson Data for Carbon Dioxide***

| | Pressure, atm | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $t$, °C | 1 | 20 | 60 | 73 | 100 | 140 | 180 | 200 |
| –75 | | –0.0200 | –0.0200 | –0.0232 | –0.0228 | –0.0240 | –0.0250 | –0.0290 |
| –50 | 2.4130 | – .0140 | – .0150 | – .0165 | – .0160 | – .0183 | – .0228 | – .0248 |
| 0 | 1.2900 | 1.4020 | .0370 | .0310 | .0215 | .0115 | .0085 | .0045 |
| 50 | 0.8950 | .8950 | .8800 | .8225 | .5570 | .1720 | .1025 | .0930 |
| 100 | .6490 | .6375 | .6080 | .5920 | .5405 | .4320 | .3000 | .2555 |
| 125 | .5600 | .5450 | .5160 | .5068 | .4750 | .4130 | .3230 | .2915 |
| 150 | .4890 | .4695 | .4430 | .4380 | .4155 | .3760 | .3102 | .2910 |
| 200 | .3770 | .3575 | .3400 | .3325 | .3150 | .2890 | .2600 | .2455 |
| 250 | .3075 | .2885 | .2625 | .2565 | .2420 | .2235 | .2045 | .1975 |
| 300 | .2650 | .2425 | .2080 | .2002 | .1872 | .1700 | .1540 | .1505 |

*Extracted from Table 266, *Smithsonian Physical Tables,* 9th rev. ed., Washington, DC, 1954. These data are corrected from an earlier publication. $\mu$ in °C/atm.

**TABLE 2-156 Approximate Inversion-Curve Locus for Carbon Dioxide***

| $P$, bar | 50 | 100 | 150 | 200 | 250 | 300 | 350 | 400 | 450 |
|---|---|---|---|---|---|---|---|---|---|
| $T_L$, K | 243 | 251 | 258 | 266 | 272 | 283 | 293 | 302 | 312 |
| $T_U$, K | 1290 | 1261 | 1233 | 1205 | 1175 | 1146 | 1111 | 1076 | 1045 |
| $P$, bar | 500 | 550 | 600 | 650 | 700 | 750 | 800 | 850 | 884 |
| $T_L$, K | 325 | 338 | 351 | 365 | 383 | 403 | 441 | 496 | 608 |
| $T_U$, K | 1015 | 983 | 950 | 914 | 878 | 840 | 796 | 739 | 608 |

*Interpolated from Vukalovich and Altunin's interpolation of data of Price, *Ind. Eng. Chem.,* **47,** 1691 (1955). $T_L$ = lower inversion temperature, and $T_U$ = upper inversion temperature.

**TABLE 2-157 Approximate Inversion-Curve Locus for Deuterium**

| $P$, bar | 0 | 25 | 50 | 75 | 100 | 125 | 150 | 175 | 194 |
|---|---|---|---|---|---|---|---|---|---|
| $T_L$, K | (31)* | 34 | 38 | 43 | 49 | 56 | 65 | 77 | 108 |
| $T_U$, K | 216 | 202 | 189 | 178 | 168 | 157 | 146 | 131 | 108 |

*Hypothetical low-pressure limit.

**TABLE 2-158 Approximate Inversion-Curve Locus for Ethane**

| $P$, bar | 0 | 25 | 50 | 75 | 100 | 125 | 150 | 175 | 200 | 225 |
|---|---|---|---|---|---|---|---|---|---|---|
| $T_L$, K | | 249 | 255 | 262 | 269 | 275 | 282 | 290 | 297 | 306 |
| $P$, bar | 250 | 275 | 300 | 325 | 350 | 375 | 400 | 425 | 450 | 475 |
| $T_L$, K | 315 | 325 | 335 | 345 | 357 | 370 | 383 | 398 | 415 | 432 |
| $P$, bar | 500 | 525 | 550 | 575 | 600 | | | | | |
| $T_L$, K | 453 | 477 | 505 | 545 | 626 | | | | | |

**TABLE 2-159 Joule-Thomson Data for Helium***

| $T$, K | 160 | 180 | 200 | 220 | 240 | 260 | 280 | 300 |
|---|---|---|---|---|---|---|---|---|
| μ | –0.0574 | –0.0587 | –0.0594 | –0.0601 | –0.0608 | –0.0614 | –0.0619 | –0.0625 |
| $T$, K | 320 | 340 | 360 | 380 | 400 | 420 | 440 | 460 |
| μ | –0.0629 | –0.0634 | –0.0637 | –0.0640 | –0.0643 | –0.0645 | –0.0645 | –0.0643 |
| $T$, K | 480 | 500 | 520 | 540 | 560 | 580 | 600 | |
| μ | –0.0640 | –0.0636 | –0.0630 | –0.0622 | –0.0611 | –0.0587 | –0.0540 | |

*Interpolated and converted from data in Table 262, *Smithsonian Physical Tables,* 9th rev. ed., Washington, DC, 1954. These data are corrected from those in an earlier publication. μ is in °C/atm. Below about 200 atm, little change in the coefficient with pressure occurs.

**TABLE 2-160 Approximate Inversion-Curve Locus for Normal Hydrogen**

| $P$, bar | 0 | 25 | 50 | 75 | 100 | 125 | 150 | 164 |
|---|---|---|---|---|---|---|---|---|
| $T_L$, K | (28)* | 32 | 38 | 44 | 52 | 61 | 73 | 92 |
| $T_U$, K | 202 | 193 | 183 | 171 | 157 | 141 | 119 | 92 |

*Hypothetical low-pressure limit.

**TABLE 2-161 Approximate Inversion-Curve Locus for Methane**

| $P$, bar | 25 | 50 | 75 | 100 | 125 | 150 | 175 | 200 | 225 | 250 | 275 | 300 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $T_L$, K | | 161 | 166 | 172 | 176 | 182 | 189 | 195 | 202 | 209 | 217 | 225 |
| $P$, bar | 325 | 350 | 375 | 400 | 425 | 450 | 475 | 500 | 525 | 534 | | |
| $T_L$, K | 234 | 243 | 254 | 265 | 277 | 292 | 309 | 331 | 365 | 400 | | |
| $T_U$, K | | | | | | | 505 | 474 | 437 | 400 | | |

**TABLE 2-162 Joule-Thomson Data for Nitrogen***

| | Pressure, atm | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $t$, °C | 1 | 20 | 33.5 | 60 | 100 | 140 | 180 | 200 |
| –150 | 1.2659 | 1.1246 | 0.1704 | 0.0601 | 0.0202 | –0.0056 | –0.0211 | –0.0284 |
| –125 | 0.8557 | 0.7948 | .7025 | .4940 | .1314 | .0498 | .0167 | .0032 |
| –100 | .6490 | .5958 | .5494 | .4506 | .2754 | .1373 | .0765 | .0587 |
| –75 | .5033 | .4671 | .4318 | .3712 | .2682 | .1735 | .1026 | .0800 |
| –50 | .3968 | .3734 | .3467 | .3059 | .2332 | .1676 | .1120 | .0906 |
| –25 | .3224 | .3013 | .2854 | .2528 | .2001 | .1506 | .1101 | .0932 |
| 0 | .2656 | .2494 | .2377 | .2088 | .1679 | .1316 | .1015 | .0891 |
| 25 | .2217 | .2060 | .1961 | .1729 | .1400 | .1105 | .0874 | .0779 |
| 50 | .1855 | .1709 | .1621 | .1449 | .1164 | .0915 | .0732 | .0666 |
| 75 | .1555 | .1421 | .1336 | .1191 | .0941 | .0740 | .0583 | .0543 |
| 100 | .1292 | .1173 | .1100 | .0975 | .0768 | .0582 | .0462 | .0419 |
| 125 | .1070 | .0973 | .0904 | .0786 | .0621 | .0459 | .0347 | .0326 |
| 150 | .0868 | .0776 | .0734 | .0628 | .0482 | .0348 | .0248 | .0228 |
| 200 | .0558 | .0472 | .0430 | .0372 | .0262 | .0168 | .0094 | .0070 |
| 250 | .0331 | .0256 | .0230 | .0160 | .0071 | .0009 | –.0037 | –.0058 |
| 300 | .0140 | .0096 | .0050 | –.0013 | –.0075 | –.0129 | –.0160 | –.0171 |

*Extracted from Table 264, *Smithsonian Physical Tables,* 9th rev. ed., Washington, DC, 1954. These data are corrected from an earlier publication. μ in °C/atm.

**TABLE 2-163 Approximate Inversion-Curve Locus for Propane**

| $P$, bar | 0 | 25 | 50 | 75 | 100 | 125 | 150 | 175 | 200 | 225 | 250 | 275 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $T_L$, K | (296)* | 303 | 311 | 318 | 327 | 336 | 345 | 355 | 365 | 374 | 389 | 403 |
| $P$, bar | 300 | 325 | 350 | 375 | 400 | 425 | 450 | 475 | 500 | 525 | 541 | |
| $T_L$, K | 418 | 435 | 452 | 473 | 495 | 521 | 551 | 586 | 628 | 686 | 780 | |

*Hypothetical low-pressure limit.

# CRITICAL CONSTANTS

## ADDITIONAL REFERENCES

Other data and estimation techniques for the elements are contained in Gates and Thodos, *Am. Inst. Chem. Eng. J.*, **6** (1960):50–54; and Ohse and von Tippelskirch, *High Temperatures—High Pressures*, **9** (1977):367–385. For inorganic substances see Mathews, *Chem. Rev.*, **72** (1972):71–100; for organics see Kudchaker, Alani, and Zwolinski, *Chem. Rev.*, **68** (1968):659–735; and for fluorocarbons see *Advances in Fluorine Chemistry*, App. B, Butterworth. Washington, 1963, pp. 173–175.

**TABLE 2-164 Critical Constants and Acentric Factors of Inorganic and Organic Compounds**

| Cmpd. no. | Name | Formula | CAS no. | Mol. wt. | $T_c$, K | $P_c \times$ 1E-06 Pa | $V_c$, $m^3$/Kmol | $Z_c$ | Acentric factor |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Methane | $CH_4$ | 74828 | 16.043 | 190.564 | 4.59 | 0.099 | 0.286 | 0.011 |
| 2 | Ethane | $C_2H_6$ | 74840 | 30.070 | 305.32 | 4.85 | 0.146 | 0.279 | 0.098 |
| 3 | Propane | $C_3H_8$ | 74986 | 44.097 | 369.83 | 4.21 | 0.200 | 0.273 | 0.149 |
| 4 | *n*-Butane | $C_4H_{10}$ | 106978 | 58.123 | 425.12 | 3.77 | 0.255 | 0.272 | 0.197 |
| 5 | *n*-Pentane | $C_5H_{12}$ | 109660 | 72.150 | 469.7 | 3.36 | 0.315 | 0.271 | 0.251 |
| 6 | *n*-Hexane | $C_6H_{14}$ | 110543 | 86.177 | 507.6 | 3.04 | 0.373 | 0.269 | 0.304 |
| 7 | *n*-Heptane | $C_7H_{16}$ | 142825 | 100.204 | 540.2 | 2.72 | 0.428 | 0.259 | 0.346 |
| 8 | *n*-Octane | $C_8H_{18}$ | 111659 | 114.231 | 568.7 | 2.47 | 0.486 | 0.254 | 0.396 |
| 9 | *n*-Nonane | $C_9H_{20}$ | 111842 | 128.258 | 594.6 | 2.31 | 0.540 | 0.252 | 0.446 |
| 10 | *n*-Decane | $C_{10}H_{22}$ | 124185 | 142.285 | 617.7 | 2.09 | 0.601 | 0.245 | 0.488 |
| 11 | *n*-Undecane | $C_{11}H_{24}$ | 1120214 | 156.312 | 639 | 1.95 | 0.658 | 0.242 | 0.530 |
| 12 | *n*-Dodecane | $C_{12}H_{26}$ | 112403 | 170.338 | 658 | 1.82 | 0.718 | 0.239 | 0.577 |
| 13 | *n*-Tridecane | $C_{13}H_{28}$ | 629505 | 184.365 | 675 | 1.68 | 0.779 | 0.233 | 0.617 |
| 14 | *n*-Tetradecane | $C_{14}H_{30}$ | 629594 | 198.392 | 693 | 1.57 | 0.830 | 0.226 | 0.643 |
| 15 | *n*-Pentadecane | $C_{15}H_{32}$ | 629629 | 212.419 | 708 | 1.47 | 0.888 | 0.222 | 0.685 |
| 16 | *n*-Hexadecane | $C_{16}H_{34}$ | 544763 | 226.446 | 723 | 1.41 | 0.943 | 0.221 | 0.721 |
| 17 | *n*-Heptadecane | $C_{17}H_{36}$ | 629787 | 240.473 | 736 | 1.34 | 0.998 | 0.219 | 0.771 |
| 18 | *n*-Octadecane | $C_{18}H_{38}$ | 593453 | 254.500 | 747 | 1.26 | 1.059 | 0.214 | 0.806 |
| 19 | *n*-Nonadecane | $C_{19}H_{40}$ | 629925 | 268.527 | 758 | 1.21 | 1.119 | 0.215 | 0.851 |
| 20 | *n*-Eicosane | $C_{20}H_{42}$ | 112958 | 282.553 | 768 | 1.17 | 1.169 | 0.215 | 0.912 |
| 21 | 2-Methylpropane | $C_4H_{10}$ | 75285 | 58.123 | 408.14 | 3.62 | 0.261 | 0.278 | 0.177 |
| 22 | 2-Methylbutane | $C_5H_{12}$ | 78784 | 72.150 | 460.43 | 3.37 | 0.304 | 0.268 | 0.226 |
| 23 | 2,3-Dimethylbutane | $C_6H_{14}$ | 79298 | 86.177 | 499.98 | 3.13 | 0.358 | 0.269 | 0.246 |
| 24 | 2-Methylpentane | $C_6H_{14}$ | 107835 | 86.177 | 497.5 | 3.02 | 0.366 | 0.267 | 0.279 |
| 25 | 2,3-Dimethylpentane | $C_7H_{16}$ | 565593 | 100.204 | 537.35 | 2.88 | 0.396 | 0.255 | 0.292 |
| 26 | 2,3,3-Trimethylpentane | $C_8H_{18}$ | 560214 | 114.231 | 573.5 | 2.81 | 0.455 | 0.268 | 0.289 |
| 27 | 2,2,4-Trimethylpentane | $C_8H_{18}$ | 540841 | 114.231 | 543.96 | 2.56 | 0.465 | 0.264 | 0.301 |
| 28 | Ethylene | $C_2H_4$ | 74851 | 28.054 | 282.34 | 5.03 | 0.132 | 0.283 | 0.086 |
| 29 | Propylene | $C_3H_6$ | 115071 | 42.081 | 365.57 | 4.63 | 0.188 | 0.286 | 0.137 |
| 30 | 1-Butene | $C_4H_8$ | 106989 | 56.108 | 419.95 | 4.04 | 0.241 | 0.279 | 0.190 |
| 31 | cis-2-Butene | $C_4H_8$ | 590181 | 56.108 | 435.58 | 4.24 | 0.233 | 0.273 | 0.204 |
| 32 | trans-2-Butene | $C_4H_8$ | 624646 | 56.108 | 428.63 | 4.08 | 0.237 | 0.272 | 0.216 |
| 33 | 1-Pentene | $C_5H_{10}$ | 109671 | 70.134 | 464.78 | 3.56 | 0.295 | 0.271 | 0.236 |
| 34 | 1-Hexene | $C_6H_{12}$ | 592416 | 84.161 | 504.03 | 3.14 | 0.354 | 0.265 | 0.280 |
| 35 | 1-Heptene | $C_7H_{14}$ | 592767 | 98.188 | 537.29 | 2.82 | 0.413 | 0.261 | 0.330 |
| 36 | 1-Octene | $C_8H_{16}$ | 111660 | 112.215 | 566.65 | 2.57 | 0.460 | 0.251 | 0.377 |
| 37 | 1-Nonene | $C_9H_{18}$ | 124118 | 126.242 | 593.25 | 2.33 | 0.528 | 0.249 | 0.417 |
| 38 | 1-Decene | $C_{10}H_{20}$ | 872059 | 140.269 | 616.4 | 2.21 | 0.584 | 0.252 | 0.478 |
| 39 | 2-Methylpropene | $C_4H_8$ | 115117 | 56.108 | 417.9 | 3.98 | 0.238 | 0.272 | 0.192 |
| 40 | 2-Methyl-1-butene | $C_5H_{10}$ | 563462 | 70.134 | 465 | 3.45 | 0.292 | 0.261 | 0.237 |
| 41 | 2-Methyl-2-butene | $C_5H_{10}$ | 513359 | 70.134 | 471 | 3.38 | 0.292 | 0.252 | 0.272 |
| 42 | 1,2-Butadiene | $C_4H_6$ | 590192 | 54.092 | 452 | 4.36 | 0.220 | 0.255 | 0.166 |
| 43 | 1,3-Butadiene | $C_4H_6$ | 106990 | 54.092 | 425.17 | 4.30 | 0.220 | 0.268 | 0.192 |
| 44 | 2-Methyl-1,3-butadiene | $C_5H_8$ | 78795 | 68.119 | 484 | 3.85 | 0.277 | 0.265 | 0.158 |
| 45 | Acetylene | $C_2H_2$ | 74862 | 26.038 | 308.32 | 6.15 | 0.113 | 0.271 | 0.188 |
| 46 | Methylacetylene | $C_3H_4$ | 74997 | 40.065 | 402.39 | 5.62 | 0.164 | 0.276 | 0.216 |
| 47 | Dimethylacetylene | $C_4H_6$ | 503173 | 54.092 | 473.2 | 4.87 | 0.221 | 0.274 | 0.239 |
| 48 | 3-Methyl-1-butyne | $C_5H_8$ | 598232 | 68.119 | 463.2 | 4.20 | 0.275 | 0.300 | 0.308 |
| 49 | 1-Pentyne | $C_5H_8$ | 627190 | 68.119 | 481.2 | 4.17 | 0.277 | 0.289 | 0.290 |
| 50 | 2-Pentyne | $C_5H_8$ | 627214 | 68.119 | 519 | 4.02 | 0.276 | 0.257 | 0.174 |
| 51 | 1-Hexyne | $C_6H_{10}$ | 693027 | 82.145 | 516.2 | 3.64 | 0.322 | 0.273 | 0.335 |
| 52 | 2-Hexyne | $C_6H_{10}$ | 764352 | 82.145 | 549 | 3.53 | 0.331 | 0.256 | 0.221 |
| 53 | 3-Hexyne | $C_6H_{10}$ | 928494 | 82.145 | 544 | 3.54 | 0.334 | 0.261 | 0.219 |
| 54 | 1-Heptyne | $C_7H_{12}$ | 628717 | 96.172 | 559 | 3.13 | 0.386 | 0.260 | 0.272 |
| 55 | 1-Octyne | $C_8H_{14}$ | 629050 | 110.199 | 585 | 2.82 | 0.441 | 0.256 | 0.323 |
| 56 | Vinylacetylene | $C_4H_4$ | 689974 | 52.076 | 454 | 4.89 | 0.205 | 0.265 | 0.109 |

**TABLE 2-164 Critical Constants and Acentric Factors of Inorganic and Organic Compounds** (*Continued*)

| Cmpd. no. | Name | Formula | CAS no. | Mol. wt. | $T_c$, K | $P_c \times 1E\text{-}06$ Pa | $V_c$, $m^3/Kmol$ | $Z_c$ | Acentric factor |
|---|---|---|---|---|---|---|---|---|---|
| 57 | Cyclopentane | $C_5H_{10}$ | 287923 | 70.134 | 511.76 | 4.50 | 0.257 | 0.272 | 0.196 |
| 58 | Methylcyclopentane | $C_6H_{12}$ | 96377 | 84.161 | 532.79 | 3.78 | 0.319 | 0.272 | 0.230 |
| 59 | Ethylcyclopentane | $C_7H_{14}$ | 1640897 | 98.188 | 569.52 | 3.40 | 0.374 | 0.269 | 0.271 |
| 60 | Cyclohexane | $C_6H_{12}$ | 110827 | 84.161 | 553.58 | 4.10 | 0.308 | 0.274 | 0.212 |
| 61 | Methylcyclohexane | $C_7H_{14}$ | 108872 | 98.188 | 572.19 | 3.48 | 0.368 | 0.269 | 0.236 |
| 62 | 1,1-Dimethylcyclohexane | $C_8H_{16}$ | 590669 | 112.215 | 591.15 | 2.94 | 0.450 | 0.269 | 0.233 |
| 63 | Ethylcyclohexane | $C_8H_{16}$ | 1678917 | 112.215 | 609.15 | 3.04 | 0.430 | 0.258 | 0.246 |
| 64 | Cyclopentene | $C_5H_8$ | 142290 | 68.119 | 507 | 4.81 | 0.245 | 0.279 | 0.196 |
| 65 | 1-Methylcyclopentene | $C_6H_{10}$ | 693890 | 82.145 | 542 | 4.13 | 0.303 | 0.278 | 0.232 |
| 66 | Cyclohexene | $C_6H_{10}$ | 110838 | 82.145 | 560.4 | 4.39 | 0.291 | 0.274 | 0.216 |
| 67 | Benzene | $C_6H_6$ | 71432 | 78.114 | 562.16 | 4.88 | 0.261 | 0.273 | 0.209 |
| 68 | Toluene | $C_7H_8$ | 108883 | 92.141 | 591.8 | 4.10 | 0.314 | 0.262 | 0.262 |
| 69 | *o*-Xylene | $C_8H_{10}$ | 95476 | 106.167 | 630.33 | 3.74 | 0.374 | 0.267 | 0.311 |
| 70 | *m*-Xylene | $C_8H_{10}$ | 108383 | 106.167 | 617.05 | 3.53 | 0.377 | 0.259 | 0.325 |
| 71 | *p*-Xylene | $C_8H_{10}$ | 106423 | 106.167 | 616.23 | 3.50 | 0.381 | 0.260 | 0.320 |
| 72 | Ethylbenzene | $C_8H_{10}$ | 100414 | 106.167 | 617.2 | 3.60 | 0.375 | 0.263 | 0.301 |
| 73 | Propylbenzene | $C_9H_{12}$ | 103651 | 120.194 | 638.32 | 3.20 | 0.440 | 0.265 | 0.344 |
| 74 | 1,2,4-Trimethylbenzene | $C_9H_{12}$ | 95636 | 120.194 | 649.13 | 3.25 | 0.430 | 0.259 | 0.380 |
| 75 | Isopropylbenzene | $C_9H_{12}$ | 98828 | 120.194 | 631.1 | 3.18 | 0.429 | 0.260 | 0.322 |
| 76 | 1,3,5-Trimethylbenzene | $C_9H_{12}$ | 108678 | 120.194 | 637.36 | 3.11 | 0.433 | 0.254 | 0.397 |
| 77 | *p*-Isopropyltoluene | $C_{10}H_{14}$ | 99876 | 134.221 | 653.15 | 2.80 | 0.497 | 0.256 | 0.366 |
| 78 | Naphthalene | $C_{10}H_8$ | 91203 | 128.174 | 748.35 | 3.99 | 0.413 | 0.265 | 0.296 |
| 79 | Biphenyl | $C_{12}H_{10}$ | 92524 | 154.211 | 789.26 | 3.86 | 0.502 | 0.295 | 0.367 |
| 80 | Styrene | $C_8H_8$ | 100425 | 104.152 | 636 | 3.82 | 0.352 | 0.254 | 0.295 |
| 81 | *m*-Terphenyl | $C_{18}H_{14}$ | 92068 | 230.309 | 924.85 | 3.53 | 0.768 | 0.352 | 0.561 |
| 82 | Methanol | $CH_4O$ | 67561 | 32.042 | 512.64 | 8.14 | 0.117 | 0.224 | 0.566 |
| 83 | Ethanol | $C_2H_6O$ | 64175 | 46.069 | 513.92 | 6.12 | 0.168 | 0.240 | 0.643 |
| 84 | 1-Propanol | $C_3H_8O$ | 71238 | 60.096 | 536.78 | 5.12 | 0.220 | 0.252 | 0.617 |
| 85 | 1-Butanol | $C_4H_{10}O$ | 71363 | 74.123 | 563.05 | 4.34 | 0.276 | 0.256 | 0.585 |
| 86 | 2-Butanol | $C_4H_{10}O$ | 78922 | 74.123 | 536.05 | 4.20 | 0.270 | 0.254 | 0.574 |
| 87 | 2-Propanol | $C_3H_8O$ | 67630 | 60.096 | 508.3 | 4.79 | 0.221 | 0.250 | 0.670 |
| 88 | 2-Methyl-2-propanol | $C_4H_{10}O$ | 75650 | 74.123 | 506.21 | 3.99 | 0.276 | 0.262 | 0.613 |
| 89 | 1-Pentanol | $C_5H_{12}O$ | 71410 | 88.150 | 586.15 | 3.87 | 0.327 | 0.260 | 0.592 |
| 90 | 2-Methyl-1-butanol | $C_5H_{12}O$ | 137326 | 88.150 | 565 | 3.87 | 0.327 | 0.270 | 0.678 |
| 91 | 3-Methyl-1-butanol | $C_5H_{12}O$ | 123513 | 88.150 | 577.2 | 3.90 | 0.327 | 0.266 | 0.586 |
| 92 | 1-Hexanol | $C_6H_{14}O$ | 111273 | 102.177 | 611.35 | 3.46 | 0.381 | 0.259 | 0.572 |
| 93 | 1-Heptanol | $C_7H_{16}O$ | 111706 | 116.203 | 631.9 | 3.18 | 0.435 | 0.263 | 0.592 |
| 94 | Cyclohexanol | $C_6H_{12}O$ | 108930 | 100.161 | 650 | 4.25 | 0.322 | 0.253 | 0.371 |
| 95 | Ethylene glycol | $C_2H_6O_2$ | 107211 | 62.068 | 719.7 | 7.71 | 0.191 | 0.246 | 0.487 |
| 96 | 1,2-Propylene glycol | $C_3H_8O_2$ | 57556 | 76.095 | 626 | 6.04 | 0.239 | 0.277 | 1.102 |
| 97 | Phenol | $C_6H_6O$ | 108952 | 94.113 | 694.25 | 6.06 | 0.229 | 0.240 | 0.438 |
| 98 | *o*-Cresol | $C_7H_8O$ | 95487 | 108.140 | 697.55 | 5.06 | 0.282 | 0.246 | 0.438 |
| 99 | *m*-Cresol | $C_7H_8O$ | 108394 | 108.140 | 705.85 | 4.52 | 0.312 | 0.240 | 0.444 |
| 100 | *p*-Cresol | $C_7H_8O$ | 106445 | 108.140 | 704.65 | 5.15 | 0.277 | 0.244 | 0.507 |
| 101 | Dimethyl ether | $C_2H_6O$ | 115106 | 46.069 | 400.1 | 5.27 | 0.171 | 0.271 | 0.192 |
| 102 | Methyl ethyl ether | $C_3H_8O$ | 540670 | 60.096 | 437.8 | 4.47 | 0.221 | 0.271 | 0.229 |
| 103 | Methyl n-propyl ether | $C_4H_{10}O$ | 557175 | 74.123 | 476.3 | 3.77 | 0.276 | 0.263 | 0.264 |
| 104 | Methyl isopropyl ether | $C_4H_{10}O$ | 598538 | 74.123 | 464.5 | 3.89 | 0.276 | 0.278 | 0.280 |
| 105 | Methyl n-butyl ether | $C_5H_{12}O$ | 628284 | 88.150 | 510 | 3.31 | 0.329 | 0.257 | 0.335 |
| 106 | Methyl isobutyl ether | $C_5H_{12}O$ | 625445 | 88.150 | 497 | 3.41 | 0.331 | 0.273 | 0.310 |
| 107 | Methyl tert-butyl ether | $C_5H_{12}O$ | 1634044 | 88.150 | 497.1 | 3.41 | 0.329 | 0.272 | 0.264 |
| 108 | Diethyl ether | $C_4H_{10}O$ | 60297 | 74.123 | 466.7 | 3.64 | 0.281 | 0.264 | 0.281 |
| 109 | Ethyl propyl ether | $C_5H_{12}O$ | 628320 | 88.150 | 500.23 | 3.37 | 0.336 | 0.273 | 0.347 |
| 110 | Ethyl isopropyl ether | $C_5H_{12}O$ | 625547 | 88.150 | 489 | 3.41 | 0.329 | 0.276 | 0.306 |
| 111 | Methyl phenyl ether | $C_7H_8O$ | 100663 | 108.140 | 645.6 | 4.27 | 0.337 | 0.268 | 0.353 |
| 112 | Diphenyl ether | $C_{12}H_{10}O$ | 101848 | 170.211 | 766.8 | 3.10 | 0.503 | 0.244 | 0.441 |
| 113 | Formaldehyde | $CH_2O$ | 50000 | 30.026 | 408 | 6.59 | 0.115 | 0.223 | 0.282 |
| 114 | Acetaldehyde | $C_2H_4O$ | 75070 | 44.053 | 466 | 5.57 | 0.154 | 0.221 | 0.292 |
| 115 | 1-Propanal | $C_3H_6O$ | 123386 | 58.080 | 504.4 | 4.92 | 0.204 | 0.239 | 0.256 |
| 116 | 1-Butanal | $C_4H_8O$ | 123728 | 72.107 | 537.2 | 4.32 | 0.258 | 0.250 | 0.278 |
| 117 | 1-Pentanal | $C_5H_{10}O$ | 110623 | 86.134 | 566.1 | 3.97 | 0.313 | 0.264 | 0.347 |
| 118 | 1-Hexanal | $C_6H_{12}O$ | 66251 | 100.161 | 591 | 3.46 | 0.369 | 0.260 | 0.387 |
| 119 | 1-Heptanal | $C_7H_{14}O$ | 111717 | 114.188 | 617 | 3.18 | 0.421 | 0.261 | 0.427 |
| 120 | 1-Octanal | $C_8H_{16}O$ | 124130 | 128.214 | 638.1 | 2.97 | 0.474 | 0.265 | 0.474 |
| 121 | 1-Nonanal | $C_9H_{18}O$ | 124196 | 142.241 | 658 | 2.74 | 0.527 | 0.264 | 0.514 |
| 122 | 1-Decanal | $C_{10}H_{20}O$ | 112312 | 156.268 | 674.2 | 2.60 | 0.580 | 0.269 | 0.582 |

**TABLE 2-164 Critical Constants and Acentric Factors of Inorganic and Organic Compounds** (*Continued*)

| Cmpd. no. | Name | Formula | CAS no. | Mol. wt. | $T_c$, K | $P_c \times$ 1E-06 Pa | $V_c$, $m^3$/Kmol | $Z_c$ | Acentric factor |
|---|---|---|---|---|---|---|---|---|---|
| 123 | Acetone | $C_3H_6O$ | 67641 | 58.080 | 508.2 | 4.71 | 0.210 | 0.234 | 0.307 |
| 124 | Methyl ethyl ketone | $C_4H_8O$ | 78933 | 72.107 | 535.5 | 4.12 | 0.267 | 0.247 | 0.320 |
| 125 | 2-Pentanone | $C_5H_{10}O$ | 107879 | 86.134 | 561.08 | 3.71 | 0.301 | 0.239 | 0.345 |
| 126 | Methyl isopropyl ketone | $C_5H_{10}O$ | 563804 | 86.134 | 553 | 3.84 | 0.313 | 0.261 | 0.349 |
| 127 | 2-Hexanone | $C_6H_{12}O$ | 591786 | 100.161 | 587.05 | 3.31 | 0.369 | 0.250 | 0.395 |
| 128 | Methyl isobutyl ketone | $C_6H_{12}O$ | 108101 | 100.161 | 571.4 | 3.27 | 0.369 | 0.254 | 0.389 |
| 129 | 3-Methyl-2-pentanone | $C_6H_{12}O$ | 565617 | 100.161 | 573 | 3.32 | 0.371 | 0.259 | 0.386 |
| 130 | 3-Pentanone | $C_5H_{10}O$ | 96220 | 86.134 | 560.95 | 3.70 | 0.336 | 0.267 | 0.340 |
| 131 | Ethyl isopropyl ketone | $C_6H_{12}O$ | 565695 | 100.161 | 567 | 3.34 | 0.369 | 0.262 | 0.394 |
| 132 | Diisopropyl ketone | $C_7H_{14}O$ | 565800 | 114.188 | 576 | 3.06 | 0.416 | 0.266 | 0.411 |
| 133 | Cyclohexanone | $C_6H_{10}O$ | 108941 | 98.145 | 653 | 4.01 | 0.311 | 0.230 | 0.308 |
| 134 | Methyl phenyl ketone | $C_8H_8O$ | 98862 | 120.151 | 709.5 | 3.85 | 0.386 | 0.252 | 0.365 |
| 135 | Formic acid | $CH_2O_2$ | 64186 | 46.026 | 588 | 5.81 | 0.125 | 0.148 | 0.317 |
| 136 | Acetic acid | $C_2H_4O_2$ | 64197 | 60.053 | 591.95 | 5.74 | 0.179 | 0.208 | 0.463 |
| 137 | Propionic acid | $C_3H_6O_2$ | 79094 | 74.079 | 600.81 | 4.61 | 0.232 | 0.214 | 0.574 |
| 138 | *n*-Butyric acid | $C_4H_8O_2$ | 107926 | 88.106 | 615.7 | 4.07 | 0.291 | 0.231 | 0.682 |
| 139 | Isobutyric acid | $C_4H_8O_2$ | 79312 | 88.106 | 605 | 3.68 | 0.291 | 0.213 | 0.612 |
| 140 | Benzoic acid | $C_7H_6O_2$ | 65850 | 122.123 | 751 | 4.47 | 0.347 | 0.248 | 0.603 |
| 141 | Acetic anhydride | $C_4H_6O_3$ | 108247 | 102.090 | 606 | 3.97 | 0.290 | 0.229 | 0.450 |
| 142 | Methyl formate | $C_2H_4O_2$ | 107313 | 60.053 | 487.2 | 5.98 | 0.173 | 0.255 | 0.254 |
| 143 | Methyl acetate | $C_3H_6O_2$ | 79209 | 74.079 | 506.55 | 4.69 | 0.229 | 0.256 | 0.326 |
| 144 | Methyl propionate | $C_4H_8O_2$ | 554121 | 88.106 | 530.6 | 4.03 | 0.284 | 0.259 | 0.349 |
| 145 | Methyl n-butyrate | $C_5H_{10}O_2$ | 623427 | 102.133 | 554.5 | 3.48 | 0.340 | 0.257 | 0.378 |
| 146 | Ethyl formate | $C_3H_6O_2$ | 109944 | 74.079 | 508.4 | 4.71 | 0.231 | 0.257 | 0.282 |
| 147 | Ethyl acetate | $C_4H_8O_2$ | 141786 | 88.106 | 523.3 | 3.85 | 0.287 | 0.254 | 0.363 |
| 148 | Ethyl propionate | $C_5H_{10}O_2$ | 105373 | 102.133 | 546 | 3.34 | 0.345 | 0.254 | 0.391 |
| 149 | Ethyl n-butyrate | $C_6H_{12}O_2$ | 105544 | 116.160 | 571 | 2.94 | 0.403 | 0.249 | 0.399 |
| 150 | *n*-Propyl formate | $C_4H_8O_2$ | 110747 | 88.106 | 538 | 4.03 | 0.286 | 0.257 | 0.310 |
| 151 | *n*-Propyl acetate | $C_5H_{10}O_2$ | 109604 | 102.133 | 549.73 | 3.37 | 0.349 | 0.257 | 0.390 |
| 152 | *n*-Butyl acetate | $C_6H_{12}O_2$ | 123864 | 116.160 | 579.15 | 3.11 | 0.389 | 0.251 | 0.410 |
| 153 | Methyl benzoate | $C_8H_8O_2$ | 93583 | 136.150 | 693 | 3.59 | 0.436 | 0.272 | 0.421 |
| 154 | Ethyl benzoate | $C_9H_{10}O_2$ | 93890 | 150.177 | 698 | 3.22 | 0.489 | 0.271 | 0.477 |
| 155 | Vinyl acetate | $C_4H_6O_2$ | 108054 | 86.090 | 519.13 | 3.93 | 0.270 | 0.246 | 0.348 |
| 156 | Methylamine | $CH_5N$ | 74895 | 31.057 | 430.05 | 7.41 | 0.154 | 0.319 | 0.279 |
| 157 | Dimethylamine | $C_2H_7N$ | 124403 | 45.084 | 437.2 | 5.26 | 0.180 | 0.260 | 0.293 |
| 158 | Trimethylamine | $C_3H_9N$ | 75503 | 59.111 | 433.25 | 4.10 | 0.254 | 0.289 | 0.210 |
| 159 | Ethylamine | $C_2H_7N$ | 75047 | 45.084 | 456.15 | 5.59 | 0.202 | 0.298 | 0.283 |
| 160 | Diethylamine | $C_4H_{11}N$ | 109897 | 73.138 | 496.6 | 3.67 | 0.301 | 0.268 | 0.300 |
| 161 | Triethylamine | $C_6H_{15}N$ | 121448 | 101.192 | 535.15 | 3.04 | 0.389 | 0.266 | 0.316 |
| 162 | *n*-Propylamine | $C_3H_9N$ | 107108 | 59.111 | 496.95 | 4.74 | 0.260 | 0.298 | 0.280 |
| 163 | di-*n*-Propylamine | $C_6H_{15}N$ | 142847 | 101.192 | 550 | 3.11 | 0.401 | 0.273 | 0.446 |
| 164 | Isopropylamine | $C_3H_9N$ | 75310 | 59.111 | 471.85 | 4.54 | 0.221 | 0.256 | 0.276 |
| 165 | Diisopropylamine | $C_6H_{15}N$ | 108189 | 101.192 | 523.1 | 3.20 | 0.417 | 0.307 | 0.388 |
| 166 | Aniline | $C_6H_7N$ | 62533 | 93.128 | 699 | 5.35 | 0.270 | 0.248 | 0.381 |
| 167 | N-Methylaniline | $C_7H_9N$ | 100618 | 107.155 | 701.55 | 5.19 | 0.373 | 0.332 | 0.480 |
| 168 | N,N-Dimethylaniline | $C_8H_{11}N$ | 121697 | 121.182 | 687.15 | 3.63 | 0.465 | 0.295 | 0.403 |
| 169 | Ethylene oxide | $C_2H_4O$ | 75218 | 44.053 | 469.15 | 7.26 | 0.142 | 0.264 | 0.201 |
| 170 | Furan | $C_4H_4O$ | 110009 | 68.075 | 490.15 | 5.55 | 0.218 | 0.297 | 0.205 |
| 171 | Thiophene | $C_4H_4S$ | 110021 | 84.142 | 579.35 | 5.71 | 0.219 | 0.260 | 0.195 |
| 172 | Pyridine | $C_5H_5N$ | 110861 | 79.101 | 619.95 | 5.64 | 0.254 | 0.278 | 0.239 |
| 173 | Formamide | $CH_3NO$ | 75127 | 45.041 | 771 | 7.75 | 0.163 | 0.197 | 0.410 |
| 174 | N,N-Dimethylformamide | $C_3H_7NO$ | 68122 | 73.095 | 649.6 | 4.37 | 0.262 | 0.212 | 0.312 |
| 175 | Acetamide | $C_2H_5NO$ | 60355 | 59.068 | 761 | 6.57 | 0.215 | 0.223 | 0.419 |
| 176 | N-Methylacetamide | $C_3H_7NO$ | 79163 | 73.095 | 718 | 5.00 | 0.267 | 0.224 | 0.437 |
| 177 | Acetonitrile | $C_2H_3N$ | 75058 | 41.053 | 545.5 | 4.85 | 0.173 | 0.185 | 0.340 |
| 178 | Propionitrile | $C_3H_5N$ | 107120 | 55.079 | 564.4 | 4.19 | 0.229 | 0.205 | 0.325 |
| 179 | *n*-Butyronitrile | $C_4H_7N$ | 109740 | 69.106 | 582.25 | 3.79 | 0.278 | 0.217 | 0.371 |
| 180 | Benzonitrile | $C_7H_5N$ | 100470 | 103.123 | 699.35 | 4.21 | 0.339 | 0.245 | 0.352 |
| 181 | Methyl mercaptan | $CH_4S$ | 74931 | 48.109 | 469.95 | 7.23 | 0.145 | 0.268 | 0.158 |
| 182 | Ethyl mercaptan | $C_2H_6S$ | 75081 | 62.136 | 499.15 | 5.49 | 0.206 | 0.273 | 0.188 |
| 183 | *n*-Propyl mercaptan | $C_3H_8S$ | 107039 | 76.163 | 536.6 | 4.63 | 0.254 | 0.263 | 0.232 |
| 184 | *n*-Butyl mercaptan | $C_4H_{10}S$ | 109795 | 90.189 | 570.1 | 3.97 | 0.307 | 0.257 | 0.272 |
| 185 | Isobutyl mercaptan | $C_4H_{10}S$ | 513440 | 90.189 | 559 | 4.06 | 0.307 | 0.268 | 0.253 |
| 186 | sec-Butyl mercaptan | $C_4H_{10}S$ | 513531 | 90.189 | 554 | 4.06 | 0.307 | 0.271 | 0.251 |
| 187 | Dimethyl sulfide | $C_2H_6S$ | 75183 | 62.136 | 503.04 | 5.53 | 0.200 | 0.264 | 0.194 |
| 188 | Methyl ethyl sulfide | $C_3H_8S$ | 624895 | 76.163 | 533 | 4.26 | 0.254 | 0.244 | 0.209 |
| 189 | Diethyl sulfide | $C_4H_{10}S$ | 352932 | 90.189 | 557.15 | 3.96 | 0.320 | 0.273 | 0.294 |

**TABLE 2-164 Critical Constants and Acentric Factors of Inorganic and Organic Compounds** (*Concluded*)

| Cmpd. no. | Name | Formula | CAS no. | Mol. wt. | $T_c$, K | $P_c \times$ 1E-06 Pa | $V_c$, $m^3$/Kmol | $Z_c$ | Acentric factor |
|---|---|---|---|---|---|---|---|---|---|
| 190 | Fluoromethane | $CH_3F$ | 593533 | 34.033 | 317.42 | 5.88 | 0.113 | 0.252 | 0.198 |
| 191 | Chloromethane | $CH_3Cl$ | 74873 | 50.488 | 416.25 | 6.69 | 0.142 | 0.275 | 0.154 |
| 192 | Trichloromethane | $CHCl_3$ | 67663 | 119.377 | 536.4 | 5.55 | 0.238 | 0.296 | 0.228 |
| 193 | Tetrachloromethane | $CCl_4$ | 56235 | 153.822 | 556.35 | 4.54 | 0.274 | 0.270 | 0.191 |
| 194 | Bromomethane | $CH_3Br$ | 74839 | 94.939 | 467 | 8.00 | 0.156 | 0.321 | 0.192 |
| 195 | Fluoroethane | $C_2H_5F$ | 353366 | 48.060 | 375.31 | 5.01 | 0.164 | 0.263 | 0.218 |
| 196 | Chloroethane | $C_2H_5Cl$ | 75003 | 64.514 | 460.35 | 5.46 | 0.155 | 0.221 | 0.206 |
| 197 | Bromoethane | $C_2H_5Br$ | 74964 | 108.966 | 503.8 | 6.29 | 0.215 | 0.323 | 0.259 |
| 198 | 1-Chloropropane | $C_3H_7Cl$ | 540545 | 78.541 | 503.15 | 4.58 | 0.247 | 0.270 | 0.228 |
| 199 | 2-Chloropropane | $C_3H_7Cl$ | 75296 | 78.541 | 489 | 4.51 | 0.247 | 0.274 | 0.196 |
| 200 | 1,1-Dichloropropane | $C_3H_6Cl_2$ | 78999 | 112.986 | 560 | 4.24 | 0.292 | 0.266 | 0.253 |
| 201 | 1,2-Dichloropropane | $C_3H_6Cl_2$ | 78875 | 112.986 | 572 | 4.23 | 0.291 | 0.259 | 0.256 |
| 202 | Vinyl chloride | $C_2H_3Cl$ | 75014 | 62.499 | 432 | 5.75 | 0.179 | 0.287 | 0.106 |
| 203 | Fluorobenzene | $C_6H_5F$ | 462066 | 96.104 | 560.09 | 4.54 | 0.269 | 0.262 | 0.247 |
| 204 | Chlorobenzene | $C_6H_5Cl$ | 108907 | 112.558 | 632.35 | 4.53 | 0.308 | 0.265 | 0.251 |
| 205 | Bromobenzene | $C_6H_5Br$ | 108861 | 157.010 | 670.15 | 4.52 | 0.324 | 0.263 | 0.251 |
| 206 | Air | | 132259100 | 28.951 | 132.45 | 3.79 | 0.092 | 0.318 | 0.000 |
| 207 | Hydrogen | $H_2$ | 1333740 | 2.016 | 33.19 | 1.32 | 0.064 | 0.307 | –0.215 |
| 208 | Helium-4 | He | 7440597 | 4.003 | 5.2 | 0.23 | 0.058 | 0.305 | –0.388 |
| 209 | Neon | Ne | 7440019 | 20.180 | 44.4 | 2.67 | 0.042 | 0.300 | –0.038 |
| 210 | Argon | Ar | 7440371 | 39.948 | 150.86 | 4.90 | 0.075 | 0.292 | 0.000 |
| 211 | Fluorine | $F_2$ | 7782414 | 37.997 | 144.12 | 5.17 | 0.067 | 0.287 | 0.053 |
| 212 | Chlorine | $Cl_2$ | 7782505 | 70.905 | 417.15 | 7.79 | 0.124 | 0.279 | 0.073 |
| 213 | Bromine | $Br_2$ | 7726956 | 159.808 | 584.15 | 10.28 | 0.135 | 0.286 | 0.128 |
| 214 | Oxygen | $O_2$ | 7782447 | 31.999 | 154.58 | 5.02 | 0.074 | 0.287 | 0.020 |
| 215 | Nitrogen | $N_2$ | 7727379 | 28.014 | 126.2 | 3.39 | 0.089 | 0.288 | 0.037 |
| 216 | Ammonia | $NH_3$ | 7664417 | 17.031 | 405.65 | 11.30 | 0.072 | 0.241 | 0.253 |
| 217 | Hydrazine | $N_2H_4$ | 302012 | 32.045 | 653.15 | 14.73 | 0.158 | 0.429 | 0.315 |
| 218 | Nitrous oxide | $N_2O$ | 10024972 | 44.013 | 309.57 | 7.28 | 0.098 | 0.277 | 0.143 |
| 219 | Nitric oxide | NO | 10102439 | 30.006 | 180.15 | 6.52 | 0.058 | 0.252 | 0.585 |
| 220 | Cyanogen | $C_2N_2$ | 460195 | 52.036 | 400.15 | 5.94 | 0.195 | 0.348 | 0.276 |
| 221 | Carbon monoxide | CO | 630080 | 28.010 | 132.92 | 3.49 | 0.095 | 0.300 | 0.048 |
| 222 | Carbon dioxide | $CO_2$ | 124389 | 44.010 | 304.21 | 7.39 | 0.095 | 0.277 | 0.224 |
| 223 | Carbon disulfide | $CS_2$ | 75150 | 76.143 | 552 | 8.04 | 0.160 | 0.280 | 0.118 |
| 224 | Hydrogen fluoride | HF | 7664393 | 20.006 | 461.15 | 6.49 | 0.069 | 0.117 | 0.383 |
| 225 | Hydrogen chloride | HCl | 7647010 | 36.461 | 324.65 | 8.36 | 0.082 | 0.253 | 0.134 |
| 226 | Hydrogen bromide | HBr | 10035106 | 80.912 | 363.15 | 8.46 | 0.100 | 0.280 | 0.069 |
| 227 | Hydrogen cyanide | HCN | 74908 | 27.026 | 456.65 | 5.35 | 0.139 | 0.195 | 0.407 |
| 228 | Hydrogen sulfide | $H_2S$ | 7783064 | 34.082 | 373.53 | 9.00 | 0.099 | 0.287 | 0.096 |
| 229 | Sulfur dioxide | $SO_2$ | 7446095 | 64.065 | 430.75 | 7.86 | 0.123 | 0.269 | 0.244 |
| 230 | Sulfur trioxide | $SO_3$ | 7446119 | 80.064 | 490.85 | 8.19 | 0.127 | 0.255 | 0.423 |
| 231 | Water | $H_2O$ | 7732185 | 18.015 | 647.13 | 21.94 | 0.056 | 0.228 | 0.343 |

All substances are listed in alphabetical order in Table 2-6*a*.

Compiled from Daubert, T. E., R. P. Danner, H. M. Sibul, and C. C. Stebbins, DIPPR Data Compilation of Pure Compound Properties, Project 801 Sponsor Release, July, 1993, Design Institute for Physical Property Data, AIChE, New York, NY; and from Ambrose, D. "Vapour-Liquid Critical Properties", Report Chem 107, National Physical Laboratory, Teddington, UK, October, 1979.

In order to ensure thermodynamic consistency, in almost all cases these properties are calculated from $T_c$ and the vapor pressure and liquid density correlation coefficients listed in those tables. This means that there will be slight differences between the values listed here and those in the DIPPR tables. Most of the differences are less than 1%, and almost all the rest are less than the estimated accuracy of the quantity in question.

The atomic weights used, taken from *J. Phys. Chem. Ref. Data* **22**(6), 1993, are C = 12.011, H = 1.00794, O = 15.9994, N = 14.00674, S = 32.066, F = 18.9984, Cl = 35.4527, Br = 79.904, and I = 126.90447.

The value of the gas constant, $R$, used here is 8314.51 J/(kmol·K), as given by E. R. Cohen and B. N. Taylor in *J. Phys. Chem. Ref. Data* **17,** 1988. K – 273.15 = °C; 1.8 × K – 459.67 = °F; Pa × 9.869233E-06 = atm; Pa × 1.450377E-04 = psia *j*; $m^3$/kmol × (1E + 03/mol. wt.) = $cm^3$/g; $m^3$/kmol × (1.601846E + 01/mol wt) = $ft^3$/lb.

# COMPRESSIBILITIES

## INTRODUCTION

The increasing ranges of pressure and temperature of interest to technology for an ever-increasing number of substances would necessitate additional tables in this subsection as well as in the subsection "Thermodynamic Properties." Space restrictions preclude this. Hence, in the present revision, an attempt was made to update the fluid-compressibility tables for selected fluids and to omit tables for other fluids. The reader is thus referred to the fourth edition for tables on miscellaneous gases at 0°C, acetylene, ammonia, ethane, ethylene, hydrogen-nitrogen mixtures, and methyl chloride. The reader is also reminded that compressibilities can be calculated from the pressure—volume (or density)—temperature tables of the subsection "Thermodynamic Properties."

## UNITS CONVERSIONS

For this subsection, the following units conversions are applicable:

$$°R = \tfrac{9}{5}\ K.$$

To convert bars to pounds-force per cubic inch, multiply by 14.504. To convert bars to kilopascals, multiply by $1 \times 10^2$.

**TABLE 2-165 Compressibility Factors for Air***

| | Pressure, bar | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp., K | 1 | 5 | 10 | 20 | 40 | 60 | 80 | 100 | 150 | 200 | 250 | 300 | 400 | 500 |
| 75 | 0.0052 | 0.0260 | 0.0519 | 0.1036 | 0.2063 | 0.3082 | 0.4094 | 0.5099 | 0.7581 | 1.0025 | | | | |
| 80 | | 0.0250 | 0.0499 | 0.0995 | 0.1981 | 0.2958 | 0.3927 | 0.4887 | 0.7258 | 0.9588 | 1.1931 | 1.4139 | | |
| 90 | 0.9764 | 0.0236 | 0.0471 | 0.0940 | 0.1866 | 0.2781 | 0.3686 | 0.4581 | 0.6779 | 0.8929 | 1.1098 | 1.3110 | 1.7161 | 2.1105 |
| 100 | 0.9797 | 0.8872 | 0.0453 | 0.0900 | 0.1782 | 0.2635 | 0.3498 | 0.4337 | 0.6386 | 0.8377 | 1.0395 | 1.2227 | 1.5937 | 1.9536 |
| 120 | 0.9880 | 0.9373 | 0.8660 | 0.6730 | 0.1778 | 0.2557 | 0.3371 | 0.4132 | 0.5964 | 0.7720 | 0.9530 | 1.1076 | 1.5091 | 1.7366 |
| 140 | 0.9927 | 0.9614 | 0.9205 | 0.8297 | 0.5856 | 0.3313 | 0.3737 | 0.4340 | 0.5909 | 0.7699 | 0.9114 | 1.0393 | 1.3202 | 1.5903 |
| 160 | 0.9951 | 0.9748 | 0.9489 | 0.8954 | 0.7803 | 0.6603 | 0.5696 | 0.5489 | 0.6340 | 0.7564 | 0.8840 | 1.0105 | 1.2585 | 1.4970 |
| 180 | 0.9967 | 0.9832 | 0.9660 | 0.9314 | 0.8625 | 0.7977 | 0.7432 | 0.7084 | 0.7180 | 0.7986 | 0.9000 | 1.0068 | 1.2232 | 1.4361 |
| 200 | 0.9978 | 0.9886 | 0.9767 | 0.9539 | 0.9100 | 0.8701 | 0.8374 | 0.8142 | 0.8061 | 0.8549 | 0.9311 | 1.0185 | 1.2054 | 1.3944 |
| 250 | 0.9992 | 0.9957 | 0.9911 | 0.9822 | 0.9671 | 0.9549 | 0.9463 | 0.9411 | 0.9450 | 0.9713 | 1.0152 | 1.0702 | 1.1990 | 1.3392 |
| 300 | 0.9999 | 0.9987 | 0.9974 | 0.9950 | 0.9917 | 0.9901 | 0.9903 | 0.9930 | 1.0074 | 1.0326 | 1.0669 | 1.1089 | 1.2073 | 1.3163 |
| 350 | 1.0000 | 1.0002 | 1.0004 | 1.0014 | 1.0038 | 1.0075 | 1.0121 | 1.0183 | 1.0377 | 1.0635 | 1.0947 | 1.1303 | 1.2116 | 1.3015 |
| 400 | 1.0002 | 1.0012 | 1.0025 | 1.0046 | 1.0100 | 1.0159 | 1.0229 | 1.0312 | 1.0533 | 1.0795 | 1.1087 | 1.1411 | 1.2117 | 1.2890 |
| 450 | 1.0003 | 1.0016 | 1.0034 | 1.0063 | 1.0133 | 1.0210 | 1.0287 | 1.0374 | 1.0614 | 1.0913 | 1.1183 | 1.1463 | 1.2090 | 1.2778 |
| 500 | 1.0003 | 1.0020 | 1.0034 | 1.0074 | 1.0151 | 1.0234 | 1.0323 | 1.0410 | 1.0650 | 1.0913 | 1.1183 | 1.1463 | 1.2051 | 1.2667 |
| 600 | 1.0004 | 1.0022 | 1.0039 | 1.0081 | 1.0164 | 1.0253 | 1.0340 | 1.0434 | 1.0678 | 1.0920 | 1.1172 | 1.1427 | 1.1947 | 1.2475 |
| 800 | 1.0004 | 1.0020 | 1.0038 | 1.0077 | 1.0157 | 1.0240 | 1.0321 | 1.0408 | 1.0621 | 1.0844 | 1.1061 | 1.1283 | 1.1720 | 1.2150 |
| 1000 | 1.0004 | 1.0018 | 1.0037 | 1.0068 | 1.0142 | 1.0215 | 1.0290 | 1.0365 | 1.0556 | 1.0744 | 1.0948 | 1.1131 | 1.1515 | 1.1889 |

*Calculated from values of pressure, volume (or density), and temperature in Vasserman, Kazavchinskii, and Rabinovich, *Thermophysical Properties of Air and Air Components,* Moscow, Nauka, 1966, and NBS-NSF Trans. TT 70-50095, 1971; and Vasserman and Rabinovich, *Thermophysical Properties of Liquid Air and Its Components,* Moscow, 1968, and NBS-NSF Trans. 69-55092, 1970.

**TABLE 2-166 Compressibility Factors for Argon***

| | Pressure, bar | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp., K | 1 | 5 | 10 | 20 | 40 | 60 | 80 | 100 | 200 | 300 | 400 | 500 |
| 100 | 0.9773 | 0.0183 | 0.0366 | 0.0729 | 0.1449 | 0.2162 | 0.2867 | 0.3567 | 0.6975 | 1.0267 | 1.3470 | 1.6932 |
| 150 | 0.9932 | 0.9647 | 0.9273 | 0.8447 | 0.6101 | 0.2249 | 0.2781 | 0.3324 | 0.5934 | 0.8387 | 1.0732 | 1.2995 |
| 200 | 0.9972 | 0.9857 | 0.9713 | 0.9419 | 0.8810 | 0.8208 | 0.7624 | 0.7121 | 0.6870 | 0.8360 | 1.0051 | 1.1982 |
| 250 | 0.9988 | 0.9935 | 0.9869 | 0.9741 | 0.9494 | 0.9263 | 0.9056 | 0.8877 | 0.8590 | 0.9207 | 1.0262 | 1.1479 |
| 300 | 0.9995 | 0.9969 | 0.9941 | 0.9884 | 0.9777 | 0.9686 | 0.9611 | 0.9552 | 0.9533 | 0.9950 | 1.0673 | 1.1786 |
| 400 | 1.0001 | 0.9997 | 0.9998 | 0.9999 | 1.0004 | 1.0018 | 1.0031 | 1.0056 | 1.0280 | 1.0656 | 1.1157 | 1.1976 |
| 500 | 1.0002 | 1.0007 | 1.0012 | 1.0034 | 1.0071 | 1.0113 | 1.0154 | 1.0205 | 1.0501 | 1.0874 | 1.1301 | 1.1997 |
| 600 | 1.0003 | 1.0012 | 1.0025 | 1.0046 | 1.0094 | 1.0143 | 1.0198 | 1.0250 | 1.0553 | 1.0904 | 1.1291 | 1.1933 |
| 800 | 1.0003 | 1.0012 | 1.0023 | 1.0050 | 1.0102 | 1.0151 | 1.0205 | 1.0258 | 1.0532 | 1.0830 | 1.1147 | 1.1707 |
| 1000 | 1.0002 | 1.0013 | 1.0022 | 1.0050 | 1.0096 | 1.0142 | 1.0193 | 1.0239 | 1.0484 | 1.0736 | 1.0999 | 1.1497 |

*Calculated from PVT values tabulated in Rabinovich (ed.), *Thermophysical Properties of Neon, Argon, Krypton and Xenon,* Standard Press, Moscow, 1976. This book was published in English translation by Hemisphere, New York, 1988 (604 pp.).

**TABLE 2-167 Compressibility Factors for Carbon Dioxide***

| | Pressure, bar | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp., °C | 1 | 5 | 10 | 20 | 40 | 60 | 80 | 100 | 200 | 300 | 400 | 500 |
| 0 | 0.9933 | 0.9658 | 0.9294 | 0.8496 | | | | | | | | |
| 50 | 0.9964 | 0.9805 | 0.9607 | 0.9195 | 0.8300 | 0.7264 | 0.5981 | 0.4239 | | | | |
| 100 | 0.9977 | 0.9883 | 0.9764 | 0.9524 | 0.9034 | 0.8533 | 0.8022 | 0.7514 | 0.5891 | 0.6420 | | |
| 150 | 0.9985 | 0.9927 | 0.9853 | 0.9705 | 0.9416 | 0.9131 | 0.8854 | 0.8590 | 0.7651 | 0.7623 | 0.8235 | 0.9098 |
| 200 | 0.9991 | 0.9953 | 0.9908 | 0.9818 | 0.9640 | 0.9473 | 0.9313 | 0.9170 | 0.8649 | 0.8619 | 0.8995 | 0.9621 |
| 250 | 0.9994 | 0.9971 | 0.9943 | 0.9886 | 0.9783 | 0.9684 | 0.9593 | 0.9511 | 0.9253 | 0.9294 | 0.9508 | 1.0096 |
| 300 | 0.9996 | 0.9982 | 0.9967 | 0.9936 | 0.9875 | 0.9822 | 0.9773 | 0.9733 | 0.9640 | 0.9746 | 1.0030 | 1.0464 |
| 350 | 0.9998 | 0.9991 | 0.9983 | 0.9964 | 0.9938 | 0.9914 | 0.9896 | 0.9882 | 0.9895 | 1.0053 | 1.0340 | 1.0734 |
| 400 | 0.9999 | 0.9997 | 0.9994 | 0.9989 | 0.9982 | 0.9979 | 0.9979 | 0.9984 | 1.0073 | 1.0266 | 1.0559 | 1.0928 |
| 450 | 1.0000 | 1.0000 | 1.0003 | 1.0005 | 1.0013 | 1.0023 | 1.0038 | 1.0056 | 1.0070 | 1.0412 | 1.0709 | 1.1067 |
| 500 | 1.0000 | 1.0004 | 1.0008 | 1.0015 | 1.0035 | 1.0056 | 1.0079 | 1.0107 | 1.0282 | 1.0522 | 1.0820 | 1.1165 |
| 600 | 1.0000 | 1.0007 | 1.0013 | 1.0030 | 1.0062 | 1.0093 | 1.0129 | 1.0168 | 1.0386 | 1.0648 | 1.0948 | 1.1277 |
| 700 | 1.0003 | 1.0010 | 1.0017 | 1.0036 | 1.0073 | 1.0161 | 1.0155 | 1.0198 | 1.0436 | 1.0707 | 1.1000 | 1.1318 |
| 800 | 1.0002 | 1.0009 | 1.0019 | 1.0040 | 1.0082 | 1.0122 | 1.0168 | 1.0212 | 1.0458 | 1.0731 | 1.1016 | 1.1324 |
| 900 | 1.0002 | 1.0009 | 1.0020 | 1.0041 | 1.0083 | 1.0128 | 1.0171 | 1.0221 | 1.0463 | 1.0726 | 1.1012 | 1.1303 |
| 1000 | 1.0002 | 1.0009 | 1.0021 | 1.0042 | 1.0084 | 1.0128 | 1.0172 | 1.0218 | 1.0460 | 1.0725 | 1.0725 | 1.1274 |

*Calculated from density-pressure-temperature data in Vukalovitch and Altunin, *Thermophysical Properties of Carbon Dioxide*, Atomizdat, Moscow, 1965, and Collet's, London, 1968, translation.

**TABLE 2-168 Compressibility Factors for Carbon Monoxide***

| | Pressure, atm | | | | | | |
|---|---|---|---|---|---|---|---|
| Temp., K | 1 | 4 | 7 | 10 | 40 | 70 | 100 |
| 200 | 0.9973 | 0.9893 | 0.9813 | 0.9734 | | | |
| 250 | 0.9989 | 0.9957 | 0.9926 | 0.9896 | 0.9632 | | |
| 300 | 0.9997 | 0.9987 | 0.9977 | 0.9968 | 0.9907 | 0.9896 | 0.9935 |
| 350 | 1.0000 | 1.0002 | 1.0003 | 1.0005 | 1.0042 | 1.0112 | 1.0216 |
| 400 | 1.0002 | 1.0010 | 1.0017 | 1.0025 | 1.0042 | 1.0112 | 1.0216 |
| 450 | 1.0003 | 1.0014 | 1.0025 | 1.0035 | 1.0152 | 1.0285 | 1.0433 |
| 500 | 1.0004 | 1.0016 | 1.0029 | 1.0041 | 1.0172 | 1.0314 | 1.0469 |
| 600 | 1.0005 | 1.0018 | 1.0032 | 1.0045 | 1.0186 | 1.0332 | 1.0485 |
| 700 | 1.0005 | 1.0018 | 1.0032 | 1.0045 | 1.0183 | 1.0325 | 1.0470 |
| 800 | 1.0004 | 1.0017 | 1.0030 | 1.0044 | 1.0175 | 1.0309 | 1.0445 |
| 900 | 1.0004 | 1.0017 | 1.0029 | 1.0041 | 1.0166 | 1.0291 | 1.0418 |
| 1000 | 1.0004 | 1.0016 | 1.0027 | 1.0039 | 1.0156 | 1.0273 | 1.0391 |
| 1500 | 1.0003 | 1.0012 | 1.0021 | 1.0029 | 1.0115 | 1.0200 | 1.0286 |
| 2000 | 1.0002 | 1.0009 | 1.0016 | 1.0022 | 1.0088 | 1.0155 | 1.0221 |
| 2500 | 1.0002 | 1.0007 | 1.0013 | 1.0018 | 1.0071 | 1.0124 | 1.0178 |
| 3000 | 1.0002 | 1.0006 | 1.0010 | 1.0015 | 1.0059 | 1.0104 | 1.0148 |

*From Hilsenrath *et al., N.B.S. Circ.* 564, 1955. Some of the above values have been rounded to four decimal places. Values at 10-K increments below 1000 K and at 50 K increments for higher temperatures appear in the original, also for pressures below atmospheric.

**TABLE 2-169 Compressibility Factors for Ethanol**

| | Pressure, bar | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Temp., K | 0.1 | 0.5 | 1.013 | 10 | 20 | 50 | 100 | 250 | 500 |
| 300 | 0.0022 | 0.0023 | 0.0024 | 0.0229 | 0.0458 | 0.114 | 0.228 | 0.565 | 1.11 |
| 350 | | | | 0.0215 | 0.0411 | 0.107 | 0.208 | 0.509 | 1.03 |
| 400 | 0.999 | 0.993 | 0.986 | 0.0204 | 0.0408 | 0.101 | 0.201 | 0.490 | 0.95 |
| 450 | 1.000 | 0.997 | 0.991 | 0.908 | | 0.101 | 0.198 | 0.472 | 0.898 |
| 500 | 1.000 | 0.997 | 0.994 | 0.941 | 0.874 | 0.122 | 0.214 | 0.473 | 0.868 |
| 600 | 1.000 | 0.998 | 0.997 | 0.972 | 0.943 | | 0.672 | 0.470 | 0.868 |
| 700 | 1.000 | 0.999 | 0.999 | 0.985 | 0.971 | 0.948 | 0.902 | 0.760 | 0.921 |
| 800 | 1.000 | 1.000 | 0.999 | 0.992 | 0.984 | 0.973 | 0.953 | 0.890 | 0.988 |
| 900 | 1.000 | 1.000 | 1.000 | 0.996 | 0.992 | 0.988 | 0.981 | 0.962 | 1.04 |
| 1000 | 1.000 | 1.000 | 1.000 | 0.998 | 0.997 | 0.993 | 0.990 | 1.002 | 1.08 |

Rounded and interpolated from Thermodynamics Research Center tables, Texas A&M University.

**TABLE 2-170 Compressibility Factors for Ethylene**

| Pressure, bar | Temperature, K | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 110 | 150 | 200 | 250 | 300 | 350 | 400 | 450 | 500 |
| 1 | 0.0047 | 0.0038 | 0.9808 | 0.9902 | 0.9944 | 0.9966 | 0.9979 | 0.9986 | 0.9991 |
| 5 | 0.0237 | 0.0189 | 0.0162 | 0.9495 | 0.9717 | 0.9828 | 0.9894 | 0.9935 | 0.9959 |
| 10 | 0.0472 | 0.0378 | 0.0323 | 0.8946 | 0.9425 | 0.9659 | 0.9785 | 0.9867 | 0.9919 |
| 15 | 0.0710 | 0.0566 | 0.0484 | 0.8320 | 0.9121 | 0.9479 | 0.9679 | 0.9749 | 0.9876 |
| 20 | 0.0946 | 0.0754 | 0.0644 | 0.7578 | 0.8804 | 0.9299 | 0.9574 | 0.9734 | 0.9833 |
| 30 | 0.1418 | 0.1129 | 0.0963 | 0.0950 | 0.8122 | 0.8936 | 0.9357 | 0.9603 | 0.9754 |
| 40 | 0.1889 | 0.1504 | 0.1280 | 0.1251 | 0.7342 | 0.8560 | 0.9144 | 0.9477 | 0.9677 |
| 60 | 0.2831 | 0.2251 | 0.1910 | 0.1838 | 0.5235 | 0.7791 | 0.8730 | 0.9231 | 0.9541 |
| 80 | 0.3767 | 0.2994 | 0.2533 | 0.2410 | 0.3302 | 0.7023 | 0.9056 | 0.9009 | 0.9428 |
| 100 | 0.4702 | 0.3734 | 0.3150 | 0.2968 | 0.3480 | 0.6359 | 0.9220 | 0.8825 | 0.9321 |
| 150 | 0.7030 | 0.5567 | 0.4671 | 0.4324 | 0.4528 | 0.5842 | 0.7483 | 0.8523 | 0.9167 |
| 200 | 0.9337 | 0.7382 | 0.6161 | 0.5630 | 0.5641 | 0.6347 | 0.7499 | 0.8494 | 0.9184 |
| 250 | 1.1636 | 0.9179 | 0.7630 | 0.6904 | 0.6740 | 0.7110 | 0.7895 | 0.8710 | 0.9343 |
| 300 | 1.3917 | 1.0960 | 0.9075 | 0.8148 | 0.7816 | 0.7969 | 0.8479 | 0.9095 | 0.9631 |
| 400 | 1.8441 | 1.4475 | 1.1910 | 1.0565 | 0.9909 | 0.9726 | 0.9849 | 1.0142 | 1.0450 |
| 500 | solid | 1.7934 | 1.4679 | 1.2908 | 1.1932 | 1.1468 | 1.1304 | 1.1341 | 1.1436 |

Calculated from Jacobsen, R.T., M. Jahangiri, et al., *Ethylene,* Blackwell Sci. Publs., Oxford, 1988 (299 pp.).

**TABLE 2-171 Compressibility Factors for Normal Hydrogen***

| Temp., K | Pressure, bar | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 10 | 20 | 40 | 60 | 80 | 100 | 200 | 400 | 600 | 800 | 1000 |
| 20 | 0.0169 | 0.1680 | 0.3302 | 0.6430 | 0.9434 | 1.2346 | 1.5166 | 2.844 | | | | |
| 40 | 0.9848 | 0.8340 | 0.6311 | 0.5240 | 0.6627 | 0.8118 | 0.9590 | 1.650 | 2.878 | 3.993 | 5.034 | 6.019 |
| 60 | 0.9955 | 0.9562 | 0.9169 | 0.8608 | 0.8498 | 0.8832 | 0.9432 | 1.347 | 2.158 | 2.902 | 3.598 | 4.263 |
| 80 | 0.9986 | 0.9776 | 0.9763 | 0.9655 | 0.9676 | 0.9842 | 1.0138 | 1.257 | 1.834 | 2.389 | 2.907 | 3.404 |
| 100 | 0.9998 | 0.9979 | 0.9976 | 1.0022 | 1.0133 | 1.0280 | 1.0528 | 1.225 | 1.659 | 2.095 | 2.512 | 2.902 |
| 200 | 1.0007 | 1.0066 | 1.0134 | 1.0275 | 1.0422 | 1.0575 | 1.0734 | 1.163 | 1.355 | 1.555 | 1.753 | 1.936 |
| 300 | 1.0005 | 1.0059 | 1.0117 | 1.0236 | 1.0357 | 1.0479 | 1.0603 | 1.124 | 1.253 | 1.383 | 1.510 | 1.636 |
| 400 | 1.0004 | 1.0048 | 1.0096 | 1.0192 | 1.0289 | 1.0386 | 1.0484 | 1.098 | 1.196 | 1.293 | 1.388 | 1.481 |
| 500 | 1.0004 | 1.0040 | 1.0080 | 1.0160 | 1.0240 | 1.0320 | 1.0400 | 1.080 | 1.159 | 1.236 | 1.311 | 1.385 |
| 600 | 1.0003 | 1.0034 | 1.0068 | 1.0136 | 1.0204 | 1.0272 | 1.0340 | 1.068 | 1.133 | 1.197 | 1.259 | 1.320 |
| 800 | 1.0002 | 1.0026 | 1.0052 | 1.0104 | 1.0156 | 1.0208 | 1.0259 | 1.051 | 1.100 | 1.147 | 1.193 | 1.237 |
| 1000 | 1.0002 | 1.0021 | 1.0042 | 1.0084 | 1.0126 | 1.0168 | 1.0209 | 1.041 | 1.080 | 1.117 | 1.153 | 1.187 |
| 2000 | 1.0009 | 1.0013 | 1.0023 | 1.0044 | 1.0065 | 1.0086 | 1.0107 | 1.021 | 1.040 | 1.057 | 1.073 | 1.088 |

*Calculated from PVT tables of McCarty, Hord, and Roder, NBS Monogr. 168, 1981.

**TABLE 2-172 Compressibility Factors for KLEA 60**

| Temp., K | Pressure, bar | | | | | | | $Z_{sat}$ | $P_{sat}$ |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 5 | 10 | 15 | 20 | 25 | 30 | | |
| 250 | 0.9687 | | | | | | | 0.9494 | 2.08 |
| 260 | 0.9780 | | | | | | | 0.9315 | 3.11 |
| 270 | 0.9803 | | | | | | | 0.9098 | 4.49 |
| 280 | 0.9824 | 0.9099 | | | | | | 0.8839 | 6.30 |
| 290 | 0.9848 | 0.9199 | | | | | | 0.8538 | 8.62 |
| 300 | 0.9867 | 0.9284 | 0.8459 | | | | | 0.8175 | 11.55 |
| 310 | 0.9872 | 0.9359 | 0.8637 | 0.7800 | | | | 0.7756 | 15.19 |
| 320 | 0.9884 | 0.9425 | 0.8790 | 0.8066 | | | | 0.7261 | 19.66 |
| 330 | 0.9894 | 0.9484 | 0.8908 | 0.8299 | 0.7577 | 0.6700 | | 0.6666 | 25.10 |
| 340 | 0.9905 | 0.9537 | 0.9026 | 0.8488 | 0.7888 | 0.7184 | 0.6305 | | |
| 350 | 0.9920 | 0.9582 | 0.9139 | 0.8663 | 0.8145 | 0.7570 | 0.6908 | | |
| $Z_{sat}$ | 0.9712 | 0.9022 | 0.8361 | 0.7777 | 0.7224 | 0.6677 | 0.6118 | | |
| $T_{sat}$ | 234.0 | 273.1 | 295.0 | 309.5 | 320.7 | 329.8 | 337.6 | | |

Converted and interpolated from "Thermodynamic Properties of KLEA 60," British units, © ICI Chemicals and Polymers, 1993 (20 pp.). Reproduced by permission. KLEA 60 is R32/125/134a (20/40/40 wt %).

**TABLE 2-173 Compressibility Factors for KLEA 61**

| | Pressure, bar | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Temp., K | 1 | 5 | 10 | 15 | 20 | 25 | 30 | $Z_{sat}$ | $P_{sat}$ |
| 250 | 0.9746 | | | | | | | 0.9381 | 2.46 |
| 260 | 0.9773 | | | | | | | 0.9172 | 3.63 |
| 270 | 0.9798 | | | | | | | 0.8920 | 5.18 |
| 280 | 0.9787 | 0.9067 | | | | | | 0.8622 | 7.19 |
| 290 | 0.9838 | 0.9185 | | | | | | 0.8272 | 9.75 |
| 300 | 0.9854 | 0.9270 | 0.8431 | | | | | 0.7868 | 12.21 |
| 310 | 0.9868 | 0.9348 | 0.8615 | 0.7755 | | | | 0.7377 | 16.88 |
| 320 | 0.9881 | 0.9416 | 0.8772 | 0.8042 | 0.7148 | | | 0.6801 | 21.68 |
| 330 | 0.9892 | 0.9481 | 0.8909 | 0.8280 | 0.7518 | 0.6659 | | 0.6087 | 27.50 |
| 340 | 0.9903 | 0.9529 | 0.9027 | 0.8484 | 0.7934 | 0.7174 | 0.6312 | | |
| 350 | 0.9917 | 0.9577 | 0.9131 | 0.8653 | 0.8134 | 0.7565 | 0.6916 | | |
| $Z_{sat}$ | 0.9686 | 0.8944 | 0.8237 | 0.7602 | 0.7003 | 0.6399 | 0.5780 | | |
| $T_{sat}$ | 230.0 | 269.0 | 290.9 | 305.5 | 316.7 | 325.9 | 333.7 | | |

Converted and interpolated from "Thermodynamic Properties of KLEA 61," British units, © ICI Chemicals and Polymers, 1993 (23 pp.). Reproduced by permission. KLEA 61 is R32/125/134a (10/70/20 wt %).

**TABLE 2-174 Compressibility Factors for KLEA 66**

| | Pressure, bar | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Temp., K | 1 | 5 | 10 | 15 | 20 | 25 | 30 | $Z_{sat}$ | $P_{sat}$ |
| 250 | 0.974 | | | | | | | 0.9541 | 1.89 |
| 260 | 0.9772 | | | | | | | 0.9374 | 2.84 |
| 270 | 0.9796 | | | | | | | 0.9172 | 4.12 |
| 280 | 0.9838 | 0.9089 | | | | | | 0.8931 | 5.81 |
| 290 | 0.9858 | 0.9209 | | | | | | 0.8645 | 7.98 |
| 300 | 0.9872 | 0.9287 | 0.8461 | | | | | 0.8328 | 10.73 |
| 310 | 0.9883 | 0.9359 | 0.8663 | | | | | 0.7920 | 14.15 |
| 320 | 0.9896 | 0.9431 | 0.8786 | 0.8056 | | | | 0.7462 | 18.37 |
| 330 | 0.9907 | 0.9490 | 0.8910 | 0.8292 | 0.7551 | | | 0.6918 | 23.50 |
| 340 | 0.9917 | 0.9540 | 0.9035 | 0.8492 | 0.7878 | 0.7147 | | 0.6255 | 29.73 |
| 350 | 0.9926 | 0.9588 | 0.9137 | 0.8659 | 0.8127 | 0.7542 | 0.6843 | | |
| $Z_{sat}$ | 0.9719 | 0.9044 | 0.8397 | 0.7827 | 0.7289 | 0.6759 | 0.6220 | | |
| $T_{sat}$ | 236.1 | 275.5 | 297.6 | 312.1 | 323.5 | 332.6 | 340.4 | | |

Converted and interpolated from "Thermodynamic properties of KLEA 66," British units, © ICI Chemicals and Polymers, 1993 (20 pp.). Reproduced by permission. KLEA 66 is R32/125/134a (23/25/52 wt %).

**TABLE 2-175 Compressibility Factors for Krypton***

| | Pressure, bar | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp., K | 1 | 5 | 10 | 20 | 40 | 60 | 80 | 100 | 200 | 300 | 400 | 500 |
| 150 | 0.9837 | 0.9155 | 0.0310 | 0.0618 | 0.1227 | 0.1829 | 0.2423 | 0.3012 | 0.5875 | 0.8636 | 1.1315 | 1.3932 |
| 200 | 0.9933 | 0.9648 | 0.9278 | 0.8459 | 0.6039 | 0.1870 | 0.2393 | 0.2903 | 0.5313 | 0.7568 | 0.9730 | 1.1820 |
| 250 | 0.9966 | 0.9841 | 0.9635 | 0.9265 | 0.8468 | 0.7605 | 0.6680 | 0.5810 | 0.5785 | 0.7461 | 0.9197 | 1.0891 |
| 300 | 0.9982 | 0.9899 | 0.9800 | 0.9595 | 0.9197 | 0.8807 | 0.8437 | 0.8097 | 0.7337 | 0.7954 | 0.9302 | 1.0627 |
| 350 | 0.9989 | 0.9949 | 0.9897 | 0.9793 | 0.9522 | 0.9415 | 0.9250 | 0.9110 | 0.8774 | 0.8992 | 0.9799 | 1.0664 |
| 400 | 0.9993 | 0.9967 | 0.9933 | 0.9867 | 0.9746 | 0.9635 | 0.9539 | 0.9459 | 0.9323 | 0.9570 | 1.0150 | 1.0910 |
| 450 | 0.9998 | 0.9985 | 0.9969 | 0.9939 | 0.9886 | 0.9838 | 0.9800 | 0.9774 | 0.9663 | 1.0011 | 1.0543 | 1.1142 |
| 500 | 0.9998 | 0.9992 | 0.9984 | 0.9970 | 0.9942 | 0.9921 | 0.9910 | 0.9906 | 1.0019 | 1.0311 | 1.0732 | 1.1258 |
| 600 | 1.0000 | 1.0003 | 1.0005 | 1.0012 | 1.0025 | 1.0043 | 1.0064 | 1.0091 | 1.0301 | 1.0618 | 1.1000 | 1.1431 |
| 800 | 1.0002 | 1.0010 | 1.0020 | 1.0041 | 1.0079 | 1.0122 | 1.0170 | 1.0214 | 1.0475 | 1.0779 | 1.1112 | 1.1147 |
| 1000 | 1.0002 | 1.0013 | 1.0023 | 1.0045 | 1.0091 | 1.0135 | 1.0184 | 1.0230 | 1.0486 | 1.0767 | 1.1063 | 1.1369 |

*Calculated from PVT values tabulated in Rabinovich (ed.), *Thermophysical Properties of Neon, Argon, Krypton and Xenon,* Standards Press, Moscow, 1976. This book was published in English translation by Hemisphere, New York, 1988 (604 pp.).

**TABLE 2-176 Compressibility Factors for Methane (R50)***

| | Pressure, bar | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp., K | 1 | 5 | 10 | 20 | 40 | 60 | 80 | 100 | 200 | 300 | 400 | 500 |
| 150 | 0.9854 | 0.9225 | 0.8275 | 0.0714 | 0.1411 | 0.2093 | 0.2763 | 0.3423 | 0.6599 | 0.9623 | 1.2537 | 1.5363 |
| 200 | 0.9936 | 0.9676 | 0.9339 | 0.8599 | 0.6784 | 0.3559 | 0.3172 | 0.3618 | 0.6141 | 0.8568 | 1.0887 | 1.3122 |
| 250 | 0.9965 | 0.9838 | 0.9680 | 0.9352 | 0.8682 | 0.8020 | 0.7386 | 0.6854 | 0.6899 | 0.8554 | 1.0359 | 1.2155 |
| 300 | 0.9983 | 0.9915 | 0.9830 | 0.9667 | 0.9343 | 0.9047 | 0.8783 | 0.8556 | 0.8280 | 0.9154 | 1.0432 | 1.1829 |
| 350 | 0.9991 | 0.9954 | 0.9911 | 0.9825 | 0.9662 | 0.9520 | 0.9401 | 0.9306 | 0.9227 | 0.9800 | 1.0723 | 1.1804 |
| 400 | 0.9995 | 0.9977 | 0.9953 | 0.9912 | 0.9835 | 0.9772 | 0.9726 | 0.9696 | 0.9779 | 1.0245 | 1.0986 | 1.1859 |
| 450 | 0.9997 | 0.9989 | 0.9979 | 0.9963 | 0.9935 | 0.9917 | 0.9911 | 0.9916 | 1.0098 | 1.0528 | 1.1152 | 1.1899 |
| 500 | 0.9999 | 0.9997 | 0.9995 | 0.9995 | 0.9996 | 1.0005 | 1.0022 | 1.0048 | 1.0285 | 1.0699 | 1.1248 | 1.1899 |
| 600 | 1.0000 | 1.0009 | 1.0020 | 1.0039 | 1.0081 | 1.0125 | 1.0171 | 1.0217 | 1.0540 | 1.0969 | 1.1470 | 1.2019 |
| 800 | 1.0003 | 1.0017 | 1.0034 | 1.0068 | 1.0130 | 1.0197 | 1.0263 | 1.0330 | 1.0678 | 1.1068 | 1.1496 | 1.1951 |
| 1000 | 1.0004 | 1.0014 | 1.0035 | 1.0071 | 1.0141 | 1.0207 | 1.0274 | 1.0342 | 1.0678 | 1.1033 | 1.1400 | 1.1790 |

*Calculated from PVT values tabulated in Goodwin, NBS Tech. Note 653, 1974, for temperatures up to 500 K, and from PVT values tabulated in Zhuravlev. *Thermophysical Properties of Gaseous and Liquid Methane,* Standartov, Moscow, 1969, and NBS-NSF transl. TT 70-50097, 1970.

**TABLE 2-177 Compressibility Factors for Methanol**

| | Pressure, bar | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp., K | 0.1 | 0.5 | 1.0133 | 10 | 20 | 50 | 100 | 150 | 200 | 250 | 300 | 400 | 500 |
| 200 | 0.0002 | 0.0011 | 0.0022 | 0.0219 | 0.0438 | 0.1091 | 0.2174 | 0.3250 | 0.4319 | 0.5381 | 0.6437 | 0.8531 | 1.6030 |
| 250 | 0.0002 | 0.0009 | 0.0019 | 0.0185 | 0.0370 | 0.0923 | 0.1837 | 0.2743 | 0.3643 | 0.4535 | 0.5422 | 0.7176 | 0.8909 |
| 300 | 0.9792 | 0.0008 | 0.0017 | 0.0164 | 0.0327 | 0.0813 | 0.1617 | 0.2413 | 0.3201 | 0.3981 | 0.4755 | 0.6284 | 0.7791 |
| 350 | 0.9844 | 0.9713 | 0.9551 | 0.0150 | 0.0298 | 0.0742 | 0.1473 | 0.2193 | 0.2904 | 0.3606 | 0.4301 | 0.5671 | 0.7016 |
| 400 | 0.9872 | 0.9795 | 0.9722 | 0.0142 | 0.0283 | 0.0702 | 0.1386 | 0.2056 | 0.2714 | 0.3362 | 0.4000 | 0.5253 | 0.6478 |
| 450 | 0.9890 | 0.9835 | 0.9792 | 0.9145 | 0.7989 | 0.0701 | 0.1366 | 0.2007 | 0.2629 | 0.3238 | 0.3834 | 0.4997 | 0.6128 |
| 500 | 0.9903 | 0.9859 | 0.9828 | 0.9525 | 0.9081 | 0.6799 | 0.1505 | 0.2110 | 0.2699 | 0.3271 | 0.3829 | 0.4912 | 0.5959 |
| 600 | 0.9922 | 0.9889 | 0.9867 | 0.9756 | 0.9643 | 0.9042 | 0.7629 | 0.6275 | 0.5255 | 0.4921 | 0.5010 | 0.5606 | 0.6358 |
| 700 | 0.9934 | 0.9907 | 0.9889 | 0.9816 | 0.9778 | 0.9541 | 0.8932 | 0.8392 | 0.8027 | 0.7797 | 0.7675 | 0.7713 | 0.7993 |
| 800 | 0.9964 | 0.9920 | 0.9904 | 0.9838 | 0.9818 | 0.9711 | 0.9411 | 0.9156 | 0.9025 | 0.8994 | 0.9026 | 0.9205 | 0.9485 |

Goodwin, R.D., *J. Phys. Chem. Ref. Data,* **16** (4), 799, 1987.

**TABLE 2-178 Compressibility Factors for Neon***

| | Pressure, bar | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp., K | 1 | 5 | 10 | 20 | 40 | 60 | 80 | 100 | 200 | 300 | 400 | 500 |
| 50 | 0.9913 | 0.9472 | 0.9083 | 0.8013 | 0.3810 | 0.4398 | 0.4984 | 0.5850 | 0.9864 | 1.3659 | 1.7289 | 2.0794 |
| 100 | 0.9993 | 0.9970 | 0.9949 | 0.9913 | 0.9854 | 0.9245 | 0.9864 | 0.9930 | 1.0796 | 1.2197 | 1.3796 | 1.5473 |
| 150 | 1.0002 | 1.0017 | 1.0036 | 1.0078 | 1.0162 | 1.0262 | 1.0375 | 1.0497 | 1.1236 | 1.2131 | 1.3113 | 1.4150 |
| 200 | 1.0003 | 1.0023 | 1.0049 | 1.0100 | 1.0204 | 1.0318 | 1.0427 | 1.0551 | 1.1191 | 1.1909 | 1.2655 | 1.3422 |
| 250 | 1.0001 | 1.0022 | 1.0045 | 1.0097 | 1.0198 | 1.0295 | 1.0403 | 1.0502 | 1.1057 | 1.1633 | 1.2223 | 1.2822 |
| 300 | 1.0000 | 1.0020 | 1.0041 | 1.0091 | 1.0181 | 1.0277 | 1.0369 | 1.0469 | 1.0961 | 1.1476 | 1.1997 | 1.2520 |
| 400 | 1.0000 | 1.0017 | 1.0036 | 1.0074 | 1.0151 | 1.0216 | 1.0301 | 1.0376 | 1.0771 | 1.1172 | 1.1575 | 1.1981 |
| 500 | 1.0000 | 1.0014 | 1.0029 | 1.0058 | 1.0124 | 1.0188 | 1.0252 | 1.0316 | 1.0641 | 1.0963 | 1.1291 | 1.1621 |
| 600 | 1.0000 | 1.0012 | 1.0024 | 1.0049 | 1.0107 | 1.0160 | 1.0214 | 1.0267 | 1.0542 | 1.0814 | 1.1091 | 1.1369 |
| 800 | 1.0000 | 1.0009 | 1.0018 | 1.0043 | 1.0081 | 1.0123 | 1.0163 | 1.0206 | 1.0413 | 1.0622 | 1.0829 | 1.1039 |
| 1000 | 1.0000 | 1.0007 | 1.0014 | 1.0034 | 1.0068 | 1.0098 | 1.0132 | 1.0165 | 1.0330 | 1.0500 | 1.0670 | 1.0836 |

*Calculated from PVT values tabulated in Rabinovich (ed.), *Thermophysical Properties of Neon, Argon, Krypton and Xenon,* Standards Press, Moscow, 1976. This book was published in English translation by Hemisphere, New York, 1988 (604 pp.).

**TABLE 2-179 Compressibility Factors for Nitrogen***

| | Pressure, bar | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp., K | 1 | 5 | 10 | 20 | 40 | 60 | 80 | 100 | 200 | 300 | 400 | 500 |
| 70 | 0.0057 | 0.0287 | 0.0573 | 0.1143 | 0.2277 | 0.3400 | 0.4516 | 0.5623 | 1.1044 | 1.6308 | Solid | Solid |
| 80 | 0.9593 | 0.0264 | 0.0528 | 0.1053 | 0.2093 | 0.3122 | 0.4140 | 0.5148 | 1.0061 | 1.4797 | 1.9396 | 2.3879 |
| 90 | 0.9722 | 0.0251 | 0.0500 | 0.0996 | 0.1975 | 0.2938 | 0.3888 | 0.4826 | 0.9362 | 1.3700 | 1.7890 | 2.1962 |
| 100 | 0.9798 | 0.8910 | 0.0487 | 0.0966 | 0.1905 | 0.2823 | 0.3720 | 0.4605 | 0.8840 | 1.2852 | 1.6707 | 2.0441 |
| 120 | 0.9883 | 0.9397 | 0.8732 | 0.7059 | 0.1975 | 0.2822 | 0.3641 | 0.4438 | 0.8188 | 1.1684 | 1.5015 | 1.8223 |
| 140 | 0.9927 | 0.9635 | 0.9253 | 0.8433 | 0.6376 | 0.4251 | 0.4278 | 0.4799 | 0.7942 | 1.0996 | 1.3920 | 1.6726 |
| 160 | 0.9952 | 0.9766 | 0.9529 | 0.9042 | 0.8031 | 0.7017 | 0.6304 | 0.6134 | 0.8107 | 1.0708 | 1.3275 | 1.5762 |
| 180 | 0.9967 | 0.9846 | 0.9690 | 0.9381 | 0.8782 | 0.8125 | 0.7784 | 0.7530 | 0.8550 | 1.0669 | 1.2893 | 1.5105 |
| 200 | 0.9978 | 0.9897 | 0.9791 | 0.9592 | 0.9212 | 0.8882 | 0.8621 | 0.8455 | 0.9067 | 1.0760 | 1.2683 | 1.4631 |
| 250 | 0.9992 | 0.9960 | 0.9924 | 0.9857 | 0.9741 | 0.9655 | 0.9604 | 0.9589 | 1.0048 | 1.1143 | 1.2501 | 1.3962 |
| 300 | 0.9998 | 0.9990 | 0.9983 | 0.9971 | 0.9964 | 0.9973 | 1.0000 | 1.0052 | 1.0559 | 1.1422 | 1.2480 | 1.3629 |
| 350 | 1.0001 | 1.0007 | 1.0011 | 1.0029 | 1.0069 | 1.0125 | 1.0189 | 1.0271 | 1.0810 | 1.1560 | 1.2445 | 1.3405 |
| 400 | 1.0002 | 1.0011 | 1.0024 | 1.0057 | 1.0125 | 1.0199 | 1.0283 | 1.0377 | 1.0926 | 1.1609 | 1.2382 | 1.3216 |
| 450 | 1.0003 | 1.0018 | 1.0033 | 1.0073 | 1.0153 | 1.0238 | 1.0332 | 1.0430 | 1.0973 | 1.1606 | 1.2303 | 1.3043 |
| 500 | 1.0004 | 1.0020 | 1.0040 | 1.0081 | 1.0167 | 1.0257 | 1.0350 | 1.0451 | 1.0984 | 1.1575 | 1.2213 | 1.2881 |
| 600 | 1.0004 | 1.0021 | 1.0040 | 1.0084 | 1.0173 | 1.0263 | 1.0355 | 1.0450 | 1.0951 | 1.1540 | 1.2028 | 1.2657 |
| 800 | 1.0004 | 1.0017 | 1.0036 | 1.0074 | 1.0157 | 1.0237 | 1.0320 | 1.0402 | 1.0832 | 1.1264 | 1.1701 | 1.2140 |
| 1000 | 1.0003 | 1.0015 | 1.0034 | 1.0067 | 1.0136 | 1.0205 | 1.0275 | 1.0347 | 1.0714 | 1.1078 | 1.1449 | 1.1814 |

*Computed from pressure-volume-temperature tables in the Vasserman monographs referenced under Table 2-165.

**TABLE 2-180 Compressibility Factors for Oxygen***

| | Pressure, bar | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp., K | 1 | 5 | 10 | 20 | 40 | 60 | 80 | 100 | 200 | 300 | 400 | 500 |
| 75 | 0.0043 | 0.0213 | 0.0425 | 0.0849 | 0.1693 | 0.2533 | 0.3368 | 0.4200 | 0.8301 | 1.2322 | 1.6278 | 2.0175 |
| 80 | 0.0041 | 0.0203 | 0.0406 | 0.0811 | 0.1616 | 0.2418 | 0.3214 | 0.4007 | 0.7912 | 1.1738 | 1.5495 | 1.9196 |
| 90 | 0.0038 | 0.0188 | 0.0376 | 0.0750 | 0.1494 | 0.2233 | 0.2966 | 0.3696 | 0.7281 | 1.0780 | 1.4211 | 1.7580 |
| 100 | 0.9757 | 0.0177 | 0.0354 | 0.0705 | 0.1404 | 0.2096 | 0.2783 | 0.3464 | 0.6798 | 1.0040 | 1.3206 | 1.6309 |
| 120 | 0.9855 | 0.9246 | 0.8367 | 0.0660 | 0.1302 | 0.1935 | 0.2558 | 0.3173 | 0.6148 | 0.8999 | 1.1762 | 1.4456 |
| 140 | 0.9911 | 0.9535 | 0.9034 | 0.7852 | 0.1334 | 0.1940 | 0.2527 | 0.3099 | 0.5815 | 0.8374 | 1.0832 | 1.3214 |
| 160 | 0.9939 | 0.9697 | 0.9379 | 0.8689 | 0.6991 | 0.3725 | 0.2969 | 0.3378 | 0.5766 | 0.8058 | 1.0249 | 1.2364 |
| 180 | 0.9960 | 0.9793 | 0.9579 | 0.9134 | 0.8167 | 0.7696 | 0.5954 | 0.5106 | 0.6043 | 0.8025 | 0.9990 | 1.1888 |
| 200 | 0.9970 | 0.9853 | 0.9705 | 0.9399 | 0.8768 | 0.8140 | 0.7534 | 0.6997 | 0.6720 | 0.8204 | 0.9907 | 1.1623 |
| 250 | 0.9987 | 0.9938 | 0.9870 | 0.9736 | 0.9477 | 0.9237 | 0.9030 | 0.8858 | 0.8563 | 0.9172 | 1.0222 | 1.1431 |
| 300 | 0.9994 | 0.9968 | 0.9941 | 0.9884 | 0.9771 | 0.9676 | 0.9597 | 0.9542 | 0.9560 | 0.9972 | 1.0689 | 1.1572 |
| 350 | 0.9998 | 0.9990 | 0.9979 | 0.9961 | 0.9919 | 0.9890 | 0.9870 | 0.9870 | 1.0049 | 1.0451 | 1.1023 | 1.1722 |
| 400 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0003 | 1.0011 | 1.0022 | 1.0045 | 1.0305 | 1.0718 | 1.1227 | 1.1816 |
| 450 | 1.0002 | 1.0007 | 1.0015 | 1.0024 | 1.0048 | 1.0074 | 1.0106 | 1.0152 | 1.0445 | 1.0859 | 1.1334 | 1.1859 |
| 500 | 1.0002 | 1.0011 | 1.0022 | 1.0038 | 1.0075 | 1.0115 | 1.0161 | 1.0207 | 1.0523 | 1.0927 | 1.1380 | 1.1866 |
| 600 | 1.0003 | 1.0014 | 1.0024 | 1.0052 | 1.0102 | 1.0153 | 1.0207 | 1.0266 | 1.0582 | 1.0961 | 1.1374 | 1.1803 |
| 800 | 1.0003 | 1.0014 | 1.0026 | 1.0055 | 1.0109 | 1.0164 | 1.0219 | 1.0271 | 1.0565 | 1.0888 | 1.1231 | 1.1582 |
| 1000 | 1.0003 | 1.0013 | 1.0026 | 1.0053 | 1.0101 | 1.0149 | 1.0198 | 1.0253 | 1.0507 | 1.0783 | 1.1072 | 1.1369 |

*Calculated from pressure-volume-temperature tables in the Vasserman monographs listed under Table 2-165.

**TABLE 2-181 Compressibility Factors for Refrigerant 32***

| | Pressure, bar | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp., K | 1 | 5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 | $Z_{sat}$ | $P_{sat}$ |
| 230 | 0.9656 | | | | | | | | | 0.9453 | 1.54 |
| 240 | 0.9711 | | | | | | | | | 0.9278 | 2.40 |
| 250 | 0.9755 | | | | | | | | | 0.9062 | 3.60 |
| 260 | 0.9791 | 0.8865 | | | | | | | | 0.8811 | 5.22 |
| 270 | 0.9819 | 0.9036 | | | | | | | | 0.8522 | 7.34 |
| 280 | 0.9844 | 0.9180 | 0.8210 | | | | | | | 0.8194 | 10.07 |
| 290 | 0.9864 | 0.9285 | 0.8476 | | | | | | | 0.7822 | 13.51 |
| 300 | 0.9880 | 0.9376 | 0.8686 | 0.7899 | | | | | | 0.7401 | 17.76 |
| 310 | 0.9894 | 0.9453 | 0.8358 | 0.8197 | 0.7439 | | | | | 0.6922 | 22.95 |
| 320 | 0.9904 | 0.9518 | 0.8998 | 0.8436 | 0.7812 | 0.7089 | | | | 0.6370 | 29.21 |
| 330 | 0.9914 | 0.9573 | 0.9118 | 0.8628 | 0.8102 | 0.7518 | 0.6851 | | | 0.5719 | 36.72 |
| 340 | 0.9923 | 0.9619 | 0.9203 | 0.8790 | 0.8338 | 0.7846 | 0.7316 | 0.6021 | | 0.4905 | 45.66 |
| 350 | 0.9932 | 0.9655 | 0.9296 | 0.8932 | 0.8534 | 0.8115 | 0.7671 | 0.6675 | 0.5312 | 0.3702 | 56.35 |
| $Z_{sat}$ | 0.9595 | 0.8843 | 0.8202 | 0.7670 | 0.7191 | 0.6722 | 0.6303 | 0.5427 | 0.4467 | | |
| $T_{sat}$ | 221.2 | 258.8 | 279.8 | 293.8 | 304.6 | 313.5 | 321.1 | 333.9 | 344.3 | | |

*Converted and interpolated from British units shown in *Thermodynamic properties of KLEA 32,* ICI Chemicals and Polymers, 1993. Reproduced by permission.

**TABLE 2-182 Compressibility Factors for Refrigerant 123**

| | Pressure, bar | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp., °C | 1 | 2.5 | 5 | 7.5 | 10 | 12.5 | 15 | 17.5 | 20 | 22.5 | 25 | $Z_{sat}$ | Psat |
| 40 | 0.9639 | | | | | | | | | | | 0.9427 | 1.54 |
| 50 | 0.9682 | | | | | | | | | | | 0.9294 | 2.13 |
| 60 | 0.9717 | 0.9248 | | | | | | | | | | 0.9134 | 2.96 |
| 70 | 0.9745 | 0.9327 | | | | | | | | | | 0.8950 | 3.78 |
| 80 | 0.9766 | 0.9401 | | | | | | | | | | 0.8727 | 4.90 |
| 100 | 0.9804 | 0.9501 | 0.9197 | 0.8355 | | | | | | | | 0.8262 | 7.87 |
| 120 | 0.9839 | 0.9591 | 0.9146 | 0.8667 | 0.8140 | | | | | | | 0.7640 | 12.01 |
| 140 | 0.9861 | 0.9650 | 0.9282 | 0.8915 | 0.8503 | 0.8023 | 0.7479 | 0.6916 | | | | 0.6890 | 17.59 |
| 160 | 0.9886 | 0.9714 | 0.9406 | 0.9077 | 0.8747 | 0.8398 | 0.8026 | 0.7600 | 0.7134 | 0.6553 | | 0.5820 | 24.92 |
| 180 | 0.9908 | 0.9762 | 0.9518 | 0.9254 | 0.8970 | 0.8709 | 0.8402 | 0.8072 | 0.7712 | 0.7346 | 0.6841 | 0.3926 | 34.54 |
| 200 | 0.9924 | 0.9806 | 0.9602 | 0.9388 | 0.9174 | 0.8931 | 0.8688 | 0.8422 | 0.8163 | 0.7882 | 0.7539 | — | — |
| 225 | 0.9938 | 0.9846 | 0.9692 | 0.9526 | 0.9378 | 0.9170 | 0.8972 | 0.8800 | 0.8566 | 0.8401 | 0.8157 | — | — |
| 250 | 0.9954 | 0.9885 | 0.9 | 0.9651 | 0.9528 | 0.9382 | 0.9229 | 0.9101 | 0.8930 | 0.8771 | 0.8581 | — | — |
| $Z_{sat}$ | 0.9575 | 0.9210 | 0.9730 | 0.8292 | 0.7947 | 0.7654 | 0.7229 | 0.7110 | 0.6564 | 0.6206 | 0.5821 | — | — |
| $T$ | 27.5 | 55.4 | 80.8 | 97.9 | 111.1 | 122.0 | 131.4 | 139.7 | 147.2 | 154.0 | 160.2 | — | — |

Dashes indicate inaccessible states; blanks indicate no available data.

**TABLE 2-183 Compressibility Factors for Refrigerant 124**

| | Pressure, bar | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp., °C | 1 | 2.5 | 5 | 7.5 | 10 | 12.5 | 15 | 17.5 | 20 | 22.5 | 25 | $Z_{sat}$ | Psat |
| −20 | | | | | | | | | | | | 0.9562 | 0.72 |
| −10 | | | | | | | | | | | | 0.9431 | 1.10 |
| 0 | 0.9573 | | | | | | | | | | | 0.9284 | 1.63 |
| 10 | 0.9641 | | | | | | | | | | | 0.9243 | 2.34 |
| 20 | 0.9693 | | | | | | | | | | | 0.8920 | 3.27 |
| 30 | 0.9736 | 0.9313 | | | | | | | | | | 0.8828 | 4.45 |
| 40 | 0.9675 | 0.9396 | 0.8728 | | | | | | | | | 0.8427 | 5.93 |
| 50 | 0.9798 | 0.9473 | 0.8889 | 0.8229 | | | | | | | | 0.8151 | 7.75 |
| 60 | 0.9820 | 0.9534 | 0.9017 | 0.8462 | | | | | | | | 0.7803 | 9.96 |
| 80 | 0.9854 | 0.9633 | 0.9226 | 0.8820 | 0.8366 | | 0.7251 | | | | | 0.7024 | 15.74 |
| 100 | 0.9880 | 0.9700 | 0.9370 | 0.9040 | 0.8710 | 0.8314 | 0.7918 | 0.7463 | 0.6950 | 0.6380 | | 0.5955 | 23.75 |
| 120 | 0.9899 | 0.9749 | 0.9478 | 0.9206 | 0.8935 | 0.8634 | 0.8329 | 0.8022 | 0.7682 | 0.7285 | 0.6878 | 0.3912 | 34.70 |
| 140 | 0.9917 | 0.9794 | 0.9575 | 0.9357 | 0.9138 | 0.8884 | 0.8641 | 0.8391 | 0.8105 | 0.7896 | 0.7647 | | |
| 160 | | 0.9825 | 0.9645 | 0.9464 | 0.9247 | 0.9061 | 0.8868 | 0.8644 | 0.8489 | 0.8285 | 0.7868 | | |
| 180 | | | 0.9690 | 0.9536 | 0.9382 | 0.9213 | 0.9056 | 0.8857 | 0.8634 | 0.8574 | 0.8379 | | |
| 200 | | | | 0.9601 | 0.9471 | 0.9338 | 0.9211 | 0.9042 | 0.8951 | 0.8783 | 0.8647 | | |
| 225 | | | | | 0.9589 | 0.9488 | 0.9391 | 0.9223 | 0.9160 | 0.9040 | 0.8947 | | |
| 250 | | | | | 0.9650 | 0.9573 | 0.9443 | 0.9412 | 0.9333 | 0.9252 | 0.9174 | | |
| $Z_{sat}$ | 0.9468 | 0.9071 | 0.8605 | 0.8185 | 0.7830 | 0.7488 | 0.7157 | 0.6825 | 0.6484 | 0.6279 | 0.5788 | | |
| $T$ | −12.4 | 11.9 | 34.0 | 48.7 | 60.2 | 69.6 | 77.8 | 85.0 | 91.4 | 96.3 | 102.6 | | |

Dashes indicate inaccessible states; blanks indicate no available data.

**TABLE 2-184 Compressibility Factors for Refrigerant 134a**

| | Pressure, bar | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp., °C | 1 | 5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 | Zsat | Psat |
| −10 | 0.9622 | | | | | | | | | 0.9316 | 2.005 |
| 0 | 0.9710 | | | | | | | | | 0.9119 | 2.926 |
| 10 | 0.9752 | | | | | | | | | 0.8888 | 4.144 |
| 20 | 0.9778 | 0.8819 | | | | | | | | 0.8621 | 5.716 |
| 30 | 0.9817 | 0.8973 | | | | | | | | 0.8314 | 7.701 |
| 40 | 0.9839 | 0.9098 | 0.8005 | | | | | | | 0.7963 | 10.17 |
| 50 | 0.9857 | 0.9206 | 0.8280 | | | | | | | 0.7560 | 13.18 |
| 60 | 0.9872 | 0.9296 | 0.8449 | 0.7361 | | | | | | 0.7098 | 16.82 |
| 70 | 0.9886 | 0.9376 | 0.8678 | 0.7917 | 0.6853 | | | | | 0.6562 | 21.17 |
| 80 | 0.9897 | 0.9442 | 0.8828 | 0.8137 | 0.7327 | 0.6290 | | | | 0.5911 | 26.38 |
| 90 | 0.9908 | 0.9495 | 0.8954 | 0.8390 | 0.7682 | 0.6860 | 0.5832 | | | 0.5054 | 32.45 |
| 100 | 0.9916 | 0.9543 | 0.9062 | 0.8555 | 0.7965 | 0.7335 | 0.6557 | | | 0.3462 | 39.72 |
| 110 | 0.9920 | 0.9592 | 0.9151 | 0.8630 | 0.8144 | 0.7630 | 0.7046 | 0.5732 | 0.4530 | — | — |
| 120 | 0.9924 | 0.9638 | 0.9235 | 0.8802 | 0.8386 | 0.7915 | 0.7418 | 0.6249 | 0.4885 | — | — |
| 130 | 0.9927 | 0.9673 | 0.9308 | 0.8949 | 0.8553 | 0.8165 | 0.7716 | 0.6771 | 0.5645 | — | — |
| 140 | 0.9929 | 0.9691 | 0.9370 | 0.9040 | 0.8694 | 0.8350 | 0.7964 | 0.7169 | 0.6303 | — | — |
| 150 | 0.9931 | 0.9727 | 0.9428 | 0.8877 | 0.8817 | 0.8495 | 0.8173 | 0.7489 | 0.6783 | — | — |
| satn. | 0.9567 | 0.8741 | 0.7989 | 0.7017 | 0.6704 | 0.6094 | 0.5415 | 0.4442 | — | — | — |
| sat. $T$ | −26.37 | 15.74 | 39.39 | 55.23 | 67.49 | 77.57 | 86.20 | 100.35 | — | — | — |

Dashes indicate inaccessible states; blanks indicate no available data.

**TABLE 2-185 Compressibility Factors for Water Substance (fps units)***

| Pressure, lb/in² abs. | Temp., °F | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 400 | 600 | 800 | 1000 | 1200 | 1400 | 1600 | 1800 | 2000 | 2200 | 2400 | 2600 | 2800 | 3000 | 3200 | 3400 | 3600 | 3800 | 4000 |
| 10 | 0.9965 | 0.9989 | 0.9992 | 0.9995 | 0.9999 | 0.9999 | 0.9999 | 1.0000 | 1.0000 | 1.0000 | 1.0001 | 1.0006 | 1.0012 | 1.0024 | 1.0053 | 1.0084 | 1.0145 | 1.0211 | 1.0332 |
| 15 | 0.9943 | 0.9972 | 0.9986 | 0.9993 | 0.9997 | 0.9998 | 0.9999 | 0.9999 | 1.0000 | 1.0000 | 1.0001 | 1.0004 | 1.0012 | 1.0022 | 1.0042 | 1.0072 | 1.0124 | 1.0188 | 1.0295 |
| 20 | 0.9930 | 0.9970 | 0.9981 | 0.9991 | 0.9995 | 0.9996 | 0.9998 | 0.9999 | 1.0000 | 1.0000 | 1.0001 | 1.0003 | 1.0011 | 1.0020 | 1.0036 | 1.0065 | 1.0112 | 1.0173 | 1.0269 |
| 40 | 0.9861 | 0.9940 | 0.9967 | 0.9981 | 0.9990 | 0.9994 | 0.9996 | 0.9998 | 0.9999 | 0.9999 | 1.0001 | 1.0003 | 1.0010 | 1.0018 | 1.0028 | 1.0054 | 1.0090 | 1.0139 | 1.0214 |
| 60 | 0.9788 | 0.9910 | 0.9951 | 0.9973 | 0.9984 | 0.9991 | 0.9994 | 0.9997 | 0.9999 | 0.9999 | 1.0001 | 1.0003 | 1.0009 | 1.0018 | 1.0024 | 1.0048 | 1.0080 | 1.0120 | 1.0186 |
| 80 | 0.9714 | 0.9878 | 0.9935 | 0.9963 | 0.9979 | 0.9987 | 0.9992 | 0.9996 | 0.9998 | 0.9999 | 1.0001 | 1.0003 | 1.0008 | 1.0016 | 1.0023 | 1.0044 | 1.0073 | 1.0108 | 1.0170 |
| 100 | 0.9469 | 0.9848 | 0.9919 | 0.9954 | 0.9974 | 0.9985 | 0.9990 | 0.9995 | 0.9998 | 0.9999 | 1.0001 | 1.0004 | 1.0007 | 1.0015 | 1.0022 | 1.0042 | 1.0067 | 1.0099 | 1.0157 |
| 150 | 0.9435 | 0.9770 | 0.9879 | 0.9931 | 0.9960 | 9.9976 | 0.9985 | 0.9993 | 0.9997 | 0.9998 | 1.0001 | 1.0004 | 1.0006 | 1.0014 | 1.0021 | 1.0039 | 1.0059 | 1.0087 | 1.0137 |
| 200 | 0.9216 | 0.9690 | 0.9839 | 0.9908 | 0.9947 | 0.9968 | 0.9980 | 0.9991 | 0.9996 | 0.9998 | 1.0001 | 1.0005 | 1.0007 | 1.0015 | 1.0021 | 1.0037 | 1.0055 | 1.0080 | 1.0126 |
| 400 | | 0.9356 | 0.9675 | 0.9817 | 0.9893 | 0.9935 | 0.9960 | 0.9982 | 0.9992 | 0.9998 | 1.0002 | 1.0007 | 1.0011 | 1.0017 | 1.0023 | 1.0033 | 1.0049 | 1.0070 | 1.0105 |
| 600 | | 0.8989 | 0.9509 | 0.9725 | 0.9839 | 0.9904 | 0.9942 | 0.9973 | 0.9988 | 0.9997 | 1.0002 | 1.0008 | 1.0014 | 1.0019 | 1.0026 | 1.0034 | 1.0048 | 1.0066 | 1.0097 |
| 800 | | 0.8586 | 0.9336 | 0.9633 | 0.9790 | 0.9872 | 0.9925 | 0.9964 | 0.9985 | 0.9996 | 1.0003 | 1.0010 | 1.0016 | 1.0022 | 1.0029 | 1.0036 | 1.0049 | 1.0065 | 1.0094 |
| 1,000 | | 0.8138 | 0.9162 | 0.9540 | 0.9733 | 0.9841 | 0.9905 | 0.9955 | 0.9981 | 0.9994 | 1.0004 | 1.0012 | 1.0019 | 1.0025 | 1.0032 | 1.0039 | 1.0052 | 1.0066 | 1.0092 |
| 1,500 | | 0.6702 | 0.8695 | 0.9305 | 0.9600 | 0.9764 | 0.9859 | 0.9932 | 0.9971 | 0.9992 | 1.0007 | 1.0017 | 1.0026 | 1.0033 | 1.0040 | 1.0048 | 1.0059 | 1.0072 | 1.0096 |
| 2,000 | | | 0.8188 | 0.9067 | 0.9468 | 0.9687 | 0.9813 | 0.9900 | 0.9958 | 0.9990 | 1.0010 | 1.0023 | 1.0034 | 1.0042 | 1.0049 | 1.0058 | 1.0068 | 1.0082 | 1.0104 |
| 4,000 | | | 0.5608 | 0.8060 | 0.8942 | 0.9392 | 0.9647 | 0.9836 | 0.9930 | 0.9989 | 1.0024 | 1.0050 | 1.0069 | 1.0082 | 1.0093 | 1.0106 | 1.0118 | 1.0132 | 1.0149 |
| 6,000 | | | | 0.7042 | 0.8442 | 0.9121 | 0.9497 | 0.9771 | 0.9907 | 0.9991 | 1.0048 | 1.0081 | 1.0110 | 1.0128 | 1.0139 | 1.0152 | 1.0165 | 1.0179 | 1.0195 |
| 8,000 | | | | 0.6185 | 0.8003 | 0.8883 | 0.9371 | 0.9714 | 0.9895 | 1.0004 | 1.0075 | 1.0118 | 1.0152 | 1.0172 | 1.0188 | 1.0204 | 1.0216 | 1.0229 | 1.0242 |
| 10,000 | | | | 0.5699 | 0.7657 | 0.8693 | 0.9274 | 0.9668 | 0.9890 | 1.0025 | 1.0105 | 1.0158 | 1.0196 | 1.0220 | 1.0240 | 1.0258 | 1.0271 | 1.0284 | 1.0298 |

*Calculated by P. E. Liley from various steam tables for the lower temperatures and from Paper B-11 by P. H. Kesselman and Yu. I. Blank, 7th. Int. Conf. Properties of Steam, Tokyo, 1968, for the higher temperatures.

**TABLE 2-186 Compressibility Factors of Water Substance (SI units)***

| Temperature, K | Pressure, bar | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 80 | 100 | 150 | 200 | 250 | 300 | 400 | 500 | 600 | 800 | 1000 |
| 400 | 0.990 | 0.003 | 0.006 | 0.009 | 0.012 | 0.014 | 0.017 | 0.023 | 0.029 | 0.035 | 0.046 | 0.058 | 0.086 | 0.114 | 0.143 | 0.171 | 0.227 | 0.282 | 0.336 | 0.445 | 0.552 |
| 450 | 0.993 | 0.003 | 0.006 | 0.009 | 0.012 | 0.014 | 0.016 | 0.022 | 0.027 | 0.033 | 0.043 | 0.054 | 0.080 | 0.107 | 0.134 | 0.159 | 0.206 | 0.255 | 0.304 | 0.402 | 0.498 |
| 500 | 0.996 | 0.980 | 0.958 | 0.930 | 0.901 | 0.878 | 0.016 | 0.021 | 0.026 | 0.031 | 0.042 | 0.052 | 0.077 | 0.102 | 0.127 | 0.152 | 0.201 | 0.249 | 0.297 | 0.390 | 0.482 |
| 550 | 0.997 | 0.985 | 0.969 | 0.956 | 0.939 | 0.922 | 0.904 | 0.865 | 0.822 | 0.773 | 0.042 | 0.052 | 0.077 | 0.102 | 0.126 | 0.150 | 0.181 | 0.198 | 0.289 | 0.378 | 0.464 |
| 600 | 0.998 | 0.990 | 0.979 | 0.970 | 0.961 | 0.948 | 0.935 | 0.910 | 0.885 | 0.858 | 0.798 | 0.726 | 0.082 | 0.107 | 0.131 | 0.155 | 0.201 | 0.246 | 0.290 | 0.375 | 0.457 |
| 650 | 0.999 | 0.992 | 0.984 | 0.977 | 0.968 | 0.959 | 0.958 | 0.937 | 0.919 | 0.902 | 0.864 | 0.824 | 0.702 | 0.514 | 0.177 | 0.183 | 0.221 | 0.260 | 0.303 | 0.383 | 0.460 |
| 700 | 1.000 | 0.994 | 0.988 | 0.984 | 0.976 | 0.967 | 0.966 | 0.952 | 0.941 | 0.929 | 0.900 | 0.876 | 0.800 | 0.716 | 0.618 | 0.503 | 0.326 | 0.316 | 0.340 | 0.406 | 0.476 |
| 750 | 1.000 | 0.996 | 0.991 | 0.988 | 0.981 | 0.975 | 0.971 | 0.961 | 0.955 | 0.945 | 0.927 | 0.907 | 0.856 | 0.801 | 0.743 | 0.682 | 0.557 | 0.465 | 0.435 | 0.456 | 0.509 |
| 800 | 1.000 | 0.997 | 0.993 | 0.991 | 0.985 | 0.982 | 0.976 | 0.970 | 0.966 | 0.957 | 0.945 | 0.929 | 0.892 | 0.853 | 0.813 | 0.773 | 0.693 | 0.620 | 0.568 | 0.538 | 0.561 |
| 850 | 1.000 | 0.997 | 0.995 | 0.992 | 0.989 | 0.984 | 0.981 | 0.977 | 0.973 | 0.967 | 0.957 | 0.946 | 0.917 | 0.889 | 0.860 | 0.831 | 0.775 | 0.715 | 0.679 | 0.631 | 0.629 |
| 900 | 1.000 | 0.998 | 0.997 | 0.993 | 0.992 | 0.989 | 0.986 | 0.982 | 0.979 | 0.974 | 0.965 | 0.958 | 0.936 | 0.915 | 0.893 | 0.872 | 0.830 | 0.792 | 0.760 | 0.714 | 0.700 |
| 950 | 1.000 | 0.998 | 0.997 | 0.994 | 0.994 | 0.993 | 0.991 | 0.985 | 0.983 | 0.980 | 0.973 | 0.967 | 0.950 | 0.933 | 0.916 | 0.901 | 0.867 | 0.839 | 0.816 | 0.780 | 0.761 |
| 1000 | 1.000 | 0.999 | 0.998 | 0.995 | 0.995 | 0.994 | 0.993 | 0.990 | 0.987 | 0.985 | 0.978 | 0.973 | 0.960 | 0.948 | 0.935 | 0.923 | 0.900 | 0.878 | 0.859 | 0.831 | 0.816 |
| 1200 | 1.000 | 1.000 | 0.999 | 0.998 | 0.998 | 0.997 | 0.997 | 0.995 | 0.994 | 0.994 | 0.992 | 0.990 | 0.986 | 0.982 | 0.975 | 0.968 | 0.961 | 0.957 | 0.949 | 0.942 | 0.937 |
| 1400 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.999 | 0.998 | 0.998 | 0.998 | 0.997 | 0.996 | 0.995 | 0.995 | 0.994 | 0.993 | 0.992 | 0.994 | 0.996 | 0.998 |
| 1600 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.001 | 1.002 | 1.002 | 1.004 | 1.006 | 1.009 | 1.012 | 1.015 | 1.020 |
| 1800 | 1.001 | 1.001 | 1.001 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.001 | 1.002 | 1.003 | 1.003 | 1.004 | 1.005 | 1.008 | 1.011 | 1.014 | 1.017 | 1.021 | 1.031 |
| 2000 | 1.003 | 1.002 | 1.002 | 1.002 | 1.002 | 1.002 | 1.002 | 1.002 | 1.002 | 1.003 | 1.003 | 1.004 | 1.004 | 1.006 | 1.008 | 1.011 | 1.014 | 1.018 | 1.021 | 1.032 | 1.043 |

*Calculated by P. E. Liley from various steam tables for the lower temperatures and from Pap. B-11 by P. H. Kesselman and Yu. I. Blank, 7th Internal Conference on the Properties of Steam, Tokyo, 1968, for the higher temperatures.

**TABLE 2-187 Compressibility Factors for Xenon***

| Temperature, K | Pressure, bar | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 5 | 10 | 20 | 40 | 60 | 80 | 100 | 200 | 300 | 400 | 500 |
| 200 | 0.9831 | 0.9088 | 0.0293 | 0.0584 | 0.1162 | 0.1733 | 0.2300 | 0.2861 | 0.5601 | 0.8253 | 1.0833 | 1.3356 |
| 250 | 0.9911 | 0.9545 | 0.9052 | 0.7887 | 0.1114 | 0.1642 | 0.2158 | 0.2663 | 0.5074 | 0.7355 | 0.9546 | 1.1670 |
| 300 | 0.9949 | 0.9736 | 0.9465 | 0.8885 | 0.7517 | 0.5492 | 0.2794 | 0.3016 | 0.5021 | 0.6997 | 0.8886 | 1.0707 |
| 350 | 0.9967 | 0.9834 | 0.9669 | 0.9322 | 0.8473 | 0.7840 | 0.7039 | 0.6249 | 0.5645 | 0.7124 | 0.8706 | 1.0269 |
| 400 | 0.9977 | 0.9892 | 0.9183 | 0.9562 | 0.9128 | 0.8696 | 0.8278 | 0.7888 | 0.6916 | 0.7642 | 0.8850 | 1.0148 |
| 450 | 0.9989 | 0.9928 | 0.9856 | 0.9714 | 0.9429 | 0.9163 | 0.8911 | 0.8679 | 0.7335 | 0.8331 | 0.9187 | 1.0224 |
| 500 | 0.9982 | 0.9951 | 0.9902 | 0.9810 | 0.9623 | 0.9452 | 0.9293 | 0.9156 | 0.8774 | 0.8953 | 0.9572 | 1.0412 |
| 600 | 0.9996 | 0.9979 | 0.9957 | 0.9917 | 0.9841 | 0.9772 | 0.9715 | 0.9667 | 0.9596 | 0.9791 | 1.0211 | 1.0799 |
| 800 | 1.0000 | 0.9998 | 1.0002 | 1.0004 | 1.0012 | 1.0020 | 1.0034 | 1.0054 | 1.0213 | 1.0476 | 1.0818 | 1.1222 |
| 1000 | 1.0000 | 1.0004 | 1.0015 | 1.0031 | 1.0144 | 1.0101 | 1.0133 | 1.0172 | 1.0394 | 1.0669 | 1.0979 | 1.1331 |

*Calculated from PVT values tabulated in Rabinovich (ed.), *Thermophysical Properties of Neon, Argon, Krypton and Xenon,* Standards Press, Moscow, 1976. This book was published in English translation by Hemisphere, New York, 1988 (604 pp.).

**TABLE 2-188 Compressibilities of Liquids***

At the constant temperature $T$, the compressibility $\beta = (1/\bar{V}_0)(dV/dP)$. In general as $P$ increases, $\beta$ decreases rapidly at first and then slowly; the change of $\beta$ with $T$ is large at low pressures but very small at pressures above 1000 to 2000 megabars. 1 megabar = 0.987 atm. = $10^6$ dynes/cm$^2$ based upon the older usage, 1 bar = 1 dyne/cm$^2$. The use of the bar as a pressure unit is not encouraged.

| Substance | Temp., °C | Pressure, megabars | Compressibility per megabar $\beta \times 10^6$ | Substance | Temp., °C | Pressure, megabars | Compressibility per megabar $\beta \times 10^6$ | Substance | Temp., °C | Pressure, megabars | Compressibility per megabar $\beta \times 10^6$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Acetone | 14 | 23 | 111 | Ethyl acetate | 20 | 400 | 75 | Methyl alcohol | 15 | 23 | 103 |
| Acetone | 20 | 500 | 61 | alcohol | 14 | 23 | 100 | alcohol | 20 | 200 | 95 |
| Acetone | 20 | 1,000 | 52 | alcohol | 20 | 500 | 63 | alcohol | 20 | 400 | 80 |
| Acetone | 40 | 12,000 | 9 | alcohol | 20 | 1,000 | 54 | alcohol | 20 | 500 | 65 |
| Amyl alcohol | 14 | 23 | 88 | alcohol | 20 | 12,000 | 8 | alcohol | 20 | 1,000 | 54 |
| alcohol, iso. | 20 | 200 | 84 | bromide | 20 | 200 | 100 | alcohol | 20 | 12,000 | 8 |
| alcohol, iso. | 20 | 400 | 70 | bromide | 20 | 400 | 82 | Nitric acid | 0 | 17 | 32 |
| alcohol, *n* | 20 | 500 | 61 | bromide | 20 | 500 | 70 | Oils: | | | |
| alcohol, *n* | 20 | 1,000 | 46 | bromide | 20 | 1,000 | 54 | Almond | 15 | 5 | 53 |
| alcohol, *n* | 20 | 12,000 | 8 | bromide | 20 | 12,000 | 8 | Castor | 15 | 5 | 46 |
| alcohol, *n* | 40 | 12,000 | 8 | chloride | 15 | 23 | 151 | Linseed | 15 | 5 | 51 |
| Benzene | 17 | 5 | 89 | chloride | 20 | 500 | 102 | Olive | 15 | 5 | 55 |
| Benzene | 20 | 200 | 77 | chloride | 20 | 1,000 | 66 | Rapeseed | 20 | | 59 |
| Benzene | 20 | 400 | 67 | chloride | 20 | 12,000 | 8 | Phosphorus trichloride | 10 | 250 | 71 |
| Bromine | 20 | 200 | 56 | ether | 25 | 23 | 188 | trichloride | 20 | 500 | 63 |
| Bromine | 20 | 400 | 51 | ether | 20 | 500 | 84 | trichloride | 20 | 1,000 | 47 |
| Butyl alcohol, iso | 18 | 8 | 97 | ether | 20 | 1,000 | 61 | trichloride | 20 | 12,000 | 8 |
| alcohol, iso | 20 | 200 | 81 | ether | 20 | 12,000 | 10 | Propyl alcohol (*n*) | 20 | 200 | 77 |
| alcohol, iso | 20 | 400 | 64 | iodide | 20 | 200 | 81 | alcohol (*n*) | 20 | 400 | 67 |
| alcohol, iso | 20 | 500 | 56 | iodide | 20 | 400 | 69 | alcohol (*n*?) | 20 | 500 | 65 |
| alcohol, iso | 20 | 1,000 | 46 | iodide | 20 | 500 | 64 | alcohol (*n*?) | 20 | 1,000 | 47 |
| alcohol, iso | 20 | 12,000 | 8 | iodide | 20 | 1,000 | 50 | alcohol (*n*?) | 20 | 12,000 | 7 |
| Carbon bisulfide | 16 | 21 | 86 | iodide | 20 | 12,000 | 8 | Toluene | 20 | 200 | 74 |
| bisulfide | 20 | 500 | 57 | Gallium | 30 | 300 | 3.97 | Toluene | 20 | 400 | 64 |
| bisulfide | 20 | 1,000 | 48 | Glycerol | 15 | 5 | 22 | Turpentine | 20 | | 74 |
| bisulfide | 20 | 12,000 | 6 | Hexane | 20 | 200 | 117 | Water | 20 | 13 | 49 |
| tetrachloride | 20 | 200 | 86 | Hexane | 20 | 400 | 91 | Water | 20 | 200 | 43 |
| tetrachloride | 20 | 400 | 73 | Kerosene | 20 | 500 | 55 | Water | 20 | 400 | 41 |
| Chloroform | 20 | 200 | 83 | Kerosene | 20 | 1,000 | 45 | Water | 20 | 500 | 39 |
| Chloroform | 20 | 400 | 70 | Kerosene | 20 | 12,000 | 8 | Water | 40 | 500 | 38 |
| Dichloroethylsulfide | 32 | 1,000 | 34 | Mercury | 20 | 300 | 3.95 | Water | 40 | 1,000 | 33 |
| Dichloroethylsulfide | 32 | 2,000 | 24 | Mercury | 22 | 500 | 3.97 | Water | 40 | 12,000 | 9 |
| Ethyl acetate | 13 | 23 | 103 | Mercury | 22 | 1,000 | 3.91 | Xylene, meta | 20 | 200 | 69 |
| acetate | 20 | 200 | 90 | Mercury | 22 | 12,000 | 2.37 | meta | 20 | 400 | 60 |

* *Smithsonian Tables,* Table 106.

Scott (*Cryogenic Engineering,* Van Nostrand, Princeton, NJ, 1959) gives data for liquid nitrogen (p. 283), oxygen (p. 276), and hydrogen (p. 303). For a convenient index to the high-pressure work of Bridgman, see *American Institute of Physics Handbook,* p. 2-163, McGraw-Hill, New York, 1957.

**TABLE 2-189 Compressibilities of Solids**

Many data on the compressibility of solids obtained prior to 1926 are contained in Gruneisen, *Handbuch der Physik*, vol. 10, Springer, Berlin, 1926, pp. 1–52; also available as translation, NASA RE 2-18-59W, 1959. See also Tables 271, 273, 276, 278, and other material in *Smithsonian Physical Tables*, 9th ed., 1954. For a review of high-pressure work to 1946, see Bridgman, *Rev. Mod. Phys.*, **18,** 1 (1946).

# LATENT HEATS

## UNITS CONVERSIONS

For this subsection, the following units conversions are applicable:

$$°F = \tfrac{9}{5}\,°C + 32.$$

To convert calories per gram-mole to British thermal units per pound-mole, multiply by 1.799; to convert calories per gram to British thermal units per pound, multiply by 1.799.

To convert millimeters of mercury to pounds-force per square inch, multiply by $1.934 \times 10^{-2}$.

## TABLE 2-190 Heats of Fusion and Vaporization of the Elements and Inorganic Compounds*

Unless stated otherwise, the values have been taken from the compilations by K. K. Kelley on "Heats of Fusion of Inorganic Compounds," U.S. Bur. Mines Bull. 393 (1936), and "The Free Energies of Vaporization and Vapor Pressures of Inorganic Substances," U.S. Bur. Mines Bull. 383 (1935).

| Substance | mp, °C | Heat of fusion,[a,b] cal/mole | bp at 1 atm, °C | Heat of vaporization,[a,b] cal/mole |
|---|---|---|---|---|
| Aluminum | | | | |
| Al | 660.0 | 2,550 | 2057 | 61,020 |
| $Al_2Br_6$ | 97.5 | 5,420 | 256.4 | 10,920 |
| $Al_2Cl_6$ | 192.5 | 16,960 | 180.2[c] | 26,750[c] |
| $AlF_3{\cdot}3NaF$ | 1000 | 16,380 | | |
| $Al_2I_6$ | 191.0 | 7,960 | 385.5 | 15,360 |
| $Al_2O_3$ | 2045 | (26,000) | 3000 | |
| Antimony | | | | |
| Sb | 630.5 | 4,770 | 1440 | 46,670 |
| $SbBr_3$ | 97 | 3,510 | | |
| $SbCl_3$ | 73.4 | 3,030 | 219 | 10,360 |
| $SbCl_5$ | 4 | 2,400 | 172[d] | 11,570 |
| $Sb_4O_6$ | 655 | (27,000) | 1425 | 17,820 |
| $Sb_4S_6$ | 546 | 11,200 | | |
| Argon | | | | |
| A | −189.3 | 290 | −185.8 | 1,590 |
| Arsenic | | | | |
| As | 814 | (6,620) | 610[c] | 31,000[c] |
| $AsBr_3$ | 31 | 2,810 | | |
| $AsCl_3$ | −16 | 2,420 | 122 | 7,570 |
| $AsF_5$ | −80.7 | 2,800 | −52.8 | 4,980 |
| $As_4O_6$ | 313 | 8,000 | 457.2 | 14,300 |
| Barium | | | | |
| Ba | 704 | (1,400)[e] | 1638 | 35,670 |
| $BaBr_2$ | 847 | 6,000 | | |
| $BaCl_2$ | 960 | 5,370 | | |
| $BaF_2$ | 1287 | 3,000 | | |
| $Ba(NO_3)_2$ | 595 | (5,980) | | |
| $Ba_3(PO_4)_2$ | 1730 | 18,600 | | |
| $BaSO_4$ | 1350 | 9,700 | | |
| Beryllium | | | | |
| Be | 1280 | 2,500[e] | | |
| Bismuth | | | | |
| Bi | 271.3 | 2,505 | 1420 | |
| $BiBr_3$ | | | 461 | 18,020 |
| $BiCl_3$ | 224 | 2,600 | 441 | 17,350 |
| $Bi_2O_3$ | 817 | 6,800 | | |
| $Bi_2S_5$ | 747 | 8,900 | | |
| Boron | | | | |
| $BBr_3$ | | | 91.3 | 7,300 |
| $BCl_3$ | | | 12.5 | 5,680 |
| $BF_3$ | −128 | 480 | −100.9 | 4,620 |
| $B_2H_6$ | −165.5 | | −92.4 | 3,685 |
| $B_3H_{10}$ | −119.8 | | 16 | 6,470 |
| $B_5H_9$ | −46.9 | | 58 | 7,700 |
| $B_5H_{11}$ | | | 67 | 8,500 |
| $B_{10}H_{14}$ | 99.7 | 7,800 | *f* | 11,600 |
| $B_2H_5Br$ | −104 | | 16 | 6,230 |
| $B_3N_3H_6$ | −58 | | 50.4 | 7,670 |
| Bromine | | | | |
| $Br_2$ | −7.2 | 2,580 | 58.0 | 7,420 |
| $BrF_5$ | −61.3 | 1,355 | 40.4 | 7,470 |
| Cadmium | | | | |
| Cd | 320.9 | 1,460 | 765 | 23,870 |
| $CdBr_2$ | 568 | (5,000) | | |
| $CdCl_2$ | 568 | 5,300 | 967 | 29,860 |
| $CdF_2$ | 1110 | (5,400) | | |
| $CdI_2$ | 387 | 3,660 | 796 | 25,400 |
| CdO | | | 1559[c] | 53,820[c] |
| $CdSO_4$ | 1000 | 4,790 | | |
| Calcium | | | | |
| Ca | 851 | 2,230 | 1487 | 36,580 |
| $CaBr_2$ | 730 | 4,180 | | |
| $CaCO_3$ | 1282 | (12,700) | | |
| $CaCl_2$ | 782 | 6,100 | | |
| $CaF_2$ | 1392 | 4,100 | | |
| $Ca(NO_3)_2$ | 561 | 5,120 | | |
| CaO | 2707 | (12,240) | | |
| $CaO{\cdot}Al_2O_3{\cdot}2SiO_2$ | 1550 | 29,400 | | |
| $CaO{\cdot}MgO{\cdot}2SiO_2$ | 1392 | (18,200) | | |
| $CaO{\cdot}SiO_2$ | 1512 | 13,400 | | |
| $CaSO_4$ | 1297 | 6,700 | | |
| Carbon | | | | |
| C (graphite) | 3600 | 11,000[e] | | |
| $CBr_4$ | 90 | 1,050 | | |
| $CCl_4$ | −24.0 | 644 | 77 | 7,280 |
| $CF_4$ | | | −127.9 | 3,110 |
| $CH_4$ | −182.5 | 224 | −161.4 | 2,040 |
| $C_2N_2$ | −27.8 | 1,938[u] | −21.1 | 5,576[u] |
| CNBr | 52 | | | 11,010[c] |
| CNCl | −5 | 2,240 | 13 | 6,300 |
| Carbon (*Cont.*) | | | | |
| CNF | | | −72.8 | 5,780[c] |
| CNI | | | 141 | 13,980[c] |
| CO | −205.0 | 200 | −191.5 | 1,444 |
| $CO_2$ | −57.5 | 1,900 | −78.4[c] | 6,030[c, r] |
| COS | −138.8 | 1,129[k] | −50.2 | 4,423[k] |
| $COCl_2$ | | | 8.0 | 5,990 |
| $CS_2$ | −112.0 | 1,049[l] | | |
| Cerium | | | | |
| Ce | 775 | 2,120 | | |
| Cesium | | | | |
| Cs | 28.4 | 500 | 690 | 16,320 |
| CsBr | | | 1300 | 35,990 |
| CsCl | 642 | 3,600 | 1300 | 35,690 |
| CsF | 715 | (2,450) | 1251 | 34,330 |
| CsI | | | 1280 | 35,930 |
| $CsNO_3$ | 407 | 3,250 | | |
| Chlorine | | | | |
| $Cl_2$ | −101.0 | 1,531[m] | −34.1 | 4,878[m] |
| ClF | | | −101 | |
| $ClF_3$ | | | 11.3 | 5,890 |
| $Cl_2O$ | | | 2.0 | 6,280 |
| $ClO_2$ | | | 10.9 | 7,100 |
| $Cl_2O_7$ | | | 79 | 8,480 |
| Chromium | | | | |
| Cr | 1550 | 3,930 | 2475 | |
| $CrO_2Cl_2$ | | | 117 | 8,250 |
| Cobalt | | | | |
| Co | 1490 | 3,660 | | |
| $CoCl_2$ | 727 | 7,390 | 1050 | 27,170 |
| Copper | | | | |
| Cu | 1083.0 | 3,110 | 2595 | 72,810 |
| $Cu_2Br_2$ | | | 1355 | 16,310 |
| $Cu_2Cl_2$ | 430 | 4,890 | 1490 | 11,920 |
| CuI | | | 1336 | 15,940 |
| $Cu_2(CN)_2$ | 473 | (5,400) | | |
| $Cu_2O$ | 1230 | (13,400) | | |
| CuO | 1447 | 2,820 | | |
| $Cu_2S$ | 1127 | 5,500 | | |
| Fluorine | | | | |
| $F_2$ | −223 | | −188.2 | 1,640 |
| $F_2O$ | | | −144.8 | 2,650 |
| Gallium | | | | |
| Ga | 29.8 | 1,336 | 2071 | |
| Germanium | | | | |
| Ge | 959 | (8,300) | | |
| $GeH_4$ | −165 | | −89.1 | 3,580 |
| $Ge_2H_6$ | −109 | | 31.4 | 5,900 |
| $Ge_3H_8$ | −105.6 | | 110.6 | 7,550 |
| $GeHCl_3$ | −71 | | 75[g] | 8,000 |
| $GeBr_4$ | 26.1 | | 189 | 8,560 |
| $GeCl_4$ | −49.5 | | 84 | 7,030 |
| $Ge(CH_3)_4$ | −88 | | 44 | 6,460 |
| Gold | | | | |
| Au | 1063.0 | 3,030 | 2966 | 81,800 |
| Helium | | | | |
| He | −271.4 | | −268.4 | 22 |
| Hydrogen | | | | |
| $H_2$ | −259.2 | 28 | −252.7 | 216 |
| HBr | −86.9 | 575 | −66.7 | 4,210 |
| HCl | −114.2 | 476 | −85.0 | 3,860 |
| HCN | −13.2 | 2,009[j] | 25.7 | 6,027[j] |
| HF | −83.0 | 1,094 | 33.3 | 7,460 |
| $(HF)_6$ | | | 51.2 | 5,020 |
| HI | −50.8 | 686 | | |
| $H_2O$ | 0.0 | 1,436 | 100.0 | 9,729[h,q] |
| $H_2{}^2O$ (= $D_2O$) | 3.8 | 1,501[s] | 101.4 | 9,945[r,q] |
| $H_2O_2$ | −2 | 2,520[c] | 158 | 10,270 |
| $HNO_3$ | −47 | 600 | | |
| $H_3PO_2$ | 17.4 | 2,310 | | |
| $H_3PO_3$ | 74 | 3,070 | | |
| $H_3PO_4$ | 42.4 | 2,520 | | |
| $H_4P_2O_6$ | 55 | 8,300 | | |
| $H_2S$ | −85.5 | 568[t] | −60.3 | 4,463[t] |
| $H_2S_2$ | −87.6 | 1,805 | | |
| $H_2SO_4$ | 10.5 | 2,360 | | |
| $H_2Se$ | | | −41.3 | 4,880 |
| $H_2SeO_4$ | 58 | 3,450 | | |
| $H_2Te$ | −48.9 | 1,670 | −2.2 | 5,650 |
| Indium | | | | |
| In | 156.4 | 781 | | |

*See also subsection "Thermodynamic Properties."

**TABLE 2-190 Heats of Fusion and Vaporization of the Elements and Inorganic Compounds** (*Continued*)

| Substance | mp, °C | Heat of fusion,[a,b] cal/mole | bp at 1 atm, °C | Heat of vaporization,[a,b] cal/mole |
|---|---|---|---|---|
| Iodine | | | | |
| $I_2$ | 113.0 | 3,650 | 183 | 10,390 |
| ICl(α) | 17.2 | 2,660 | | |
| ICl(β) | 13.9 | 2,270 | | |
| $IF_7$ | | | 4[c] | 7,460[c] |
| Iron | | | | |
| Fe | 1530 | 3,560 | 2735 | 84,600 |
| $FeCl_2$ | 677 | 7,800 | 1026 | 30,210 |
| $Fe_2Cl_6$ | 304 | 20,590 | 319 | 12,040 |
| $Fe(CO)_5$ | −21 | 3,250 | 105 | 9,000 |
| FeO | 1380 | (7,700) | | |
| FeS | 1195 | 5,000 | | |
| Krypton | | | | |
| Kr | −157 | 360[e] | 152.9 | 2,310[e] |
| Lead | | | | |
| Pb | 327.4 | 1,224 | 1744 | 42,060 |
| $PbBr_2$ | 488 | 4,290 | 914 | 27,700 |
| $PbCl_2$ | 498 | 5,650 | 954 | 29,600 |
| $PbF_2$ | 824 | 1,860 | 1293 | 38,300 |
| $PbI_2$ | 412 | 5,970 | 872 | 24,850 |
| $PbMoO_4$ | 1065 | (25,800) | | |
| PbO | 890 | 2,820 | 1472 | 51,310 |
| PbS | 1114 | 4,150 | 1281 | (50,000) |
| $PbSO_4$ | 1087 | 9,600 | | |
| $PbWO_4$ | 1123 | (15,200) | | |
| Lithium | | | | |
| Li | 179 | 1,100 | 1372 | 32,250 |
| $LiBO_2$ | 845 | (5,570) | | |
| LiBr | 552 | 2,900 | 1310 | 35,420 |
| LiCl | 614 | 3,200 | 1382 | 35,960 |
| LiF | 847 | (2,360) | 1681 | 50,970 |
| LiI | 440 | (1,420) | 1171 | 40,770 |
| LiOH | 462 | 2,480 | | |
| $Li_2MoO_4$ | 705 | 4,200 | | |
| $LiNO_3$ | | | | |
| $Li_2SiO_3$ | 1177 | 7,210 | | |
| $Li_4SiO_4$ | 1249 | 7,430 | | |
| $Li_2SO_4$ | 857 | 3,040 | | |
| $Li_2WO_4$ | 742 | (6,700) | | |
| Magnesium | | | | |
| Mg | 650 | 2,160 | 1107 | 32,520 |
| $MgBr_2$ | 711 | 8,300 | | |
| $MgCl_2$ | 712 | 8,100 | 1418 | 32,690 |
| $MgF_2$ | 1221 | 5,900 | | |
| MgO | 2642 | 18,500 | | |
| $Mg_3(PO_4)_2$ | 1184 | (11,300) | | |
| $MgSiO_3$ | 1524 | 14,700 | | |
| $MgSO_4$ | 1127 | 3,500 | | |
| $MgZn_2$ | 589 | (8,270) | | |
| Manganese | | | | |
| Mn | 1220 | 3,450 | 2152 | 55,150 |
| $MnCl_2$ | 650 | 7,340 | 1190 | 29,630 |
| $MnSiO_3$ | 1274 | (8,200) | | |
| $MnTiO_3$ | 1404 | (7,960) | | |
| Mercury | | | | |
| Hg | −38.9 | 557 | 361 | 13,980 |
| $HgBr_2$ | 241 | 3,960 | 319 | 14,080 |
| $HgCl_2$ | 277 | 4,150 | 304 | 14,080 |
| $HgI_2$ | 250 | 4,500 | 354 | 14,260 |
| $HgSO_4$ | 850 | (1,440) | | |
| Molybdenum | | | | |
| Mo | 2622 | (6,660) | (4800) | (128,000) |
| $MoF_6$ | 17 | 2,500 | 36 | 6,000 |
| $MoO_3$ | 745 | (2,500) | 1151 | |
| Neon | | | | |
| Ne | −248.5 | 77 | −246.0 | 440[e] |
| Nickel | | | | |
| Ni | 1455 | 4,200 | 2730 | 87,300 |
| $NiCl_2$ | | | 987[c] | 48,360[c] |
| $Ni(CO)_4$ | | | 42.5 | 7,000 |
| $Ni_2S$ | 645 | (2,980) | | |
| $Ni_3S_2$ | 790 | 5,800 | | |
| Nitrogen | | | | |
| $N_2$ | −210.0 | 172 | −195.8 | 1,336 |
| $NF_3$ | | | −129.0 | 3,000 |
| $NH_3$ | −77.7 | 1,352[n] | −33.4 | 5,581[n] |
| $NH_4CNS$ | 146 | (4,700) | | |
| $NH_4NO_3$ | 169.6 | 1,460 | | |
| $N_2O$ | −90.8 | 1,563 | −88.5 | 3,950 |
| NO | −163.6 | 550 | −151.7 | 3,307 |
| $N_2O_4$ | −13 | 5,540 | 30 | 7,040 |
| $N_2O_5$ | | | 32.4 | 13,800[c] |
| NOCl | | | −6.4 | 6,140 |
| Osmium | | | | |
| $OsF_8$ | | | 47.4 | 6,840 |
| $OsO_4$ (yellow) | 56 | 4,060 | 130 | 9,450 |
| $OsO_4$ (white) | 42 | 2,340 | | |
| Oxygen | | | | |
| $O_2$ | −218.9 | 106 | −183.0 | 1,629 |
| $O_3$ | | | −111 | 2,880 |
| Palladium | | | | |
| Pd | 1554 | 4,120 | | |
| Phosphorus | | | | |
| $P_4$ (yellow) | 44.2 | 615 | 280 | 12,520 |
| $P_4$ (violet) | | | 417[c] | 25,600[c] |
| $P_4$ (black) | | | 453[c] | 33,100 |
| $PCl_3$ | | | 74.2 | 7,280 |
| $PH_3$ | −133.8 | 270[o] | −87.7 | 3,489[o] |
| $P_4O_6$ | 23.8 | 3,360 | 174 | 10,380 |
| $P_4O_{10}$(α) | 569 | 17,080 | 591 | 20,670 |
| $P_4O_{10}$(β) | | | 358[c] | |
| $POCl_3$ | 1.1 | 3,110 | 105.1 | 8,380 |
| $P_2S_3$ | | | 508 | |
| Platinum | | | | |
| Pt | 1773.5 | 4,700 | (4400) | (107,000) |
| Potassium | | | | |
| K | 63.5 | 574 | 776 | 18,920 |
| $KBO_2$ | 947 | (5,700) | | |
| KBr | 742 | 5,000 | 1383 | 37,060 |
| KCl | 770 | 6,410 | 1407 | 38,840 |
| KCN | 623 | (3,500) | | |
| KCNS | 179 | 2,250 | | |
| $K_2CO_3$ | 897 | 7,800 | | |
| $K_2CrO_4$ | 984 | 6,920 | | |
| $K_2Cr_2O_7$ | 398 | 8,770 | | |
| KF | 857 | 6,500 | | |
| KI | 682 | 4,100 | 1324 | 34,690 |
| $K_2MoO_4$ | 922 | (4,000) | | |
| $KNO_3$ | 338 | 2,840 | | |
| KOH | 360 | (2,000) | 1327 | 30,850 |
| $KPO_3$ | 817 | 2,110 | | |
| $K_3PO_4$ | 1340 | 8,900 | | |
| $K_4P_2O_7$ | 1092 | 14,000 | | |
| $K_2SO_4$ | 1074 | 8,100 | | |
| $K_2TiO_3$ | 810 | (10,600) | | |
| $K_2WO_4$ | 927 | (4,400) | | |
| Praseodymium | | | | |
| Pr | 932 | 2,700 | | |
| Radon | | | | |
| Rn | −71 | | −61.8 | 4,010 |
| Rhenium | | | | |
| Re | (3000) | | | |
| $Re_2O_7$ | 296 | 15,340 | 362.4 | 18,060 |
| $Re_2O_8$ | 147 | 3,800 | | |
| Rubidium | | | | |
| Rb | 39.1 | 525 | 679 | 18,110 |
| RbBr | 677 | 3,700 | 1352 | 37,120 |
| RbCl | 717 | 4,400 | 1381 | 36,920 |
| RbF | 833 | 4,130 | 1408 | 39,510 |
| RbI | 638 | 2,990 | 1304 | 35,960 |
| $RbNO_3$ | 305 | 1,340 | | |
| Selenium | | | | |
| $Se_2$ | 217 | 1,220 | 753 | 25,490 |
| $Se_6$ | | | 736 | 20,600 |
| $SeF_6$ | | | −45.8[c] | 6,350[c] |
| $SeO_2$ | | | 317[c] | 20,900 |
| $SeOCl_2$ | 10 | 1,010 | 168 | |
| Silicon | | | | |
| Si | 1427 | 9,470 | 2290 | |
| $SiCl_4$ | −67.6 | 1,845 | 56.8 | 6,860 |
| $Si_2Cl_6$ | −1 | | 139 | |
| $Si_3Cl_8$ | | | 211.4 | 12,340 |
| $(SiCl_3)_2O$ | −33 | | 135.6 | 8,820 |
| $SiF_4$ | | | −94.8[c] | 6,130[c] |
| $Si_2F_6$ | −18.5 | 3,900 | −18.9[c] | 10,400[c] |
| $SiF_3Cl$ | −138 | | −70.1 | 4,460 |
| $SiF_2Cl_2$ | −144 | | −31.5 | 5,080 |
| $SiH_4$ | −185 | | −111.6 | 2,960 |
| $Si_2H_6$ | −132.5 | | −14.3 | 5,110 |
| $Si_3H_8$ | −117 | | 53.1 | 6,780 |
| $Si_4H_{10}$ | −93.5 | | 100 | 8,890 |
| $SiH_3Br$ | −93.8 | | 2.4 | 5,650 |
| $SiH_2Br_2$ | −70.0 | | 70.5 | 6,840 |
| $SiHCl_3$ | −126.5 | | 31.8 | 6,360 |
| $(SiH_3)_3N$ | −105.6 | | 48.7 | 6,850 |
| $(SiH_3)_2O$ | −144 | | −15.4 | 5,350 |
| $SiO_2$ (quartz) | 1470 | 3,400 | 2230 | |
| $SiO_2$ (cristobalite) | 1700 | 2,100 | | |
| Silver | | | | |
| Ag | 960.5 | 2,700 | 2212 | 60,720 |
| AgBr | 430 | 2,180 | | |
| AgCl | 455 | 3,155 | 1564 | 42,520 |
| AgCN | 350 | 2,750 | | |
| AgI | 557 | 2,250 | 1506 | 34,450 |
| $AgNO_3$ | 209 | 2,755 | | |
| $Ag_2S$ | 842 | 3,360 | | |
| $Ag_2SO_4$ | 657 | (4,300) | | |
| Sodium | | | | |
| Na | 97.7 | 630 | 914 | 23,120 |
| $NaBO_2$ | 966 | 8,660 | | |

**TABLE 2-190 Heats of Fusion and Vaporization of the Elements and Inorganic Compounds** (*Concluded*)

| Substance | mp, °C | Heat of fusion,[a,b] cal/mole | bp at 1 atm, °C | Heat of vaporization,[a,b] cal/mole |
|---|---|---|---|---|
| Sodium (*Cont.*) | | | | |
| NaBr | 747 | 6,140 | 1392 | 37,950 |
| NaCl | 800 | 7,220 | 1465 | 40,810 |
| $NaClO_3$ | 255 | 5,290 | | |
| NaCN | 562 | (4,400) | 1500 | 37,280 |
| NaCNS | 323 | 4,450 | | |
| $Na_2CO_3$ | 854 | 7,000 | | |
| NaF | 992 | 7,000 | 1704 | 53,260 |
| NaI | 662 | 5,240 | | |
| $Na_2MoO_4$ | 687 | 3,600 | | |
| $NaNO_3$ | 310 | 3,760 | | |
| NaOH | 322 | 2,000 | 1378 | |
| $½Na_2O·½Al_2O_3·3SiO_2$ | 1107 | 13,150 | | |
| $NaPO_3$ | 988 | (5,000) | | |
| $Na_4P_2O_7$ | 970 | (13,700) | | |
| $Na_2S$ | 920 | (1,200) | | |
| $Na_2SiO_3$ | 1087 | 10,300 | | |
| $Na_2Si_2O_5$ | 884 | 8,460 | | |
| $Na_2SO_4$ | 884 | 5,830 | | |
| $Na_2WO_4$ | 702 | 5,800 | | |
| Strontium | | | | |
| Sr | 757 | 2,190 | 1384 | 33,610 |
| $SrBr_2$ | 643 | 4,780 | | |
| $SrCl_2$ | 872 | 4,100 | | |
| $SrF_2$ | 1400 | 4,260 | | |
| $Sr_3(PO_4)_2$ | 1770 | 18,500 | | |
| Sulfur | | | | |
| S (rhombic) | 112.8 | | 444.6 | 2,200 |
| S (monoclinic) | 119.2 | | | |
| $S_2Cl_2$ | | | 138 | 8,720 |
| $SF_6$ | | | −63.5[c] | 5,600[c] |
| $SO_2$ | −75.5 | 1,769[p] | −5.0 | 5,960[p] |
| $SO_3(\alpha)$ | 17 | 2,060 | 44.8 | 10,190 |
| $SO_3(\beta)$ | 32.4 | 2,890 | | |
| $SO_3(\gamma)$ | 62.2 | 6,310 | | |
| $SOBr_2$ | | | 139.5 | 9,920 |
| $SOCl_2$ | | | 75.4 | 7,600 |
| $SO_2Cl_2$ | | | 69.2 | 7,760 |
| Tellurium | | | | |
| Te | 453 | 3,230 | 1090 | |
| $TeCl_4$ | | | 392 | 16,830 |
| $TeF_6$ | | | −38.6[c] | 6,700[c] |
| Thallium | | | | |
| Tl | 302.5 | 1,030 | 1457 | 38,810 |
| TlBr | 460 | 5,990 | 819 | 23,800 |
| TlCl | 427 | 4,260 | 807 | 24,420 |
| $Tl_2CO_3$ | 273 | 4,400 | | |
| TlI | 440 | 3,125 | 823 | 25,030 |
| $TlNO_3$ | 207 | 2,290 | | |
| $Tl_2S$ | 449 | 3,000 | | |
| $Tl_2SO_4$ | 632 | 5,500 | | |
| Tin | | | | |
| $Sn_4$ | 231.8 | 1,720 | 2270 | 68,000 |
| $SnBr_2$ | 232 | (1,700) | | |
| $SnBr_4$ | 30 | 3,000 | | |
| $SnCl_2$ | 247 | 3,050 | 623 | 20,740 |
| $SnCl_4$ | −33.2 | 2,190 | 113 | 8,330 |
| $Sn(CH_3)_4$ | | | 78.3 | 7,320 |
| $SnH_4$ | −149.8 | | −52.3 | 4,420 |
| $SnI_4$ | 143.5 | (4,300) | | |
| Titanium | | | | |
| $TiBr_4$ | 38.2 | (2,060) | | |
| $TiCl_4$ | −23 | 2,240 | 136 | 8,350 |
| $TiO_2$ | 1825 | (11,400) | | |
| Tungsten | | | | |
| W | 3390 | (8,400) | (5900) | (176,000) |
| $WF_6$ | −0.4 | 1,800 | 17.3 | 6,350 |
| Uranium | | | | |
| $UF_6$ | | | 55.1[c] | 9,990[c] |
| Xenon | | | | |
| Xe | −111.5 | 740 | −108.0 | 3,110 |
| Zinc | | | | |
| Zn | 419.5 | 1,595 | 907 | 27,430 |
| $ZnCl_2$ | 283 | (5,500) | 732 | 28,710 |
| $Zn(C_2H_5)_2$ | | | 118 | 8,960 |
| ZnO | 1975 | 4,470 | | |
| ZnS | 1645 | (9,000) | | |
| Zirconium | | | | |
| $ZrBr_4$ | | | 357[c] | 25,800[c] |
| $ZrCl_4$ | | | 311[c] | 25,290[c] |
| $ZrI_4$ | | | 431[c] | 29,030[c] |
| $ZrO_2$ | 2715 | 20,800 | | |

[a] Values in parentheses are uncertain.
[b] For the freezing point or the normal boiling point unless otherwise stated.
[c] Sublimation.
[d] Decomposes at about 75°C; value obtained by extrapolation.
[e] Bichowsky and Rossini, "Thermochemistry of the Chemical Substances," Reinhold, New York (1936).
[f] Decomposes before the normal boiling point is reached.
[g] Decomposes at about 40°C; value obtained by extrapolation.
[h] See also pp. 2-304 through 2-307 on steam table.
[i] Giauque and Ruehrwein, *J. Am. Chem. Soc.*, **61** (1939): 2626.
[j] Giauque and Egan, *J. Chem. Phys.*, **5** (1937): 45.
[k] Kemp and Giauque, *J. Am. Chem.* Soc., **59** (1937): 79.
[l] Brown and Manov, *J. Am. Chem.* Soc., **59** (1937): 500.
[m] Giauque and Powell, *J. Am. Chem.* Soc. **61** (1939): 1970.
[n] Overstreet and Giauque, *J. Am. Chem.* Soc **59** (1937): 254.
[o] Stephenson and Giauque, *J. Chem. Phys.*, **5** (1937): 149.
[p] Giauque and Stephenson, *J. Am. Chem. Soc.*, **60** (1938): 1389.
[q] Osborne, Stimson, and Ginnings, *Bur. Standards J. Research*, **23,** 197 (1939): 261.
[r] Miles and Menzies, *J. Am. Chem. Soc.*, **58** (1936): 1067.
[s] Long and Kemp, *J. Am. Chem. Soc.*, **58** (1936): 1829.
[t] Giauque and Blue, *J. Am. Chem. Soc.*, **58** (1936): 831.
[u] Ruehrwein and Giauque, *J. Am. Chem. Soc.*, **61** (1939): 2940.

**TABLE 2-191 Heats of Fusion of Miscellaneous Materials**

| Material | mp, °C | Heat of fusion, cal/g |
|---|---|---|
| Alloys | | |
| 30.5 Pb + 69.5 Sn | 183 | 17 |
| 36.9 Pb + 63.1 Sn | 179 | 15.5 |
| 63.7 Pb + 36.3 Sn | 177.5 | 11.6 |
| 77.8 Pb + 22.2 Sn | 176.5 | 9.54 |
| 1 Pb + 9 Sn | 236 | 28 |
| 24 Pb + 27.3 Sn + 48.7 Bi | 98.8 | 6.85 |
| 25.8 Pb + 14.7 Sn + 52.4 Bi + 7 Cd | 75.5 | 8.4 |
| Silicates | | |
| Anorthite ($CaAl_2Si_2O_8$) | | 100 |
| Orthoclase ($KAlSi_3O_8$) | | 100 |
| Microcline ($KAlSi_3O_8$) | | 83 |
| Wollastonite ($CaSiO_8$) | | 100 |
| Malacolite ($Ca_8MgSi_4O_{12}$) | | 94 |
| Diopside ($CaMgSi_2O_4$) | | 100 |
| Olivine ($Mg_2SiO_4$) | | 130 |
| Fayalite ($Fe_2SiO_4$) | | 85 |
| Spermaceti | 43.9 | 37.0 |
| Wax (bees') | 61.8 | 42.3 |

## TABLE 2-192 Heats of Fusion of Organic Compounds

The values for the hydrocarbons are from the tables of the American Petroleum Institute Research Project 44 at the National Bureau of Standards, with some from Parks and Huffman, *Ind. Eng. Chem.*, **23,** 1138 (1931).

The values for the nonhydrocarbon compounds were recalculated from data in *International Critical Tables,* vol. 5.

| Hydrocarbon compounds | Formula | mp, °C | Heat of fusion, cal/g |
|---|---|---|---|
| Paraffins | | | |
| Methane | $CH_4$ | −182.48 | 14.03 |
| Ethane | $C_2H_6$ | −183.23 | 22.712 |
| Propane | $C_3H_8$ | −187.65 | 19.100 |
| *n*-Butane | $C_4H_{10}$ | −138.33 | 19.167 |
| 2-Methylpropane | $C_4H_{10}$ | −159.60 | 18.668 |
| *n*-Pentane | $C_5H_{12}$ | −129.723 | 27.874 |
| 2-Methylbutane | $C_5H_{12}$ | −159.890 | 17.076 |
| 2,2-Dimethylpropane | $C_5H_{12}$ | −16.6 | 10.786 |
| *n*-Hexane | $C_6H_{14}$ | −95.320 | 36.138 |
| 2-Methylpentane | $C_6H_{14}$ | −153.680 | 17.407 |
| 2,2-Dimethylbutane | $C_6H_{14}$ | −99.73 | 1.607 |
| 2,3-Dimethylbutane | $C_6H_{14}$ | −128.41 | 2.251 |
| *n*-Heptane | $C_7H_{16}$ | −90.595 | 33.513 |
| 2-Methylhexane | $C_7H_{16}$ | −118.270 | 21.158 |
| 3-Ethylpentane | $C_7H_{16}$ | −118.593 | 22.555 |
| 2,2-Dimethylpentane | $C_7H_{16}$ | −123.790 | 13.982 |
| 2,4-Dimethylpentane | $C_7H_{16}$ | −119.230 | 15.968 |
| 3,3-Dimethylpentane | $C_7H_{16}$ | −134.46 | 16.856 |
| 2,2,3-Trimethylbutane | $C_7H_{16}$ | −24.96 | 5.250 |
| *n*-Octane | $C_8H_{18}$ | −56.798 | 43.169 |
| 2-Methylheptane | $C_8H_{18}$ | −109.04 | 21.458 |
| 3-Methylpentane | $C_8H_{18}$ | −120.50 | 23.795 |
| 4-Methylheptane | $C_8H_{18}$ | −120.955 | 22.692 |
| 2,2-Dimethylhexane | $C_8H_{18}$ | −121.18 | 24.226 |
| 2,5-Dimethylhexane | $C_8H_{18}$ | −91.200 | 26.903 |
| 3,3-Dimethylhexane | $C_8H_{18}$ | −126.10 | 14.9 |
| 2-Methyl-3-ethylpentane | $C_8H_{18}$ | −114.960 | 23.690 |
| 3-Methyl-3-ethylpentane | $C_8H_{18}$ | −90.870 | 22.657 |
| 2,2,3-Trimethylpentane | $C_8H_{18}$ | −112.27 | 18.061 |
| 2,2,4-Trimethylpentane | $C_8H_{18}$ | −107.365 | 19.278 |
| 2,3,3-Trimethylpentane | $C_8H_{18}$ | −100.70 | 3.204 |
| 2,3,4-Trimethylpentane | $C_8H_{18}$ | −109.210 | 19.392 |
| 2,2,3,3-Tetramethylbutane | $C_8H_{18}$ | +100.69 | 14.900 |
| *n*-Nonane | $C_9H_{20}$ | −53.9 | 41.2 |
| *n*-Decane | $C_{10}H_{22}$ | −30.0 | 48.3 |
| *n*-Undecane | $C_{11}H_{24}$ | −25.9 | 34.1 |
| *n*-Dodecane | $C_{12}H_{26}$ | −9.6 | 51.3 |
| Eicosane | $C_{20}H_{42}$ | +36.4 | 52.0 |
| Pentacosane | $C_{25}H_{52}$ | +53.3 | 53.6 |
| Tritriacontane | $C_{33}H_{68}$ | +71.1 | 54.0 |
| Aromatics | | | |
| Benzene | $C_6H_6$ | +5.533 | 30.100 |
| Methylbenzene (Toluene) | $C_7H_8$ | −94.991 | 17.171 |
| Ethylbenzene | $C_8H_{10}$ | −94.950 | 20.629 |
| *o*-Xylene | $C_8H_{10}$ | −25.187 | 30.614 |
| *m*-Xylene | $C_8H_{10}$ | −47.872 | 26.045 |
| *p*-Xylene | $C_8H_{10}$ | +13.263 | 38.526 |
| *n*-Propylbenzene | $C_9H_{12}$ | −99.500 | 16.97 |
| Isopropylbenzene | $C_9H_{12}$ | −96.028 | 19.22 |
| 1-Methyl-2-ethylbenzene | $C_9H_{12}$ | −80.833 | 21.13 |
| Aromatics—(*Cont.*) | | | |
| 1-Methyl-3-ethylbenzene | $C_9H_{12}$ | −95.55 | 15.14 |
| 1-Methyl-4-ethylbenzene | $C_9H_{12}$ | −62.350 | 25.29 |
| 1,2,3-Trimethylbenzene | $C_9H_{12}$ | −25.375 | 16.64 |
| 1,2,4-Trimethylbenzene | $C_9H_{12}$ | −43.80 | 24.54 |
| 1,3,5-Trimethylbenzene | $C_9H_{12}$ | −44.720 | 18.97 |
| Naphthalene | $C_{10}H_8$ | +80.0 | 36.0 |
| Camphene | $C_{10}H_{12}$ | +51 | 57 |
| Durene | $C_{10}H_{14}$ | +79.3 | 37.4 |
| Isodurene | $C_{10}H_{14}$ | −24.0 | 23.0 |
| Prehnitene | $C_{10}H_{14}$ | −7.7 | 20.0 |
| *p*-Cymene | $C_{10}H_{14}$ | −68.9 | 17.1 |
| *n*-Butyl benzene | $C_{10}H_{14}$ | −88.5 | 19.5 |
| *tert*-Butyl benzene | $C_{10}H_{14}$ | −58.1 | 14.9 |
| β-Methyl naphthalene | $C_{11}H_{10}$ | +34.1 | 20.1 |
| Diphenyl | $C_{12}H_{10}$ | +68.6 | 28.8 |
| Hexamethyl benzene | $C_{12}H_{18}$ | +165.5 | 30.4 |
| Diphenyl methane | $C_{13}H_{12}$ | +25.2 | 26.4 |
| Anthracene | $C_{14}H_{10}$ | +216.5 | 38.7 |
| Phenanthrene | $C_{14}H_{10}$ | +96.3 | 25.0 |
| Tolane | $C_{14}H_{10}$ | +60 | 28.7 |
| Stilbene | $C_{14}H_{12}$ | +124 | 40.0 |
| Dibenzil | $C_{14}H_{14}$ | +51.4 | 30.7 |
| Triphenyl methane | $C_{19}H_{16}$ | +92.1 | 21.1 |
| Alkyl cyclohexanes | | | |
| Cyclohexane | $C_6H_{12}$ | +6.67 | 7.569 |
| Methylcyclohexane | $C_7H_{14}$ | −126.58 | 16.429 |
| Alkyl cyclopentanes | | | |
| Cyclopentane | $C_5H_{10}$ | −93.80 | 2.068 |
| Methylcyclopentane | $C_6H_{12}$ | −142.445 | 19.68 |
| Ethylcyclopentane | $C_7H_{14}$ | −138.435 | 11.10 |
| 1,1-Dimethylcyclopentane | $C_7H_{14}$ | −69.73 | 3.36 |
| *cis*-1,2-Dimethylcyclopentane | $C_7H_{14}$ | −53.85 | 3.87 |
| *trans*-1,2-Dimethylcyclopentane | $C_7H_{14}$ | −117.57 | 15.68 |
| *trans*-1,3-Dimethylcyclopentane | $C_7H_{14}$ | −133.680 | 17.93 |
| Monoolefins | | | |
| Ethene (Ethylene) | $C_2H_4$ | −169.15 | 28.547 |
| Propene (Propylene) | $C_3H_6$ | −185.25 | 17.054 |
| 1-Butene | $C_4H_8$ | −185.35 | 16.393 |
| *cis*-2-Butene | $C_4H_8$ | −138.91 | 31.135 |
| *trans*-2-Butene | $C_4H_8$ | −105.55 | 41.564 |
| 2-Methylpropene (isobutene) | $C_4H_8$ | −140.35 | 25.265 |
| 1-Pentene | $C_5H_{10}$ | −165.27 | 16.82 |
| *cis*-2-pentene | $C_5H_{10}$ | −151.363 | 24.239 |
| *trans*-2-pentene | $C_5H_{10}$ | −140.235 | 26.536 |
| 2-Methyl-1-butene | $C_5H_{10}$ | −137.560 | 26.879 |
| 3-Methyl-1-butene | $C_5H_{10}$ | −168.500 | 18.009 |
| 2-Methyl-2-butene | $C_5H_{10}$ | −133.780 | 25.738 |
| Acetylenes | | | |
| Acetylene | $C_2H_2$ | −81.5 | 23.04 |
| 2-Butyne (dimethylacetylene) | $C_4H_6$ | −132.23 | 40.808 |

| Nonhydrocarbon compounds | Formula | mp, °C | Heat of fusion, cal/g |
|---|---|---|---|
| Acetic acid | $C_2H_4O_2$ | 16.7 | 46.68 |
| Acetone | $C_3H_6O$ | −95.5 | 23.42 |
| Acrylic acid | $C_3H_4O_2$ | 12.3 | 37.03 |
| Allo-cinnamic acid | $C_9H_8O_2$ | 68 | 27.35 |
| Aminobenzoic acid (*o*-) | $C_7H_7NO_2$ | 145 | 35.48 |
| (*m*-) | $C_7H_7NO_2$ | 179.5 | 38.03 |
| (*p*-) | $C_7H_7NO_2$ | 188.5 | 36.46 |
| Amyl alcohol | $C_5H_{12}O$ | −78.9 | 26.65 |
| Anethole | $C_{10}H_{12}O$ | 22.5 | 25.80 |
| Aniline | $C_6H_5NH_2$ | −6.3 | 27.09 |
| Anthraquinone | $C_{14}H_8O_2$ | 284.8 | 37.48 |
| Apiol | $C_{12}H_{14}O_4$ | 29.5 | 25.80 |
| Azobenzene | $C_{12}H_{10}N_2$ | 67.1 | 28.91 |
| Azoxybenzene | $C_{12}H_{10}N_2O$ | 36 | 21.62 |
| Benzil | $C_{14}H_{10}O_2$ | 95.2 | 22.15 |
| Benzoic acid | $C_7H_6O_2$ | 122.45 | 33.90 |
| Benzophenone | $C_{13}H_{10}O$ | 47.85 | 23.53 |
| Benzylaniline | $C_{13}H_{13}N$ | 32.37 | 21.86 |
| Bromocamphor | $C_{10}H_{15}BrO$ | 78 | 41.57 |
| Bromochlorbenzene (*o*-) | $C_6H_4BrCl$ | −12.6 | 15.41 |
| (*m*-) | $C_6H_4BrCl$ | −21.2 | 15.29 |
| (*p*-) | $C_6H_4BrCl$ | 64.6 | 23.41 |
| Bromoiodobenzene (*o*-) | $C_6H_4BrI$ | 21 | 12.18 |
| (*m*-) | $C_6H_4BrI$ | 9.3 | 10.27 |
| (*p*-) | $C_6H_4BrI$ | 90.1 | 16.60 |
| Bromol hydrate | $C_2H_3Br_3O_2$ | 46 | 16.90 |
| Bromophenol (*p*-) | $C_6H_5BrO$ | 63.5 | 20.50 |
| Bromotoluene (*p*-) | $C_7H_7Br$ | 28 | 20.86 |
| Butyl alcohol (*n*-) | $C_4H_{10}O$ | −89.2 | 29.93 |
| (*t*-) | $C_4H_{10}O$ | 25.4 | 21.88 |
| Butyric acid (*n*-) | $C_4H_8O_2$ | −5.7 | 30.04 |
| Capric acid (*n*-) | $C_{10}H_{20}O_2$ | 31.99 | 38.87 |
| Caprylic acid (*n*-) | $C_8H_{16}O_2$ | 16.3 | 35.40 |
| Carbazole | $C_{12}H_9N$ | 243 | 42.05 |
| Carbon tetrachloride | $CCl_4$ | −22.8 | 41.57 |
| Carvoxime (*d*-) | $C_{10}H_{15}NO$ | 71.5 | 23.29 |
| (*l*-) | $C_{10}H_{15}NO$ | 71 | 23.41 |
| (*dl*-) | $C_{10}H_{15}NO$ | 91 | 24.61 |
| Cetyl alcohol | $C_{16}H_{34}O$ | 49.27 | 33.80 |
| Chloracetic acid (α-) | $C_2H_3ClO_2$ | 61.2 | 31.06 |
| (β-) | $C_2H_3ClO_2$ | 56 | 35.12 |
| Chloral alcoholate | $C_4H_7Cl_3O_2$ | 9 | 24.03 |
| hydrate | $C_2H_3Cl_3O_2$ | 47.4 | 33.18 |
| Chloroaniline (*p*-) | $C_6H_6ClN$ | 71 | 37.15 |
| Chlorobenzoic acid (*o*-) | $C_7H_5ClO_2$ | 140.2 | 39.30 |
| (*m*-) | $C_7H_5ClO_2$ | 154.25 | 36.41 |
| (*p*-) | $C_7H_5ClO_2$ | 239.7 | 49.21 |
| Chloronitrobenzene (*m*-) | $C_6H_4ClNO_2$ | 44.4 | 29.38 |
| (*p*-) | $C_6H_4ClNO_2$ | 83.5 | 31.51 |
| Cinnamic acid | $C_9H_8O_2$ | 133 | 36.50 |
| anhydride | $C_{18}H_{14}O_3$ | 48 | 28.14 |
| Cresol (*p*-) | $C_7H_8O$ | 34.6 | 26.28 |
| Crotonic acid (α-) | $C_4H_6O_2$ | 72 | 25.32 |
| (*cis*-) | $C_4H_6O_2$ | 71.2 | 34.90 |
| Cyanamide | $CH_2N_2$ | 44 | 49.81 |
| Cyclohexanol | $C_6H_{12}O$ | 25.46 | 4.19 |

**TABLE 2-192 Heats of Fusion of Organic Compounds** (*Concluded*)

| Nonhydrocarbon compounds | Formula | mp, °C | Heat of fusion, cal/g |
|---|---|---|---|
| Dibromobenzene (*o*-) | $C_6H_4Br_2$ | 1.8 | 12.78 |
| (*m*-) | $C_6H_4Br_2$ | –6.9 | 13.38 |
| (*p*-) | $C_6H_4Br_2$ | 86 | 20.55 |
| Dibromophenol (2, 4-) | $C_6H_4Br_2O$ | 12 | 13.97 |
| Dichloroacetic acid | $C_2H_2Cl_2O_2$ | –4(?) | 14.21 |
| Dichlorobenzene (*o*-) | $C_6H_4Cl_2$ | –16.7 | 21.02 |
| (*m*-) | $C_6H_4Cl_2$ | –24.8 | 20.55 |
| (*p*-) | $C_6H_4Cl_2$ | 53.13 | 29.67 |
| Dihydroxybenzene (*o*-) | $C_6H_6O_2$ | 104.3 | 49.40 |
| (*m*-) | $C_6H_6O_2$ | 109.65 | 46.20 |
| (*p*-) | $C_6H_6O_2$ | 172.3 | 58.77 |
| Di-iodobenzene (*o*-) | $C_6H_4I_2$ | 23.4 | 10.15 |
| (*m*-) | $C_6H_4I_2$ | 34.2 | 11.54 |
| (*p*-) | $C_6H_4I_2$ | 129 | 16.20 |
| Dimethyl tartrate (*dl*-) | $C_6H_{10}O_6$ | 87 | 35.12 |
| (*d*-) | $C_6H_{10}O_6$ | 49 | 21.50 |
| pyrone | $C_7H_8O_2$ | 132 | 56.14 |
| Dinitrobenzene (*o*-) | $C_6H_4N_2O_4$ | 116.93 | 32.25 |
| (*m*-) | $C_6H_4N_2O_4$ | 89.7 | 24.70 |
| (*p*-) | $C_6H_4N_2O_4$ | 173.5 | 39.99 |
| Dinitrotoluene (2, 4-) | $C_7H_6N_2O_4$ | 70.14 | 26.40 |
| Dioxane | $C_4H_8O_2$ | 11.0 | 34.85 |
| Diphenyl amine | $C_{12}H_{11}N$ | 52.98 | 25.23 |
| Elaidic acid | $C_{18}H_{34}O_2$ | 44.4 | 52.08 |
| Ethyl acetate | $C_4H_8O_2$ | 83.8 | 28.43 |
| alcohol | $C_2H_6O$ | –114.4 | 25.76 |
| Ethylene dibromide | $C_2H_4Br_2$ | 10.012 | 13.52 |
| Ethyl ether | $C_4H_{10}O$ | –116.3 | 23.54 |
| Formic acid | $CH_2O_2$ | 8.40 | 58.89 |
| Glutaric acid | $C_6H_8O_4$ | 97.5 | 37.39 |
| Glycerol | $C_3H_8O_3$ | 18.07 | 47.49 |
| Glycol, ethylene | $C_2H_6O_2$ | –11.5 | 43.26 |
| Hydrazo benzene | $C_{12}H_{12}N_2$ | 134 | 22.89 |
| Hydrocinnamic acid | $C_9H_{10}O_2$ | 48 | 28.14 |
| Hydroxyacetanilide | $C_8H_9NO_2$ | 91.3 | 33.59 |
| Iodotoluene (*p*-) | $C_7H_7I$ | 34 | 18.75 |
| Isopropyl alcohol | $C_3H_8O$ | –88.5 | 21.08 |
| ether | $C_6H_{14}O$ | –86.8 | 25.79 |
| Lauric acid (*n*-) | $C_{12}H_{24}O_2$ | 43.22 | 43.72 |
| Levulinic acid | $C_5H_8O_3$ | 33 | 18.97 |
| Menthol (*l*-) (α) | $C_{10}H_{20}O$ | 43.5 | 18.63 |
| Methyl alcohol | $CH_4O$ | –97.8 | 23.7 |
| Myristic acid | $C_{14}H_{28}O_2$ | 53.86 | 47.49 |
| Methyl cinnamate | $C_{10}H_{10}O_2$ | 36 | 26.53 |
| fumarate | $C_6H_8O_4$ | 102 | 57.93 |
| oxalate | $C_4H_6O_4$ | 54.35 | 42.64 |
| phenylpropiolate | $C_{10}H_8O_2$ | 18 | 22.86 |
| succinate | $C_6H_{10}O_4$ | 19.5 | 35.72 |

| Nonhydrocarbon compounds | Formula | mp, °C | Heat of fusion, cal/g |
|---|---|---|---|
| Naphthol (α-) | $C_{10}H_8O$ | 95.0 | 38.94 |
| (β-) | $C_{10}H_8O$ | 120.6 | 31.30 |
| Naphthylamine (α-) | $C_{10}H_9N$ | 50 | 22.34 |
| Nitroaniline (*o*-) | $C_6H_6N_2O_2$ | 71.2 | 27.88 |
| (*m*-) | $C_6H_6N_2O_2$ | 114.0 | 40.97 |
| (*p*-) | $C_6H_6N_2O_2$ | 147.3 | 36.46 |
| Nitrobenzene | $C_6H_5NO_2$ | 5.85 | 22.52 |
| Nitrobenzoic acid (*o*-) | $C_7H_5NO_4$ | 145.8 | 40.06 |
| (*m*-) | $C_7H_5NO_4$ | 141.1 | 27.59 |
| (*p*-) | $C_7H_5NO_4$ | 239.2 | 52.80 |
| Nitronaphthalene | $C_{10}H_7NO_2$ | 56.7 | 25.44 |
| Nitrophenol (*o*-) | $C_6H_5NO_3$ | 45.13 | 26.76 |
| Palmitic acid | $C_{16}H_{32}O_2$ | 61.82 | 39.18 |
| Paraldehyde | $C_6H_{12}O_3$ | 10.5 | 25.02 |
| Pelargic acid (*n*-) (β-) | $C_9H_{18}O_2$ | | 39.04 |
| Pelargonic acid (*n*-) (α-) | $C_9H_{18}O_2$ | 12.35 | 30.63 |
| Phenol | $C_6H_6O$ | 40.92 | 29.03 |
| Phenylacetic acid | $C_8H_8O_2$ | 76.7 | 25.44 |
| Phenylhydrazine | $C_6H_8N_2$ | 19.6 | 36.31 |
| Propyl ether (*n*) | $C_6H_{14}O$ | –126.1 | 20.66 |
| Quinone | $C_6H_4O_2$ | 115.7 | 40.85 |
| Stearic acid | $C_{18}H_{30}O_2$ | 68.82 | 47.54 |
| Succinic anhydride | $C_4H_4O_3$ | 119 | 48.74 |
| Succinonitrile | $C_4H_4N_2$ | 54.5 | 11.71 |
| Tetrachloroxylene (*o*-) | $C_8H_6Cl_4$ | 86 | 21.02 |
| (*p*-) | $C_8H_6Cl_4$ | 95 | 22.10 |
| Thiophene | $C_4H_4S$ | –39.4 | 14.11 |
| Thiosinamine | $C_4H_8N_2S$ | 77 | 33.45 |
| Thymol | $C_{10}H_{14}O$ | 51.5 | 27.47 |
| Toluic acid (*o*-) | $C_8H_8O_2$ | 103.7 | 35.40 |
| (*m*-) | $C_8H_8O_2$ | 108.75 | 27.59 |
| (*p*-) | $C_8H_8O_2$ | 179.6 | 39.90 |
| Toluidine (*p*-) | $C_7H_9N$ | 43.3 | 39.90 |
| Tribromophenol (2, 4, 6-) | $C_6H_3Br_3O$ | 93 | 13.38 |
| Trichloroacetic acid | $C_2HCl_3O_2$ | 57.5 | 8.60 |
| Trinitroglycerol | $C_3H_5N_3O_9$ | 12.3 | 23.02 |
| Trinitrotoluene (2, 4, 6-) | $C_7H_5N_3O_6$ | 80.83 | 22.34 |
| Tristearin | $C_{57}H_{110}O_6$ | 70.8, 54.5 | 45.63 |
| Undecylic acid (α-) (*n*-) | $C_{11}H_{22}O_2$ | 28.25 | 32.20 |
| (β-) (*n*-) | $C_{11}H_{22}O_2$ | | 42.91 |
| Urethane | $C_3H_7NO_2$ | 48.7 | 40.85 |
| Veratrol | $C_8H_{10}O_2$ | 22.5 | 27.45 |
| Xylene dibromide (*o*-) | $C_8H_8Br_2$ | 95 | 24.25 |
| (*m*-) | $C_8H_8Br_2$ | 77 | 21.45 |
| dichloride (*o*-) | $C_8H_8Cl_2$ | 55 | 29.03 |
| (*m*-) | $C_8H_8Cl_2$ | 34 | 26.64 |
| (*p*-) | $C_8H_8Cl_2$ | 100 | 32.73 |

**TABLE 2-193 Heats of Vaporization of Inorganic and Organic Compounds**

| Cmpd. no. | Name | Formula | CAS no. | Mol wt | C1 × 1E–07 | C2 | C3 | C4 | $T_{min}$, K | $\Delta H_v$ at $T_{min}$ × 1E–07 | $T_{max}$, K | $\Delta H_v$ at $T_{max}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Methane | $CH_4$ | 74828 | 16.043 | 1.0194 | 0.26087 | –0.14694 | 0.22154 | 90.69 | 0.8724 | 190.56 | 0 |
| 2 | Ethane | $C_2H_6$ | 74840 | 30.070 | 2.1091 | 0.60646 | –0.55492 | 0.32799 | 90.35 | 1.7879 | 305.32 | 0 |
| 3 | Propane | $C_3H_8$ | 74986 | 44.097 | 2.9209 | 0.78237 | –0.77319 | 0.39246 | 85.47 | 2.4787 | 369.83 | 0 |
| 4 | *n*-Butane | $C_4H_{10}$ | 106978 | 58.123 | 3.6238 | 0.8337 | –0.82274 | 0.39613 | 134.86 | 2.8684 | 425.12 | 0 |
| 5 | *n*-Pentane | $C_5H_{12}$ | 109660 | 72.150 | 3.9109 | 0.38681 | 0 | 0 | 143.42 | 3.3968 | 469.7 | 0 |
| 6 | *n*-Hexane | $C_6H_{14}$ | 110543 | 86.177 | 4.4544 | 0.39002 | 0 | 0 | 177.83 | 3.7647 | 507.6 | 0 |
| 7 | *n*-Heptane | $C_7H_{16}$ | 142825 | 100.204 | 5.0014 | 0.38795 | 0 | 0 | 182.57 | 4.2619 | 540.2 | 0 |
| 8 | *n*-Octane | $C_8H_{18}$ | 111659 | 114.231 | 5.5180 | 0.38467 | 0 | 0 | 216.38 | 4.5898 | 568.7 | 0 |
| 9 | *n*-Nonane | $C_9H_{20}$ | 111842 | 128.258 | 6.0370 | 0.38522 | 0 | 0 | 219.66 | 5.0545 | 594.6 | 0 |
| 10 | *n*-Decane | $C_{10}H_{22}$ | 124185 | 142.285 | 6.6126 | 0.39797 | 0 | 0 | 243.51 | 5.4168 | 617.7 | 0 |
| 11 | *n*-Undecane | $C_{11}H_{24}$ | 1120214 | 156.312 | 7.2284 | 0.40607 | 0 | 0 | 247.57 | 5.9240 | 639 | 0 |
| 12 | *n*-Dodecane | $C_{12}H_{26}$ | 112403 | 170.338 | 7.7337 | 0.40681 | 0 | 0 | 263.57 | 6.2802 | 658 | 0 |
| 13 | *n*-Tridecane | $C_{13}H_{28}$ | 629505 | 184.365 | 8.4339 | 0.4257 | 0 | 0 | 267.76 | 6.8015 | 675 | 0 |
| 14 | *n*-Tetradecane | $C_{14}H_{30}$ | 629594 | 198.392 | 9.0539 | 0.44467 | 0 | 0 | 279.01 | 7.2002 | 693 | 0 |
| 15 | *n*-Pentadecane | $C_{15}H_{32}$ | 629629 | 212.419 | 9.6741 | 0.45399 | 0 | 0 | 283.07 | 7.6728 | 708 | 0 |
| 16 | *n*-Hexadecane | $C_{16}H_{34}$ | 544763 | 226.446 | 10.1560 | 0.45726 | 0 | 0 | 291.31 | 8.0225 | 723 | 0 |
| 17 | *n*-Heptadecane | $C_{17}H_{36}$ | 629787 | 240.473 | 10.4730 | 0.4374 | 0 | 0 | 295.13 | 8.3699 | 736 | 0 |
| 18 | *n*-Octadecane | $C_{18}H_{38}$ | 593453 | 254.500 | 10.9690 | 0.44327 | 0 | 0 | 301.31 | 8.7246 | 747 | 0 |
| 19 | *n*-Nonadecane | $C_{19}H_{40}$ | 629925 | 268.527 | 11.6740 | 0.45865 | 0 | 0 | 305.04 | 9.2185 | 758 | 0 |
| 20 | *n*-Eicosane | $C_{20}H_{42}$ | 112958 | 282.553 | 12.8600 | 0.50351 | 0.32986 | –0.42184 | 309.58 | 9.5933 | 768 | 0 |
| 21 | 2-Methylpropane | $C_4H_{10}$ | 75285 | 58.123 | 3.1667 | 0.3855 | 0 | 0 | 113.54 | 2.7927 | 408.14 | 0 |
| 22 | 2-Methylbutane | $C_5H_{12}$ | 78784 | 72.150 | 3.7700 | 0.3952 | 0 | 0 | 113.25 | 3.3720 | 460.43 | 0 |
| 23 | 2,3-Dimethylbutane | $C_6H_{14}$ | 79298 | 86.177 | 4.1404 | 0.38124 | 0 | 0 | 145.19 | 3.6328 | 499.98 | 0 |
| 24 | 2-Methylpentane | $C_6H_{14}$ | 107835 | 86.177 | 4.2780 | 0.384 | 0 | 0 | 119.55 | 3.8495 | 497.5 | 0 |
| 25 | 2,3-Dimethylpentane | $C_7H_{16}$ | 565593 | 100.204 | 4.6536 | 0.37579 | 0 | 0 | 160 | 4.0747 | 537.35 | 0 |
| 26 | 2,3,3-Trimethylpentane | $C_8H_{18}$ | 560214 | 114.231 | 4.9910 | 0.383 | 0 | 0 | 172.22 | 4.3530 | 573.5 | 0 |
| 27 | 2,2,4-Trimethylpentane | $C_8H_{18}$ | 540841 | 114.231 | 4.7721 | 0.37992 | 0 | 0 | 165.78 | 4.1565 | 543.96 | 0 |
| 28 | Ethylene | $C_2H_4$ | 74851 | 28.054 | | 0.3746 | 0 | 0 | 104 | 1.6025 | 282.34 | 0 |
| 29 | Propylene | $C_3H_6$ | 115071 | 42.081 | 2.8694 | 0.8375 | –0.9216 | 0.5012 | 87.89 | 2.4031 | 365.57 | 0 |
| 30 | 1-Butene | $C_4H_8$ | 106989 | 56.108 | 3.2300 | 0.3747 | 0 | 0 | 87.8 | 2.9582 | 419.95 | 0 |
| 31 | *cis*-2-Butene | $C_4H_8$ | 590181 | 56.108 | 3.4190 | 0.3754 | 0 | 0 | 134.26 | 2.9773 | 435.58 | 0 |
| 32 | *trans*-2-Butene | $C_4H_8$ | 624646 | 56.108 | 3.3320 | 0.3736 | 0 | 0 | 167.62 | 2.7684 | 428.63 | 0 |
| 33 | 1-Pentene | $C_5H_{10}$ | 109671 | 70.134 | 3.7740 | 0.37647 | 0 | 0 | 107.93 | 3.4166 | 464.78 | 0 |
| 34 | 1-Hexene | $C_6H_{12}$ | 592416 | 84.161 | 4.3236 | 0.3788 | 0 | 0 | 133.39 | 3.8483 | 504.03 | 0 |
| 35 | 1-Heptene | $C_7H_{14}$ | 592767 | 98.188 | 4.8120 | 0.3685 | 0 | 0 | 154.27 | 4.2478 | 537.29 | 0 |
| 36 | 1-Octene | $C_8H_{16}$ | 111660 | 112.215 | 5.3980 | 0.3835 | 0 | 0 | 171.45 | 4.7013 | 566.65 | 0 |
| 37 | 1-Nonene | $C_9H_{18}$ | 124118 | 126.242 | 5.9940 | 0.3953 | 0 | 0 | 191.78 | 5.1366 | 593.25 | 0 |
| 38 | 1-Decene | $C_{10}H_{20}$ | 872059 | 140.269 | 6.4898 | 0.39187 | 0 | 0 | 206.89 | 5.5289 | 616.4 | 0 |
| 39 | 2-Methylpropene | $C_4H_8$ | 115117 | 56.108 | 3.2720 | 0.383 | 0 | 0 | 132.81 | 2.8262 | 417.9 | 0 |
| 40 | 2-Methyl-1-butene | $C_5H_{10}$ | 563462 | 70.134 | 3.9091 | 0.39866 | 0 | 0 | 135.58 | 3.4072 | 465 | 0 |
| 41 | 2-Methyl-2-butene | $C_5H_{10}$ | 513359 | 70.134 | 3.9121 | 0.3634 | 0 | 0 | 139.39 | 3.4437 | 471 | 0 |
| 42 | 1,2-Butadiene | $C_4H_6$ | 590192 | 54.092 | 3.5220 | 0.395 | 0 | 0 | 136.95 | 3.0540 | 452 | 0 |
| 43 | 1,3-Butadiene | $C_4H_6$ | 106990 | 54.092 | 3.2580 | 0.373 | 0 | 0 | 164.25 | 2.7155 | 425.17 | 0 |
| 44 | 2-Methyl-1,3-butadiene | $C_5H_8$ | 78795 | 68.119 | 3.9310 | 0.425 | 0 | 0 | 127.27 | 3.4529 | 484 | 0 |
| 45 | Acetylene | $C_2H_2$ | 74862 | 26.038 | 2.3795 | 0.375 | 0 | 0 | 192.4 | 1.6488 | 308.32 | 0 |
| 46 | Methylacetylene | $C_3H_4$ | 74997 | 40.065 | 3.2775 | 0.3997 | 0 | 0 | 170.45 | 2.6297 | 402.39 | 0 |
| 47 | Dimethylacetylene | $C_4H_6$ | 503173 | 54.092 | 3.8560 | 0.3737 | 0 | 0 | 240.91 | 2.9557 | 473.2 | 0 |
| 48 | 3-Methyl-1-butyne | $C_5H_8$ | 598232 | 68.119 | 3.7920 | 0.3565 | 0 | 0 | 183.45 | 3.1681 | 463.2 | 0 |
| 49 | 1-Pentyne | $C_5H_8$ | 627190 | 68.119 | 3.9540 | 0.3512 | 0 | 0 | 167.45 | 3.4025 | 481.2 | 0 |
| 50 | 2-Pentyne | $C_5H_8$ | 627214 | 68.119 | 4.4158 | 0.44347 | 0 | 0 | 163.83 | 3.7321 | 519 | 0 |
| 51 | 1-Hexyne | $C_6H_{10}$ | 693027 | 82.145 | 4.5740 | 0.3698 | 0 | 0 | 141.25 | 4.0640 | 516.2 | 0 |
| 52 | 2-Hexyne | $C_6H_{10}$ | 764352 | 82.145 | 4.9110 | 0.4392 | 0 | 0 | 183.65 | 4.1067 | 549 | 0 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 53 | 3-Hexyne | $C_6H_{10}$ | 928494 | 82.145 | 4.8080 | 0.436 | 0 | 0 | 170.05 | 4.0831 | 544 | 0 |
| 54 | 1-Heptyne | $C_7H_{12}$ | 628717 | 96.172 | 5.0514 | 0.41163 | 0 | 0 | 192.22 | 4.2470 | 559 | 0 |
| 55 | 1-Octyne | $C_8H_{14}$ | 629050 | 110.199 | 5.6306 | 0.4148 | 0 | 0 | 193.55 | 4.7663 | 585 | 0 |
| 56 | Vinylacetylene[1] | $C_4H_4$ | 689974 | 52.076 | 3.6490 | 0.4 | 0.043 | 0 | 173.15 | 2.9876 | 454 | 0 |
| 57 | Cyclopentane | $C_5H_{10}$ | 287923 | 70.134 | 3.8900 | 0.361 | 0 | 0 | 179.28 | 3.3292 | 511.76 | 0 |
| 58 | Methylcyclopentane | $C_6H_{12}$ | 96377 | 84.161 | 4.3600 | 0.38531 | 0 | 0 | 130.73 | 3.9118 | 532.79 | 0 |
| 59 | Ethylcyclopentane | $C_7H_{14}$ | 1640897 | 98.188 | 4.8288 | 0.37809 | 0 | 0 | 134.71 | 4.3604 | 569.52 | 0 |
| 60 | Cyclohexane | $C_6H_{12}$ | 110827 | 84.161 | 4.4940 | 0.3974 | 0 | 0 | 279.69 | 3.3977 | 553.58 | 0 |
| 61 | Methylcyclohexane | $C_7H_{14}$ | 108872 | 98.188 | 4.7534 | 0.39461 | 0 | 0 | 146.58 | 4.2295 | 572.19 | 0 |
| 62 | 1,1-Dimethylcyclohexane | $C_8H_{16}$ | 590669 | 112.215 | 5.0402 | 0.4036 | 0 | 0 | 239.66 | 4.0862 | 591.15 | 0 |
| 63 | Ethylcyclohexane | $C_8H_{16}$ | 1678917 | 112.215 | 5.3832 | 0.41763 | 0 | 0 | 161.84 | 4.7318 | 609.15 | 0 |
| 64 | Cyclopentene | $C_5H_8$ | 142290 | 68.119 | 3.8107 | 0.3543 | 0 | 0 | 138.13 | 3.4046 | 507 | 0 |
| 65 | 1-Methylcyclopentene | $C_6H_{10}$ | 693890 | 82.145 | 4.3541 | 0.36805 | 0 | 0 | 146.62 | 3.8769 | 542 | 0 |
| 66 | Cyclohexene | $C_6H_{10}$ | 110838 | 82.145 | 4.4405 | 0.37479 | 0 | 0 | 169.67 | 3.8791 | 560.4 | 0 |
| 67 | Benzene | $C_6H_6$ | 71432 | 78.114 | 4.7500 | 0.45238 | 0.0534 | −0.1181 | 278.68 | 3.4909 | 562.16 | 0 |
| 68 | Toluene | $C_7H_8$ | 108883 | 92.141 | 5.0144 | 0.3859 | 0 | 0 | 178.18 | 4.3670 | 591.8 | 0 |
| 69 | *o*-Xylene | $C_8H_{10}$ | 95476 | 106.167 | 5.5330 | 0.377 | 0 | 0 | 247.98 | 4.5826 | 630.33 | 0 |
| 70 | *m*-Xylene | $C_8H_{10}$ | 108383 | 106.167 | 5.4600 | 0.3726 | 0 | 0 | 225.3 | 4.6097 | 617.05 | 0 |
| 71 | *p*-Xylene | $C_8H_{10}$ | 106423 | 106.167 | 5.3740 | 0.3656 | 0 | 0 | 286.41 | 4.2761 | 616.23 | 0 |
| 72 | Ethylbenzene | $C_8H_{10}$ | 100414 | 106.167 | 5.4640 | 0.392 | 0 | 0 | 178.15 | 4.7811 | 617.2 | 0 |
| 73 | Propylbenzene | $C_9H_{12}$ | 103651 | 120.194 | 5.7663 | 0.3956 | −8.9129E−03 | 0 | 215.03 | 5.0574 | 574.54 | 2.4695E+07 |
| 74 | 1,2,4-Trimethylbenzene | $C_9H_{12}$ | 95636 | 120.194 | 5.9126 | 0.35632 | 0 | 0 | 229.33 | 5.0621 | 649.13 | 0 |
| 75 | Isopropylbenzene | $C_9H_{12}$ | 98828 | 120.194 | 5.7950 | 0.3956 | 0 | 0 | 177.14 | 5.0869 | 631.1 | 0 |
| 76 | 1,3,5-Trimethylbenzene | $C_9H_{12}$ | 108678 | 120.194 | 6.0380 | 0.37999 | 0 | 0 | 228.42 | 5.1010 | 637.36 | 0 |
| 77 | *p*-Isopropyltoluene | $C_{10}H_{14}$ | 99876 | 134.221 | 6.3314 | 0.40289 | 0 | 0 | 205.25 | 5.4387 | 653.15 | 0 |
| 78 | Naphthalene | $C_{10}H_8$ | 91203 | 128.174 | 7.0510 | 0.4612 | 0 | 0 | 353.43 | 5.2508 | 748.35 | 0 |
| 79 | Biphenyl | $C_{12}H_{10}$ | 92524 | 154.211 | 7.5736 | 0.3975 | 0 | 0 | 342.2 | 6.0420 | 789.26 | 0 |
| 80 | Styrene | $C_8H_8$ | 100425 | 104.152 | 5.7260 | 0.4055 | 0 | 0 | 242.54 | 4.7128 | 636 | 0 |
| 81 | *m*-Terphenyl | $C_{18}H_{14}$ | 92068 | 230.309 | 10.1230 | 0.3767 | 0 | 0 | 360 | 8.4070 | 924.85 | 0 |
| 82 | Methanol | $CH_4O$ | 67561 | 32.042 | 5.2390 | 0.3682 | 0 | 0 | 175.47 | 4.4900 | 512.64 | 0 |
| 83 | Ethanol | $C_2H_6O$ | 64175 | 46.069 | 5.6900 | 0.3359 | 0 | 0 | 159.05 | 5.0245 | 513.92 | 0 |
| 84 | 1-Propanol | $C_3H_8O$ | 71238 | 60.096 | 6.3300 | 0.3575 | 0 | 0 | 146.95 | 5.6460 | 536.78 | 0 |
| 85 | 1-Butanol | $C_4H_{10}O$ | 71363 | 74.123 | 6.7390 | 0.173 | 0.2915 | 0 | 184.51 | 6.0575 | 563.05 | 0 |
| 86 | 2-Butanol | $C_4H_{10}O$ | 78922 | 74.123 | 7.2560 | 0.4774 | 0 | 0 | 158.45 | 6.1383 | 536.05 | 0 |
| 87 | 2-Propanol | $C_3H_8O$ | 67630 | 60.096 | 6.3080 | 0.3921 | 0 | 0 | 185.28 | 5.2807 | 508.3 | 0 |
| 88 | 2-Methyl-2-propanol | $C_4H_{10}O$ | 75650 | 74.123 | 7.7320 | 0.5645 | 0 | 0 | 298.97 | 4.6703 | 506.21 | 0 |
| 89 | 1-Pentanol | $C_5H_{12}O$ | 71410 | 88.150 | 8.3100 | 0.511 | 0 | 0 | 195.56 | 6.7533 | 586.15 | 0 |
| 90 | 2-Methyl-1-butanol | $C_5H_{12}O$ | 137326 | 88.150 | 7.7839 | 0.45313 | 0 | 0 | 203 | 6.3619 | 565 | 0 |
| 91 | 3-Methyl-1-butanol | $C_5H_{12}O$ | 123513 | 88.150 | 8.0815 | 0.50185 | 0 | 0 | 155.95 | 6.8999 | 577.2 | 0 |
| 92 | 1-Hexanol | $C_6H_{14}O$ | 111273 | 102.177 | 8.5980 | 0.513 | 0 | 0 | 228.55 | 6.7623 | 611.35 | 0 |
| 93 | 1-Heptanol | $C_7H_{16}O$ | 111706 | 116.203 | 9.6900 | 0.572 | 0 | 0 | 239.15 | 7.3822 | 631.9 | 0 |
| 94 | Cyclohexanol | $C_6H_{12}O$ | 108930 | 100.161 | 9.2440 | 0.64825 | 0 | 0 | 296.6 | 6.2273 | 650 | 0 |
| 95 | Ethylene glycol | $C_2H_6O_2$ | 107211 | 62.068 | 8.2900 | 0.4266 | 0 | 0 | 260.15 | 6.8461 | 719.7 | 0 |
| 96 | 1,2-Propylene glycol | $C_3H_8O_2$ | 57556 | 76.095 | 8.0700 | 0.295 | 0 | 0 | 213.15 | 7.1374 | 626 | 0 |
| 97 | Phenol | $C_6H_6O$ | 108952 | 94.113 | 7.3060 | 0.4246 | 0 | 0 | 314.06 | 5.6577 | 694.25 | 0 |
| 98 | *o*-Cresol | $C_7H_8O$ | 95487 | 108.140 | 7.1979 | 0.40317 | 0 | 0 | 304.19 | 5.7135 | 697.55 | 0 |
| 99 | *m*-Cresol | $C_7H_8O$ | 108394 | 108.140 | 8.0082 | 0.45314 | 0 | 0 | 285.39 | 6.3326 | 705.85 | 0 |
| 100 | *p*-Cresol | $C_7H_8O$ | 106445 | 108.140 | 8.4942 | 0.50234 | 0 | 0 | 307.93 | 6.3649 | 704.65 | 0 |
| 101 | Dimethyl ether | $C_2H_6O$ | 115106 | 46.069 | 2.9940 | 0.3505 | 0 | 0 | 131.65 | 2.6032 | 400.1 | 0 |
| 102 | Methyl ethyl ether | $C_3H_8O$ | 540670 | 60.096 | 3.5300 | 0.376 | 0 | 0 | 160 | 2.9751 | 437.8 | 0 |
| 103 | Methyl *n*-propyl ether | $C_4H_{10}O$ | 557175 | 74.123 | 3.9795 | 0.3729 | 0 | 0 | 133.97 | 3.5184 | 476.3 | 0 |
| 104 | Methyl isopropyl ether | $C_4H_{10}O$ | 598538 | 74.123 | 3.9305 | 0.3711 | 0 | 0 | 127.93 | 3.4876 | 464.5 | 0 |
| 105 | Methyl-*n*-butyl ether | $C_5H_{12}O$ | 628284 | 88.150 | 4.5328 | 0.3824 | 0 | 0 | 157.48 | 3.9358 | 510 | 0 |
| 106 | Methyl isobutyl ether | $C_5H_{12}O$ | 625445 | 88.150 | 4.2678 | 0.37995 | 0 | 0 | 150 | 3.7232 | 497 | 0 |
| 107 | Methyl tert-butyl ether | $C_5H_{12}O$ | 1634044 | 88.150 | 4.2024 | 0.37826 | 0 | 0 | 164.55 | 3.6096 | 497.1 | 0 |

**TABLE 2-193 Heats of Vaporization of Inorganic and Organic Compounds** (*Continued*)

| Cmpd. no. | Name | Formula | CAS no. | Mol wt | C1 × 1E–07 | C2 | C3 | C4 | $T_{min}$, K | $\Delta H_v$ at $T_{min}$ × 1E–07 | $T_{max}$, K | $\Delta H_v$ at $T_{max}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 108 | Diethyl ether | $C_4H_{10}O$ | 60297 | 74.123 | 4.0600 | 0.3868 | 0 | 0 | 156.85 | 3.4651 | 466.7 | 0 |
| 109 | Ethyl propyl ether | $C_5H_{12}O$ | 628320 | 88.150 | 5.4380 | 0.60624 | 0 | 0 | 145.65 | 4.4140 | 500.23 | 0 |
| 110 | Ethyl isopropyl ether | $C_5H_{12}O$ | 625547 | 88.150 | 4.2580 | 0.37221 | 0 | 0 | 140 | 3.7556 | 489 | 0 |
| 111 | Methyl phenyl ether | $C_7H_8O$ | 100663 | 108.140 | 5.8662 | 0.37127 | 0 | 0 | 235.65 | 4.9560 | 645.6 | 0 |
| 112 | Diphenyl ether | $C_{12}H_{10}O$ | 101848 | 170.211 | 6.8243 | 0.30877 | 0 | 0 | 300.03 | 5.8546 | 766.8 | 0 |
| 113 | Formaldehyde | $CH_2O$ | 50000 | 30.026 | 3.0760 | 0.2954 | 0 | 0 | 181.15 | 2.5863 | 408 | 0 |
| 114 | Acetaldehyde | $C_2H_4O$ | 75070 | 44.053 | 4.6070 | 0.62 | 0 | 0 | 150.15 | 3.6199 | 466 | 0 |
| 115 | 1-Propanal | $C_3H_6O$ | 123386 | 58.080 | 4.1492 | 0.36751 | 0 | 0 | 170 | 3.5675 | 504.4 | 0 |
| 116 | 1-Butanal | $C_4H_8O$ | 123728 | 72.107 | 4.6403 | 0.3849 | 0 | 0 | 176.75 | 3.9797 | 537.2 | 0 |
| 117 | 1-Pentanal | $C_5H_{10}O$ | 110623 | 86.134 | 5.1478 | 0.37541 | 0 | 0 | 182 | 4.4502 | 566.1 | 0 |
| 118 | 1-Hexanal | $C_6H_{12}O$ | 66251 | 100.161 | 5.6661 | 0.38533 | 0 | 0 | 217.15 | 4.7495 | 591 | 0 |
| 119 | 1-Heptanal | $C_7H_{14}O$ | 111717 | 114.188 | 6.1299 | 0.37999 | 0 | 0 | 229.8 | 5.1353 | 617 | 0 |
| 120 | 1-Octanal | $C_8H_{16}O$ | 124130 | 128.214 | 6.8347 | 0.41039 | 0 | 0 | 246 | 5.5966 | 638.1 | 0 |
| 121 | 1-Nonanal | $C_9H_{18}O$ | 124196 | 142.241 | 7.3363 | 0.41735 | 0 | 0 | 255.15 | 5.9779 | 658 | 0 |
| 122 | 1-Decanal | $C_{10}H_{20}O$ | 112312 | 156.268 | 7.9073 | 0.4129 | 0 | 0 | 267.15 | 6.4201 | 674.2 | 0 |
| 123 | Acetone | $C_3H_6O$ | 67641 | 58.080 | 4.2150 | 0.3397 | 0 | 0 | 178.45 | 3.6390 | 508.2 | 0 |
| 124 | Methyl ethyl ketone | $C_4H_8O$ | 78933 | 72.107 | 4.6220 | 0.355 | 0 | 0 | 186.48 | 3.9704 | 535.5 | 0 |
| 125 | 2-Pentanone | $C_5H_{10}O$ | 107879 | 86.134 | 5.1740 | 0.39422 | 0 | 0 | 196.29 | 4.3663 | 561.08 | 0 |
| 126 | Methyl isopropyl ketone | $C_5H_{10}O$ | 563804 | 86.134 | 5.1400 | 0.3858 | 0 | 0 | 250 | 4.0753 | 553 | 0 |
| 127 | 2-Hexanone | $C_6H_{12}O$ | 591786 | 100.161 | 5.6770 | 0.3817 | 0 | 0 | 217.35 | 4.7584 | 587.05 | 0 |
| 128 | Methyl isobutyl ketone | $C_6H_{12}O$ | 108101 | 100.161 | 5.4000 | 0.383 | 0 | 0 | 189.15 | 4.6294 | 571.4 | 0 |
| 129 | 3-Methyl-2-pentanone | $C_6H_{12}O$ | 565617 | 100.161 | 5.1130 | 0.3395 | 0 | 0 | 167.15 | 4.5480 | 573 | 0 |
| 130 | 3-Pentanone | $C_5H_{10}O$ | 96220 | 86.134 | 5.2359 | 0.40465 | 0 | 0 | 234.18 | 4.2075 | 560.95 | 0 |
| 131 | Ethyl isopropyl ketone | $C_6H_{12}O$ | 565695 | 100.161 | 5.3880 | 0.40616 | 0 | 0 | 200 | 4.5154 | 567 | 0 |
| 132 | Diisopropyl ketone | $C_7H_{14}O$ | 565800 | 114.188 | 5.5980 | 0.3774 | 0 | 0 | 204.81 | 4.7426 | 576 | 0 |
| 133 | Cyclohexanone | $C_6H_{10}O$ | 108941 | 98.145 | 5.5500 | 0.3538 | 0 | 0 | 242 | 4.7114 | 653 | 0 |
| 134 | Methyl phenyl ketone | $C_8H_8O$ | 98862 | 120.151 | 6.6104 | 0.37425 | 0 | 0 | 292.81 | 5.4166 | 709.5 | 0 |
| 135 | Formic acid | $CH_2O_2$ | 64186 | 46.026 | 2.3700 | 1.999 | –5.1503 | 3.331 | 281.45 | 1.9532 | 588 | 0 |
| 136 | Acetic acid | $C_2H_4O_2$ | 64197 | 60.053 | 2.0265 | 0.11911 | –1.3487 | 1.4227 | 289.81 | 2.3185 | 591.95 | 0 |
| 137 | Propionic acid | $C_3H_6O_2$ | 79094 | 74.079 | 2.7290 | 0.06954 | –1.0423 | 1.1152 | 252.45 | 2.9964 | 600.81 | 0 |
| 138 | *n*-Butyric acid | $C_4H_8O_2$ | 107926 | 88.106 | 7.4996 | 2.333 | –3.8644 | 2.016 | 267.95 | 4.1566 | 615.7 | 0 |
| 139 | Isobutyric acid | $C_4H_8O_2$ | 79312 | 88.106 | 4.4967 | 1.1615 | –2.4573 | 1.5823 | 227.15 | 3.6179 | 605 | 0 |
| 140 | Benzoic acid[2] | $C_7H_6O_2$ | 65850 | 122.123 | 10.1900 | 0.478 | 0 | 0 | 395.45 | 7.1277 | 751 | 0 |
| 141 | Acetic anhydride | $C_4H_6O_3$ | 108247 | 102.090 | 6.3520 | 0.3986 | 0 | 0 | 200.15 | 5.4139 | 606 | 0 |
| 142 | Methyl formate | $C_2H_4O_2$ | 107313 | 60.053 | 4.1030 | 0.3825 | 0 | 0 | 174.15 | 3.4644 | 487.2 | 0 |
| 143 | Methyl acetate | $C_3H_6O_2$ | 79209 | 74.079 | 4.4920 | 0.3685 | 0 | 0 | 175.15 | 3.8418 | 506.55 | 0 |
| 144 | Methyl propionate | $C_4H_8O_2$ | 554121 | 88.106 | 5.0080 | 0.3959 | 0 | 0 | 185.65 | 4.2231 | 530.6 | 0 |
| 145 | Methyl *n*-butyrate | $C_5H_{10}O_2$ | 623427 | 102.133 | 5.3781 | 0.39523 | 0 | 0 | 187.35 | 4.5694 | 554.5 | 0 |
| 146 | Ethyl formate | $C_3H_6O_2$ | 109944 | 74.079 | 4.5909 | 0.4123 | 0 | 0 | 193.55 | 3.7679 | 508.4 | 0 |
| 147 | Ethyl acetate | $C_4H_8O_2$ | 141786 | 88.106 | 4.9330 | 0.3847 | 0 | 0 | 189.6 | 4.1490 | 523.3 | 0 |
| 148 | Ethyl propionate | $C_5H_{10}O_2$ | 105373 | 102.133 | 5.3325 | 0.401 | 0 | 0 | 199.25 | 4.4449 | 546 | 0 |
| 149 | Ethyl *n*-butyrate | $C_6H_{12}O_2$ | 105544 | 116.160 | 5.6419 | 0.37985 | 0 | 0 | 175.15 | 4.9090 | 571 | 0 |
| 150 | *n*-Propyl formate | $C_4H_8O_2$ | 110747 | 88.106 | 4.9687 | 0.4025 | 0 | 0 | 180.25 | 4.2162 | 538 | 0 |
| 151 | *n*-Propyl acetate | $C_5H_{10}O_2$ | 109604 | 102.133 | 5.4327 | 0.407 | 0 | 0 | 178.15 | 4.6322 | 549.73 | 0 |
| 152 | *n*-Butyl acetate | $C_6H_{12}O_2$ | 123864 | 116.160 | 5.7800 | 0.3935 | 0 | 0 | 199.65 | 4.8943 | 579.15 | 0 |
| 153 | Methyl benzoate | $C_8H_8O_2$ | 93583 | 136.150 | 6.9650 | 0.4061 | 0 | 0 | 260.75 | 5.7500 | 693 | 0 |
| 154 | Ethyl benzoate | $C_9H_{10}O_2$ | 93890 | 150.177 | 6.3400 | 0.2911 | 0 | 0 | 238.45 | 5.6137 | 698 | 0 |
| 155 | Vinyl acetate | $C_4H_6O_2$ | 108054 | 86.090 | 4.7700 | 0.3765 | 0 | 0 | 180.35 | 4.0619 | 519.13 | 0 |
| 156 | Methylamine | $CH_5N$ | 74895 | 31.057 | 3.8580 | 0.404 | 0 | 0 | 179.69 | 3.1006 | 430.05 | 0 |
| 157 | Dimethylamine | $C_2H_7N$ | 124403 | 45.084 | 4.0900 | 0.42005 | 0 | 0 | 180.96 | 3.2678 | 437.2 | 0 |
| 158 | Trimethylamine | $C_3H_9N$ | 75503 | 59.111 | 3.3050 | 0.354 | 0 | 0 | 156.08 | 2.8216 | 433.25 | 0 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 159 | Ethylamine | $C_2H_7N$ | 75047 | 45.084 | 4.2750 | 0.5857 | –0.332 | 0.169 | 192.15 | 3.2955 | 456.15 | 0 |
| 160 | Diethylamine | $C_4H_{11}N$ | 109897 | 73.138 | 4.6133 | 0.42628 | 0 | 0 | 223.35 | 3.5761 | 496.6 | 0 |
| 161 | Triethylamine | $C_6H_{15}N$ | 121448 | 101.192 | 4.6640 | 0.3663 | 0 | 0 | 158.45 | 4.1011 | 535.15 | 0 |
| 162 | *n*-Propylamine | $C_3H_9N$ | 107108 | 59.111 | 4.4488 | 0.39494 | 0 | 0 | 188.36 | 3.6857 | 496.95 | 0 |
| 163 | di-*n*-Propylamine | $C_6H_{15}N$ | 142847 | 101.192 | 5.4280 | 0.3665 | 0 | 0 | 210.15 | 4.5500 | 550 | 0 |
| 164 | Isopropylamine | $C_3H_9N$ | 75310 | 59.111 | 4.4041 | 0.43325 | 0 | 0 | 177.95 | 3.5874 | 471.85 | 0 |
| 165 | Diisopropylamine | $C_6H_{15}N$ | 108189 | 101.192 | 5.0070 | 0.4362 | 0 | 0 | 176.85 | 4.1823 | 523.1 | 0 |
| 166 | Aniline | $C_6H_7N$ | 62533 | 93.128 | 7.1950 | 0.458 | 0 | 0 | 267.13 | 5.7710 | 699 | 0 |
| 167 | *N*-Methylaniline | $C_7H_9N$ | 100618 | 107.155 | 6.3860 | 0.3104 | 0 | 0 | 216.15 | 5.6961 | 701.55 | 0 |
| 168 | *N,N*-Dimethylaniline | $C_8H_{11}N$ | 121697 | 121.182 | 6.7900 | 0.4053 | 0 | 0 | 275.6 | 5.5162 | 687.15 | 0 |
| 169 | Ethylene oxide | $C_2H_4O$ | 75218 | 44.053 | 3.6652 | 0.37878 | 0 | 0 | 160.65 | 3.1271 | 469.15 | 0 |
| 170 | Furan | $C_4H_4O$ | 110009 | 68.075 | 4.0050 | 0.3995 | 0 | 0 | 196.29 | 3.2647 | 490.15 | 0 |
| 171 | Thiophene | $C_4H_4S$ | 110021 | 84.142 | 4.5793 | 0.38557 | 0 | 0 | 234.94 | 3.7472 | 579.35 | 0 |
| 172 | Pyridine | $C_5H_5N$ | 110861 | 79.101 | 5.1740 | 0.38865 | 0 | 0 | 231.51 | 4.3144 | 619.95 | 0 |
| 173 | Formamide[3] | $CH_3NO$ | 75127 | 45.041 | 7.3580 | 0.3564 | 0 | 0 | 275.7 | 6.2844 | 771 | 0 |
| 174 | *N,N*-Dimethylformamide | $C_3H_7NO$ | 68122 | 73.095 | 5.9217 | 0.37996 | 0 | 0 | 212.72 | 5.0931 | 649.6 | 0 |
| 175 | Acetamide | $C_2H_5NO$ | 60355 | 59.068 | 8.1070 | 0.42 | 0 | 0 | 353.15 | 6.2386 | 761 | 0 |
| 176 | *N*-Methylacetamide | $C_3H_7NO$ | 79163 | 73.095 | 7.3402 | 0.38974 | 0 | 0 | 301.15 | 5.9384 | 718 | 0 |
| 177 | Acetonitrile | $C_2H_3N$ | 75058 | 41.053 | 4.3511 | 0.34765 | 0 | 0 | 229.32 | 3.5996 | 545.5 | 0 |
| 178 | Propionitrile | $C_3H_5N$ | 107120 | 55.079 | 4.9348 | 0.41873 | 0 | 0 | 180.26 | 4.2005 | 564.4 | 0 |
| 179 | *n*-Butyronitrile | $C_4H_7N$ | 109740 | 69.106 | 5.2200 | 0.165 | 0.6692 | –0.539 | 161.25 | 4.7223 | 582.25 | 0 |
| 180 | Benzonitrile | $C_7H_5N$ | 100470 | 103.123 | 6.2615 | 0.35427 | 0 | 0 | 260.4 | 5.3091 | 699.35 | 0 |
| 181 | Methyl mercaptan | $CH_4S$ | 74931 | 48.109 | 3.4448 | 0.37427 | 0 | 0 | 150.18 | 2.9825 | 469.95 | 0 |
| 182 | Ethyl mercaptan | $C_2H_6S$ | 75081 | 62.136 | 3.8440 | 0.37534 | 0 | 0 | 125.26 | 3.4489 | 499.15 | 0 |
| 183 | *n*-Propyl mercaptan | $C_3H_8S$ | 107039 | 76.163 | 4.4782 | 0.41073 | 0 | 0 | 159.95 | 3.8723 | 536.6 | 0 |
| 184 | *n*-Butyl mercaptan | $C_4H_{10}S$ | 109795 | 90.189 | 4.9702 | 0.41199 | 0 | 0 | 157.46 | 4.3505 | 570.1 | 0 |
| 185 | Isobutyl mercaptan | $C_4H_{10}S$ | 513440 | 90.189 | 4.7420 | 0.40535 | 0 | 0 | 128.31 | 4.2664 | 559 | 0 |
| 186 | sec-Butyl mercaptan | $C_4H_{10}S$ | 513531 | 90.189 | 4.6432 | 0.399 | 0 | 0 | 133.02 | 4.1614 | 554 | 0 |
| 187 | Dimethyl sulfide | $C_2H_6S$ | 75183 | 62.136 | 3.8690 | 0.3694 | 0 | 0 | 174.88 | 3.3042 | 503.04 | 0 |
| 188 | Methyl ethyl sulfide | $C_3H_8S$ | 624895 | 76.163 | 4.4740 | 0.4097 | 0 | 0 | 167.23 | 3.8344 | 533 | 0 |
| 189 | Diethyl sulfide | $C_4H_{10}S$ | 352932 | 90.189 | 4.7182 | 0.3643 | 0 | 0 | 169.2 | 4.1353 | 557.15 | 0 |
| 190 | Fluoromethane | $CH_3F$ | 593533 | 34.033 | 2.4708 | 0.37014 | 0 | 0 | 131.35 | 2.0276 | 317.42 | 0 |
| 191 | Chloromethane | $CH_3Cl$ | 74873 | 50.488 | 2.9745 | 0.353 | 0 | 0 | 175.43 | 2.4520 | 416.25 | 0 |
| 192 | Trichloromethane | $CHCl_3$ | 67663 | 119.377 | 4.1860 | 0.3584 | 0 | 0 | 209.63 | 3.5047 | 536.4 | 0 |
| 193 | Tetrachloromethane | $CCl_4$ | 56235 | 153.822 | 4.3252 | 0.37688 | 0 | 0 | 250.33 | 3.4528 | 556.35 | 0 |
| 194 | Bromomethane | $CH_3Br$ | 74839 | 94.939 | 3.1690 | 0.3015 | 0 | 0 | 179.47 | 2.7379 | 467 | 0 |
| 195 | Fluoroethane | $C_2H_5F$ | 353366 | 48.060 | 2.7617 | 0.32162 | 0 | 0 | 129.95 | 2.4089 | 375.31 | 0 |
| 196 | Chloroethane | $C_2H_5Cl$ | 75003 | 64.514 | 3.5240 | 0.3652 | 0 | 0 | 134.8 | 3.1052 | 460.35 | 0 |
| 197 | Bromoethane | $C_2H_5Br$ | 74964 | 108.966 | 3.9004 | 0.38012 | 0 | 0 | 154.55 | 3.3933 | 503.8 | 0 |
| 198 | 1-Chloropropane | $C_3H_7Cl$ | 540545 | 78.541 | 3.9890 | 0.37956 | 0 | 0 | 150.35 | 3.4862 | 503.15 | 0 |
| 199 | 2-Chloropropane | $C_3H_7Cl$ | 75296 | 78.541 | 3.8871 | 0.38043 | 0 | 0 | 155.97 | 3.3586 | 489 | 0 |
| 200 | 1,1-Dichloropropane | $C_3H_6Cl_2$ | 78999 | 112.986 | 4.7740 | 0.39204 | 0 | 0 | 200 | 4.0147 | 560 | 0 |
| 201 | 1,2-Dichloropropane | $C_3H_6Cl_2$ | 78875 | 112.986 | 4.6750 | 0.36529 | 0 | 0 | 172.71 | 4.0997 | 572 | 0 |
| 202 | Vinyl chloride | $C_2H_3Cl$ | 75014 | 62.499 | 3.4125 | 0.4513 | 0 | 0 | 119.36 | 2.9491 | 432 | 0 |
| 203 | Fluorobenzene | $C_6H_5F$ | 462066 | 96.104 | 4.5820 | 0.3717 | 0 | 0 | 230.94 | 3.7605 | 560.09 | 0 |
| 204 | Chlorobenzene | $C_6H_5Cl$ | 108907 | 112.558 | 5.1480 | 0.36614 | 0 | 0 | 227.95 | 4.3707 | 632.35 | 0 |
| 205 | Bromobenzene | $C_6H_5Br$ | 108861 | 157.010 | 5.5520 | 0.37694 | 0 | 0 | 242.43 | 4.6875 | 670.15 | 0 |
| 206 | Air | | 132259100 | 28.951 | 0.8474 | 0.3822 | 0 | 0 | 59.15 | 0.6759 | 132.45 | 0 |
| 207 | Hydrogen | $H_2$ | 1333740 | 2.016 | 0.1013 | 0.698 | –1.817 | 1.447 | 13.95 | 0.0913 | 33.19 | 0 |
| 208 | Helium-4 | He | 7440597 | 4.003 | 0.0125 | 1.3038 | –2.6954 | 1.7098 | 2.2 | 0.0097 | 5.2 | 0 |
| 209 | Neon | Ne | 7440019 | 20.180 | 0.2389 | 0.3494 | 0 | 0 | 24.56 | 0.1803 | 44.4 | 0 |
| 210 | Argon | Ar | 7440371 | 39.948 | 0.8731 | 0.3526 | 0 | 0 | 83.78 | 0.6561 | 150.86 | 0 |
| 211 | Fluorine | $F_2$ | 7782414 | 37.997 | 0.8876 | 0.34072 | 0 | 0 | 53.48 | 0.7578 | 144.12 | 0 |
| 212 | Chlorine | $Cl_2$ | 7782505 | 70.905 | 3.0680 | 0.8458 | –0.9001 | 0.453 | 172.12 | 2.2878 | 417.15 | 0 |
| 213 | Bromine | $Br_2$ | 7726956 | 159.808 | 4.0000 | 0.351 | 0 | 0 | 265.85 | 3.2323 | 584.15 | 0 |

**TABLE 2-193 Heats of Vaporization of Inorganic and Organic Compounds** (*Concluded*)

| Cmpd. no. | Name | Formula | CAS no. | Mol wt | C1 × 1E–07 | C2 | C3 | C4 | $T_{min}$, K | $\Delta H_v$ at $T_{min}$ × 1E–07 | $T_{max}$, K | $\Delta H_v$ at $T_{max}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 214 | Oxygen | $O_2$ | 7782447 | 31.999 | 0.9008 | 0.4542 | –0.4096 | 0.3183 | 54.36 | 0.7742 | 154.58 | 0 |
| 215 | Nitrogen | $N_2$ | 7727379 | 28.014 | 0.7491 | 0.40406 | –0.317 | 0.27343 | 63.15 | 0.6024 | 126.2 | 0 |
| 216 | Ammonia | $NH_3$ | 7664417 | 17.031 | 3.1523 | 0.3914 | –0.2289 | 0.2309 | 195.41 | 2.5298 | 405.65 | 0 |
| 217 | Hydrazine | $N_2H_4$ | 302012 | 32.045 | 5.9794 | 0.9424 | –1.398 | 0.8862 | 274.69 | 4.5238 | 653.15 | 0 |
| 218 | Nitrous oxide | $N_2O$ | 10024972 | 44.013 | 2.3215 | 0.384 | 0 | 0 | 182.3 | 1.6502 | 309.57 | 0 |
| 219 | Nitric oxide | NO | 10102439 | 30.006 | 2.1310 | 0.4056 | 0 | 0 | 109.5 | 1.4578 | 180.15 | 0 |
| 220 | Cyanogen | $C_2N_2$ | 460195 | 52.036 | 3.3840 | 0.3707 | 0 | 0 | 245.25 | 2.3803 | 400.15 | 0 |
| 221 | Carbon monoxide | CO | 630080 | 28.010 | 0.8585 | 0.4921 | –0.326 | 0.2231 | 68.13 | 0.6517 | 132.5 | 915280 |
| 222 | Carbon dioxide | $CO_2$ | 124389 | 44.010 | 2.1730 | 0.382 | –0.4339 | 0.42213 | 216.58 | 1.5202 | 304.21 | 0 |
| 223 | Carbon disulfide | $CS_2$ | 75150 | 76.143 | 3.4960 | 0.2986 | 0 | 0 | 161.11 | 3.1537 | 552 | 0 |
| 224 | Hydrogen fluoride | HF | 7664393 | 20.006 | 13.4510 | 13.36 | –23.383 | 10.785 | 277.56 | 0.7104 | 461.15 | 0 |
| 225 | Hydrogen chloride | HCl | 7647010 | 36.461 | 2.2093 | 0.3466 | 0 | 0 | 158.97 | 1.7498 | 324.65 | 0 |
| 226 | Hydrogen bromide | HBr | 10035106 | 80.912 | 2.4850 | 0.39 | 0 | 0 | 185.15 | 1.8817 | 363.15 | 0 |
| 227 | Hydrogen cyanide[2] | HCN | 74908 | 27.026 | 3.3490 | 0.2053 | 0 | 0 | 259.83 | 2.8176 | 456.65 | 0 |
| 228 | Hydrogen sulfide | $H_2S$ | 7783064 | 34.082 | 2.5676 | 0.37358 | 0 | 0 | 187.68 | 1.9782 | 373.53 | 0 |
| 229 | Sulfur dioxide | $SO_2$ | 7446095 | 64.065 | 3.6760 | 0.4 | 0 | 0 | 197.67 | 2.8753 | 430.75 | 0 |
| 230 | Sulfur trioxide | $SO_3$ | 7446119 | 80.064 | 7.3370 | 0.5647 | 0 | 0 | 289.95 | 4.4303 | 490.85 | 0 |
| 231 | Water | $H_2O$ | 7732185 | 18.015 | 5.2053 | 0.3199 | –0.212 | 0.25795 | 273.16 | 4.4733 | 647.13 | 0 |

All substances are listed in alphabetical order in Table 2-6*a*.

Compiled from Daubert, T. E., R. P. Danner, H. M. Sibul, and C. C. Stebbins, DIPPR Data Compilation of Pure Compound Properties, Project 801 Sponsor Release, July, 1993, Design Institute for Physical Property Data, AIChE, New York, NY; and from Thermodynamics Research Center, "Selected Values of Properties of Hydrocarbons and Related Compounds," Thermodynamics Research Center Hydrocarbon Project, Texas A&M University, College Station, Texas (extant 1994).

Temperatures are expressed in kelvins; heats of vaporization, in J/kmol.

J/kmol × 2.390E–04 = cal/gmol; J/kmol × 4.302106E–04 = Btu/lbmol.

The heat of vaporization equation used is $\Delta H_v = C1 \times (1 - T_r)^{C2 + C3 \times T_r + C4 \times T_r \times T_r}$. $T_r$ is the reduced temperature, $T/T_c$.

[1] Coefficients are hypothetical; compound *decomposes violently* on heating.

[2] For the monomer.

[3] Equation coefficients are hypothetical above the decomposition temperature.

# SPECIFIC HEATS OF PURE COMPOUNDS

## UNITS CONVERSIONS

For this subsection, the following units conversions are applicable:

°F = ⁹⁄₅ °C + 32
°F = 1.8 K

To convert calories per gram-kelvin to British thermal units per pound-degree Rankine, multiply by 1.0; to convert calories per gram-mole-kelvin to British thermal units per pound-mole-degree Rankine, multiply by 1.0.

To convert kilojoules per kilogram-kelvin to British thermal units per pound-degree Rankine, multiply by 0.2388.

## ADDITIONAL REFERENCES

Additional data are contained in the subsection "Thermodynamic Properties." Data on water are also contained in that subsection. Additional tables for water are found in Eng. Sci. Data Item 68008, 251 Regent Street, London, England, which contains about 5000 values from 1 to 1000 bar, 0 to 1500°C.

**TABLE 2-194 Heat Capacities of the Elements and Inorganic Compounds***

| Substance | State† | Heat capacity at constant pressure ($T$ = K; 0°C = 273.1 K), cal/deg mol | Range of temperature, K | Uncertainty, % |
|---|---|---|---|---|
| Aluminum[1] | | | | |
| Al | *c* | $4.80 + 0.00322T$ | 273–931 | 1 |
| | *l* | 7.00 | 931–1273 | 5 |
| $AlBr_3$ | *c* | $18.74 + 0.01866T$ | 273–370 | 3 |
| | *l* | 29.5 | 370–407 | 5 |
| $AlCl_3$ | *c* | $13.25 + 0.02800T$ | 273–465 | 3 |
| | *l* | 31.2 | 465–504 | 3 |
| $AlCl_3 \cdot 6H_2O$ | *c* | 76 | 288–327 | ? |
| $AlF_3$ | *c* | 19.3 | 288–326 | ? |
| $AlF_3 \cdot 3½H_2O$ | *c* | 50.5 | 288–326 | ? |
| $AlF_3 \cdot 3NaF$ | *c* | $38.63 + 0.04760T - 449200/T^2$ | 273–1273 | 2 |
| | *l* | 142 | 1273–1373 | ? |
| $AlI_3$ | *c* | $16.88 + 0.02266T$ | 273–464 | 3 |
| | *l* | 28.8 | 464–480 | 5 |
| $Al_2O_3$ | *c* | $22.08 + 0.008971T - 522500/T^2$ | 273–1973 | 3 |
| $Al_2O_3 \cdot SiO_2$ | *c*, sillimanite | $40.79 + 0.004763T - 992800/T^2$ | 273–1573 | 3 |
| | *c*, disthene | $41.81 + 0.005283T - 1211000/T^2$ | 273–1673 | 2 |
| | *c*, andalusite | $43.96 + 0.001923T - 1086000/T^2$ | 273–1573 | 3 |
| $3Al_2O_3 \cdot 2SiO_2$ | *c*, mullite | $59.65 + 0.0670T$ | 273–576 | 5 |
| $4Al_2O_3 \cdot 3SiO_2$ | *c* | $113.2 + 0.0652T$ | 273–575 | 3 |
| $Al_2(SO_4)_3$ | *c* | 63.5 | 273–373 | ? |
| $Al_2(SO_4)_3 \cdot 18H_2O$ | *c* | 235 | 288–325 | ? |
| Antimony | | | | |
| Sb | *c* | $5.51 + 0.00178T$ | 273–903 | 2 |
| | *l* | 7.15 | 903–1273 | 5 |
| $SbBr_3$ | *c* | $17.2 + 0.0293T$ | 273–370 | ? |
| $SbCl_3$ | *c* | $10.3 + 0.0511T$ | 273–346 | ? |
| $Sb_2O_3$ | *c* | $19.1 + 0.0171T$ | 273–929 | ? |
| $Sb_2O_4$ | *c* | $22.6 + 0.0162T$ | 273–1198 | ? |
| $Sb_2S_3$ | *c* | $24.2 + 0.0132T$ | 273–821 | ? |
| Argon[2] | | | | |
| A | *g* | 4.97 | All | 0 |
| Arsenic | | | | |
| As | *c* | $5.17 + 0.00234T$ | 273–1168 | 5 |
| $AsCl_3$ | *l* | 31.9 | 286–371 | ? |
| $As_2O_3$ | *c* | $8.37 + 0.0486T$ | 273–548 | ? |
| $As_2S_3$ | *c* | 25.8 | 293–373 | ? |
| Barium | | | | |
| $BaCl_2$ | *c* | $17.0 + 0.00334T$ | 273–1198 | ? |
| $BaCl_2 \cdot H_2O$ | *c* | 28.2 | 273–307 | ? |
| $BaCl_2 \cdot 2H_2O$ | *c* | 37.3 | 273–307 | ? |
| $Ba(ClO_3)_2 \cdot H_2O$ | *c* | 51 | 289–320 | ? |
| $BaCO_3$ | *c*, α | $17.26 + 0.0131T$ | 273–1083 | 5 |
| | *c*, β | 30.0 | 1083–1255 | 15 |
| $BaMoO_4$ | *c* | 34 | 273–297 | ? |
| $Ba(NO_3)_2$ | *c* | 39.8 | 285–371 | ? |
| $BaSO_4$ | *c* | $21.35 + 0.0141T$ | 273–1323 | 5 |
| Beryllium[3,4] | | | | |
| Be | *c* | $4.698 + 0.001555T - 121000/T^2$ | 273–1173 | 1 |
| BeO | *c* | $8.69 + 0.00365T - 313000/T^2$ | 273–1175 | 5 |
| $BeO \cdot Al_2O_3$ | *c* | 25.4 | 273–373 | ? |
| $BeSO_4$ | *c* | 20.8 | 273–373 | ? |

*From Kelley, U.S. Bur. Mines Bull. 371, 1934. For a revision see Kelley, U.S. Bur. Mines Bull. 477, 1948. Data for many elements and compounds are given by Johnson (ed.), WADD-TR-60-56, 1960, for cryogenic temperatures. Tabulated data for gases can be obtained from many of the references cited in the "Thermodynamic Properties" subsection and other tables in this section. Thinh, Duran, et al., *Hydrocarbon Process.*, **50,** 98 (January 1971), review previous equation fits and give newer fits for 408 hydrocarbons and related compounds. Later publications include Duran, Thinh, et al., *Hydrocarbon Process.*, **55,** 153 (August 1976); Thompson, *J. Chem. Eng. Data,* **22**(4), 431 (1977); and Passut and Danner, *Ind. Eng. Chem. Process Des. Dev.*, **11,** 543 (1972); **13,** 193 (1974).

† The symbols in this column have the following meaning; *c,* crystal; *l,* liquid; *g,* gas; *gls,* glass.

**TABLE 2-194 Heat Capacities of the Elements and Inorganic Compounds** (*Continued*)

| Substance | State† | Heat capacity at constant pressure ($T$ = K; 0°C = 273.1 K), cal/deg mol | Range of temperature, K | Uncertainty, % |
|---|---|---|---|---|
| Bismuth[4] | | | | |
| Bi | *c* | $5.38 + 0.00260T$ | 273–544 | 3 |
| | *l* | 7.60 | 544–1273 | 3 |
| $Bi_2O_3$ | *c* | $23.27 + 0.01105T$ | 273–777 | 2 |
| $Bi_2S_3$ | *c* | 30.4 | 284–372 | ? |
| Boron | | | | |
| B | *c* | $1.54 + 0.00440T$ | 273–1174 | 5 |
| $B_2O_3$ | *gls* | $5.14 + 0.0320T$ | 273–513 | 3 |
| | *gls* | 30.4 | 513–623 | 3 |
| BN | *c* | $1.61 + 0.00400T$ | 273–1173 | 5 |
| Bromine | | | | |
| $Br_2$ | *g* | 9.00 | 300–2000 | 5 |
| Cadmium | | | | |
| Cd | *c* | $5.46 + 0.002466T$ | 273–594 | 1 |
| | *l* | 7.13 | 594–973 | 5 |
| CdO | *c* | $9.65 + 0.00208T$ | 273–2086 | ? |
| CdS | *c* | $12.9 + 0.00090T$ | 273–1273 | ? |
| $CdSO_4 \cdot 8/3H_2O$ | *c* | 51.3 | 293 | ? |
| Calcium | | | | |
| Ca | *c* | $5.31 + 0.00333T$ | 273–673 | 2 |
| | *c* | $6.29 + 0.00140T$ | 673–873 | 2 |
| $CaCl_2$ | *c* | $16.9 + 0.00386T$ | 273–1055 | ? |
| $CaCO_3$ | *c* | $19.68 + 0.01189T - 307600/T^2$ | 273–1033 | 3 |
| $CaF_2$ | *c* | $14.7 + 0.00380T$ | 273–1651 | ? |
| $CaMg(CO_3)_2$ | *c* | 40.1 | 299–372 | ? |
| $CaMoO_4$ | *c* | 33 | 273–297 | ? |
| CaO | *c* | $10.00 + 0.00484T - 108000/T^2$ | 273–1173 | 2 |
| $Ca(OH)_2$ | *c* | 21.4 | 276–373 | ? |
| $CaO \cdot Al_2O_3 \cdot 2SiO_2$ | *c*, anorthite | $63.13 + 0.01500T - 1537000/T^2$ | 273–1673 | 1 |
| | *gls* | $67.41 + 0.01048T - 1874000/T^2$ | 273–973 | 1 |
| $CaO \cdot MgO \cdot 2SiO_2$ | *c*, diopside | $54.46 + 0.005746T - 1500000/T^2$ | 273–1573 | 1 |
| | *gls* | $51.68 + 0.009724T - 1308000/T^2$ | 273–973 | 1 |
| $CaO \cdot SiO_2$ | *c*, wollastonite | $27.95 + 0.002056T - 745600/T^2$ | 273–1573 | 1 |
| | *c*, pseudowollastonite | $25.48 + 0.004132T - 488100/T^2$ | 273–1673 | 1 |
| | *gls* | $23.16 + 0.009672T - 487100/T^2$ | 273–973 | 1 |
| $CaP_2O_6$ | *c* | 39.5 | 287–371 | ? |
| $CaSO_4$ | *c* | $18.52 + 0.02197T - 156800/T^2$ | 273–1373 | 5 |
| $CaSO_4 \cdot 2H_2O$ | *c* | 46.8 | 282–373 | ? |
| $CaWO_4$ | *c* | 27.9 | 292–322 | ? |
| Carbon[5] | | | | |
| C | *c*, graphite | $2.673 + 0.002617T - 116900/T^2$ | 273–1373 | 2 |
| | *c*, diamond | $2.162 + 0.003059T - 130300/T^2$ | 273–1313 | 3 |
| $CH_4$ | *g* | $5.34 + 0.0115T$ | 273–1200 | 2 |
| CO[6] | *g* | $6.60 + 0.00120T$ | 273–2500 | 1½ |
| $CO_2$ | *g* | $10.34 + 0.00274T - 195500/T^2$ | 273–1200 | 1½ |
| $CS_2$ | *l* | 18.4 | 293 | ? |
| Cerium | | | | |
| Ce | *c* | $5.88 + 0.00123T$ | 273–908 | ? |
| $CeO_2$ | *c* | 15.1 | 273–373 | ? |
| $Ce_2(MoO_4)_3$ | *c* | 96 | 273–297 | ? |
| $Ce_2(SO_4)_3$ | *c* | 66.4 | 273–373 | ? |
| $Ce_2(SO_4)_3 \cdot 5H_2O$ | *c* | 131.6 | 273–319 | ? |
| Cesium | | | | |
| Cs | *c* | $1.96 + 0.0182T$ | 273–301 | 3 |
| | *l* | 8.00 | 302 | 3 |
| | *g* | 4.97 | All | 0 |
| CsBr | *c* | $12.6 + 0.00259T$ | 273–909 | ? |
| CsCl | *c* | $11.7 + 0.00309T$ | 273–752 | ? |
| CsF | *c* | $11.3 + 0.00285T$ | 273–957 | ? |
| CsI | *c* | $11.6 + 0.00268T$ | 273–894 | ? |
| Chlorine | | | | |
| $Cl_2$ | *g* | $8.28 + 0.00056T$ | 273–2000 | 1½ |
| Chromium[4] | | | | |
| Cr | *c* | $4.84 + 0.00295T$ | 273–1823 | 5 |
| | *l* | 9.70 | 1823–1923 | 10 |
| $CrCl_3$ | *c* | 23 | 286–319 | ? |
| $Cr_2O_3$ | *c* | $26.0 + 0.00400T$ | 273–2263 | ? |
| CrSb | *c* | $12.3 + 0.00120T$ | 273–1383 | ? |
| $CrSb_2$ | *c* | $19.2 + 0.00184T$ | 273–949 | ? |
| $Cr_2(SO_4)_3$ | *c* | 67.4 | 273–373 | ? |
| Cobalt[4] | | | | |
| Co | *c* | $5.12 + 0.00333T$ | 273–1763 | 5 |
| | *l* | 8.40 | 1763–1873 | 5 |
| $CoAs_2 \cdot CoS_2$ | *c* | 32.9 | 283–373 | ? |
| CoSb | *c* | $11.7 + 0.00156T$ | 273–1464 | ? |
| $Co_2Sn$ | *c* | $15.83 + 0.00950T$ | 273–903 | 2 |
| CoS | *c* | $10.6 + 0.00251T$ | 273–1373 | ? |
| $CoSO_4 \cdot 7H_2O$ | *c* | 96 | 286–303 | ? |

**TABLE 2-194 Heat Capacities of the Elements and Inorganic Compounds** (*Continued*)

| Substance | State† | Heat capacity at constant pressure ($T$ = K; 0°C = 273.1 K), cal/deg mol | Range of temperature, K | Uncertainty, % |
|---|---|---|---|---|
| Copper[7] | | | | |
| Cu | *c* | $5.44 + 0.001462T$ | 273–1357 | 1 |
| | *l* | 7.50 | 1357–1573 | 3 |
| CuAl | *c* | $9.88 + 0.00500T$ | 273–733 | 2 |
| $CuAl_2$ | *c* | $16.78 + 0.00366T$ | 273–773 | 2 |
| $Cu_3Al$ | *c* | $19.61 + 0.01054T$ | 273–775 | 2 |
| CuI | *c* | $12.1 + 0.00286T$ | 273–675 | ? |
| $CuI_2$ | *c* | 20.1 | 274–328 | ? |
| CuO | *c* | $10.87 + 0.003576T - 150600/T^2$ | 273–810 | 2 |
| $CuO{\cdot}SiO_2{\cdot}H_2O$ | *c* | 29 | 293–323 | ? |
| CuS | *c* | $10.6 + 0.00264T$ | 273–1273 | ? |
| $Cu_2S$ | *c*, α | $9.38 + 0.0312T$ | 273–376 | 3 |
| | *c*, β | 20.9 | 376–1173 | 2 |
| CuS·FeS | *c* | 24 | 292–321 | ? |
| $Cu_2Sb$ | *c* | $13.73 + 0.01350T$ | 273–573 | 2 |
| $Cu_2Sb$ | *c* | $21.79 + 0.00900T$ | 273–693 | 2 |
| $Cu_2Se$ | *c*, α | 20.85 | 273–383 | 5 |
| | *c*, β | 20.35 | 383–488 | 5 |
| $Cu_3Si$ | *c* | $20.3 + 0.00587T$ | 273–1135 | ? |
| $CuSO_4$ | *c* | 24.1 | 282 | ? |
| $CuSO_4{\cdot}H_2O$ | *c* | 31.3 | 282 | ? |
| $CuSO_4{\cdot}3H_2O$ | *c* | 49.0 | 282 | ? |
| $CuSO_4{\cdot}5H_2O$ | *c* | 67.2 | 282 | ? |
| Fluorine[8] | | | | |
| $F_2$ | *g* | $6.50 + 0.00100T$ | 300–3000 | 5 |
| Gallium | | | | |
| $Ga_2O_3$ | *c* | $18.2 + 0.0252T$ | 273–923 | ? |
| $Ga_2(SO_4)_3$ | *c* | 62.4 | 273–373 | ? |
| Germanium[4] | | | | |
| Ge | *c* | | | |
| Gold | | | | |
| Au | *c* | $5.61 + 0.00144T$ | 273–1336 | 2 |
| | *l* | 7.00 | 1336–1573 | 5 |
| $AuSb_2$ | *c*, α | $17.12 + 0.00465T$ | 273–628 | 1 |
| | *c*, βγ | $11.47 + 0.01756T$ | 628–713 | ? |
| Helium[9] | | | | |
| He | *g* | 4.97 | All | 0 |
| Hydrogen[10] | | | | |
| H | *g* | 4.97 | All | 0 |
| $H_2$ | *g* | $6.62 + 0.00081T$ | 273–2500 | 2 |
| HBr | *g* | $6.80 + 0.00084T$ | 273–2000 | 2 |
| HCl | *g* | $6.70 + 0.00084T$ | 273–2000 | 1½ |
| HI | *g* | $6.93 + 0.00083T$ | 273–2000 | 2 |
| $H_2O$ | *l* | See Tables 2-355 through 2-357 | | |
| | *g* | $8.22 + 0.00015T + 0.00000134T^2$ | 300–2500 | ? |
| $H_2S$ | *g* | $7.20 + 0.00360T$ | 300–600 | 8 |
| $H_2S_2O_7$ | *c* | 27 | 281 | ? |
| | *l* | 58 | 308 | ? |
| Indium | | | | |
| In | *c* | | | |
| Iodine | | | | |
| $I_2$ | *g* | 9.00 | 300–2000 | 5 |
| Iridium | | | | |
| Ir | *c* | $5.50 + 0.00148T$ | 273–1873 | 1 |
| Iron[4] | | | | |
| Fe | *c*, α | $4.13 + 0.00638T$ | 273–1041 | 3 |
| | *c*, β | $6.12 + 0.00336T$ | 1041–1179 | 3 |
| | *c*, γ | 8.40 | 1179–1674 | 5 |
| | *c*, δ | 10.0 | 1674–1803 | 5 |
| | *l* | 8.15 | 1803–1873 | 5 |
| $FeAs_2$ | *c* | 17.8 | 283–373 | ? |
| $Fe_3C$ | *c* | $25.17 + 0.00223T$ | 273–1173 | 10 |
| $FeCO_3$ | *c* | 22.7 | 293–368 | ? |
| FeO | *c* | $12.62 + 0.001492T - 76200/T^2$ | 273–1173 | 2 |
| $Fe_2O_3$ | *c* | $24.72 + 0.01604T - 423400/T^2$ | 273–1097 | 2 |
| $Fe_3O_4$ | *c* | $41.17 + 0.01882T - 979500/T^2$ | 273–1065 | 2 |
| $Fe_2O_3{\cdot}3H_2O$ | *c* | 47.8 | 286–373 | ? |
| FeS | *c*, α | $2.03 + 0.0390T$ | 273–411 | 5 |
| | *c*, β | $12.05 + 0.00273T$ | 411–1468 | 3 |
| $FeS_2$ | *c* | $10.7 + 0.01336T$ | 273–773 | ? |
| FeSi | *c* | $10.54 + 0.00458T$ | 273–903 | 2 |
| $Fe_2SiO_4$ | *c* | $33.57 + 0.01907T - 879700/T^2$ | 273–1161 | 2 |
| $FeSO_4$ | *c* | 22 | 293–373 | ? |
| $Fe_2(SO_4)_3$ | *c* | 66.2 | 273–373 | ? |
| $FeSO_4{\cdot}4H_2O$ | *c* | 63.6 | 282 | ? |
| $FeSO_4{\cdot}7H_2O$ | *c* | 96 | 291–319 | ? |
| Krypton | | | | |
| Kr | *g* | 4.97 | All | 0 |

**TABLE 2-194 Heat Capacities of the Elements and Inorganic Compounds** (*Continued*)

| Substance | State† | Heat capacity at constant pressure ($T$ = K; 0°C = 273.1 K), cal/deg mol | Range of temperature, K | Uncertainty, % |
|---|---|---|---|---|
| Lanthanum | | | | |
| La | *c* | $5.91 + 0.00100T$ | 273–1009 | ? |
| $La_2O_3$ | *c* | $22.6 + 0.00544T$ | 273–2273 | ? |
| $La_2(MoO_4)_3$ | *c* | 86 | 273–307 | ? |
| $La_2(SO_4)_3$ | *c* | 66.9 | 273–373 | ? |
| $La_2(SO_4)_3 \cdot 9H_2O$ | *c* | 152 | 273–319 | ? |
| Lead[4] | | | | |
| Pb | *c* | $5.77 + 0.00202T$ | 273–600 | 2 |
| | *l* | 6.8 | 600–1273 | 5 |
| $Pb_3(AsO_4)_2$ | *c* | 65.5 | 286–370 | ? |
| $PbB_2O_4$ | *c* | 26.5 | 288–371 | ? |
| $PbB_4O_7$ | *c* | 41.4 | 289–371 | ? |
| $PbBr_2$ | *c* | $18.13 + 0.00310T$ | 273–761 | 2 |
| | *l* | 27.4 | 761–860 | 10 |
| $PbCl_2$ | *c* | $15.88 + 0.00835T$ | 273–771 | 2 |
| | *l* | 27.2 | 771–851 | 10 |
| $2PbCl_2 \cdot NH_4Cl$ | *c* | 53.1 | 293 | ? |
| $PbCO_3$ | *c* | 21.1 | 286–320 | ? |
| $PbCrO_4$ | *c* | 29.1 | 292–323 | ? |
| $PbF_2$ | *c* | $16.5 + 0.00412T$ | 273–1091 | ? |
| $PbI_2$ | *c* | $18.66 + 0.00293T$ | 273–648 | 2 |
| | *l* | 32.3 | 648–776 | 20 |
| $PbMoO_4$ | *c* | 30.4 | 292–322 | ? |
| $Pb(NO_3)_2$ | *c* | 36.4 | 286–320 | ? |
| PbO | *c* | $10.33 + 0.00318T$ | 273–544 | 2 |
| $PbO_2$ | *c* | $12.7 + 0.00780T$ | 273–? | ? |
| $Pb_2P_2O_7$ | *c* | 48.3 | 284–371 | ? |
| PbS | *c* | $10.63 + 0.00401T$ | 273–873 | 3 |
| $PbSO_4$ | *c* | 26.4 | 293–372 | ? |
| $PbS_2O_3$ | *c* | 29 | 293–373 | ? |
| $PbWO_4$ | *c* | 35 | 273–297 | ? |
| Lithium | | | | |
| Li | *c* | $0.68 + 0.0180T$ | 273–459 | 10 |
| | *g* | 4.97 | All | 0 |
| LiBr | *c* | $11.5 + 0.00302T$ | 273–825 | ? |
| $LiBr \cdot H_2O$ | *c* | 22.6 | 278–318 | ? |
| LiCl | *c* | $11.0 + 0.00339T$ | 273–887 | ? |
| $LiCl \cdot H_2O$ | *c* | 23.6 | 279–360 | ? |
| LiF | *c* | $8.20 + 0.00520T$ | 273–1117 | ? |
| LiI | *c* | $12.5 + 0.00208T$ | 273–723 | ? |
| $LiI \cdot H_2O$ | *c* | 23.6 | 277–359 | ? |
| $LiI \cdot 2H_2O$ | *c* | 32.9 | 277–345 | ? |
| $LiI \cdot 3H_2O$ | *c* | 43.2 | 277–347 | ? |
| $LiNO_3$ | *c* | $9.17 + 0.0360T$ | 273–523 | 5 |
| | *l* | 26.8 | 523–575 | 5 |
| Magnesium[4] | | | | |
| Mg | *c* | $6.20 + 0.00133T - 67800/T^2$ | 273–923 | 1 |
| | *l* | 7.4 | 923–1048 | 10 |
| MgAg | *c* | $10.58 + 0.00412T$ | 273–905 | 2 |
| $Mg_4Al_3$ | *c* | $34.4 + 0.0198T$ | 273–736 | ? |
| MgAu | *c* | $11.3 + 0.00189T$ | 273–1433 | ? |
| $Mg_2Au$ | *c* | $16.2 + 0.00451T$ | 273–1073 | ? |
| $Mg_3Au$ | *c* | $21.2 + 0.00614T$ | 273–1103 | ? |
| $MgCl_2$ | *c* | $17.3 + 0.00377T$ | 273–991 | ? |
| $MgCl_2 \cdot 6H_2O$ | *c* | 77.1 | 292–342 | ? |
| $MgCO_3$ | *c* | 16.9 | 290 | ? |
| $MgCu_2$ | *c* | $14.96 + 0.00776T$ | 273–903 | 3 |
| $Mg_2Cu$ | *c* | $15.5 + 0.00652T$ | 273–843 | ? |
| $MgNi_2$ | *c* | $15.87 + 0.00692T$ | 273–903 | 2 |
| MgO | *c* | $10.86 + 0.001197T - 208700/T^2$ | 273–2073 | 2 |
| $MgO \cdot Al_2O_3$ | *c* | 28 | 288–319 | ? |
| $MgO \cdot SiO_2$ | *c*, amphibole | $25.60 + 0.004380T - 674200/T^2$ | 273–1373 | 1 |
| | *c*, pyroxene | $23.35 + 0.008062T - 558800/T^2$ | 273–773 | 1 |
| | *gls* | $23.30 + 0.007734T - 542000/T^2$ | 273–973 | 1 |
| $6MgO \cdot MgCl_2 \cdot 8B_2O_3$ | *c*, α | $58.7 + 0.408T$ | 273–538 | 5 |
| | *c*, β | $107.2 + 0.2876T$ | 538–623 | 5 |
| $Mg(OH)_2$ | *c* | 18.2 | 292–323 | ? |
| $Mg_3Sb_2$ | *c* | $28.2 + 0.00560T$ | 273–1234 | ? |
| $Mg_2Si$ | *c* | $15.4 + 0.00415T$ | 273–1343 | ? |
| $MgSO_4$ | *c* | 26.7 | 296–372 | ? |
| $MgSO_4 \cdot H_2O$ | *c* | 33 | 282 | ? |
| $MgSO_4 \cdot 6H_2O$ | *c* | 80 | 282 | ? |
| $MgSO_4 \cdot 7H_2O$ | *c* | 89 | 291–319 | ? |

**TABLE 2-194 Heat Capacities of the Elements and Inorganic Compounds** (*Continued*)

| Substance | State† | Heat capacity at constant pressure ($T$ = K; 0°C = 273.1 K), cal/deg mol | Range of temperature, K | Uncertainty, % |
|---|---|---|---|---|
| Manganese | | | | |
| Mn | *c*, α | $3.76 + 0.00747T$ | 273–1108 | 5 |
| | *c*, β | $5.06 + 0.00395T$ | 1108–1317 | 5 |
| | *c*, γ | $4.80 + 0.00422T$ | 1317–1493 | 5 |
| | *l* | 11.0 | 1493–1673 | 10 |
| $MnCl_2$ | *c* | $16.2 + 0.00520T$ | 273–923 | ? |
| $MnCO_3$ | *c* | $7.79 + 0.0421T + 0.0000090T^2$ | 273–773 | ? |
| MnO | *c* | $7.43 + 0.01038T - 0.00000362T^2$ | 273–1923 | ? |
| $Mn_2O_3$ | *c* | $10.33 + 0.0530T - 0.0000257T^2$ | 273–1173 | ? |
| $Mn_3O_4$ | *c* | $19.25 + 0.0538T - 0.0000209T^2$ | 273–1773 | ? |
| $MnO_2$ | *c* | $1.92 + 0.0471T - 0.0000297T^2$ | 273–773 | ? |
| $Mn_2O_3 \cdot H_2O$ | *c* | 31 | 291–322 | ? |
| MnS | *c* | $10.21 + 0.00656T - 0.00000242T^2$ | 273–1883 | ? |
| $MnSO_4$ | *c* | 27.5 | 293–373 | ? |
| $MnSO_4 \cdot 5H_2O$ | *c* | 78 | 290–319 | ? |
| Mercury[11] | | | | |
| Hg | *l* | 6.61 | 273–630 | 1 |
| | *g* | 4.97 | All | 0 |
| $Hg_2$ | *g* | 9.00 | 300–2000 | 5 |
| HgCl | *c* | $11.05 + 0.00370T$ | 273–798 | ? |
| $HgCl_2$ | *c* | $15.3 + 0.0103T$ | 273–553 | ? |
| $Hg(CN)_2$ | *c* | 25 | 285–319 | ? |
| HgI | *c* | $11.4 + 0.00461T$ | 273–563 | ? |
| $HgI_2$ | *c*, α | $17.4 + 0.004001T$ | 273–403 | 3 |
| | *c*, β | 20.2 | 403–523 | 3 |
| HgO | *c* | 11.5 | 278–371 | ? |
| HgS | *c* | $10.9 + 0.00365T$ | 273–853 | ? |
| $Hg_2SO_4$ | *c* | 31.0 | 273–307 | ? |
| Molybdenum | | | | |
| Mo | *c* | $5.69 + 0.00188T - 50300/T^2$ | 273–1773 | 5 |
| $MoO_3$ | *c* | $15.1 + 0.0121T$ | 273–1068 | ? |
| $MoS_2$ | *c* | $19.7 + 0.00315T$ | 273–729 | ? |
| Neon[12] | | | | |
| Ne | *g* | 4.97 | All | 0 |
| Nickel[4] | | | | |
| Ni | *c*, α | $4.26 + 0.00640T$ | 273–626 | 2 |
| | *c*, β | $6.99 + 0.000905T$ | 626–1725 | 5 |
| | *l* | 8.55 | 1725–1903 | 10 |
| NiO | *c* | $11.3 + 0.00215T$ | 273–1273 | ? |
| NiS | *c* | $9.25 + 0.00640T$ | 273–597 | 3 |
| $Ni_2Si$ | *c* | $15.8 + 0.00329T$ | 273–1582 | ? |
| NiSi | *c* | $10.0 + 0.00312T$ | 273–1273 | ? |
| $Ni_3Sn$ | *c* | $20.78 + 0.0102T$ | 273–904 | 2 |
| $NiSO_4$ | *c* | 33.4 | 293–373 | ? |
| $NiSO_4 \cdot 6H_2O$ | *c* | 82 | 291–325 | ? |
| NiTe | *c* | $11.00 + 0.00433T$ | 273–700 | 2 |
| Nitrogen[13] | | | | |
| $N_2$ | *g* | $6.50 + 0.00100T$ | 300–3000 | 3 |
| $NH_3$ | *g* | $6.70 + 0.00630T$ | 300–800 | 1½ |
| $NH_4Br$ | *c* | 22.8 | 274–328 | ? |
| $NH_4Cl$ | *c*, α | $9.80 + 0.0368T$ | 273–457 | 5 |
| | *c*, β | $5.0 + 0.0340T$ | 457–523 | 5 |
| $NH_4I$ | *c* | 17.8 | 273–328 | ? |
| $NH_4NO_3$ | *c* | 31.8 | 273–293 | ? |
| $(NH_4)_2SO_4$ | *c* | 51.6 | 275–328 | ? |
| NO | *g* | $8.05 + 0.000233T - 156300/T^2$ | 300–5000 | 2 |
| Osmium | | | | |
| Os | *c* | $5.686 + 0.000875T$ | 273–1877 | 1 |
| Oxygen[14] | | | | |
| $O_2$ | *g* | $8.27 + 0.000258T - 187700/T^2$ | 300–5000 | 1 |
| Palladium | | | | |
| Pd | *c* | $5.41 + 0.00184T$ | 273–1822 | 2 |
| Phosphorus | | | | |
| P | *c*, yellow | 5.50 | 273–317 | 5 |
| | *c*, red | $0.21 + 0.0180T$ | 273–472 | 10 |
| | *l* | 6.6 | 317–373 | 10 |
| $PCl_3$ | *l* | 28.7 | 284–371 | ? |
| $P_4O_{10}$ | *c* | $15.72 + 0.1092T$ | 273–631 | 2 |
| | *g* | 73.6 | 631–1371 | 3 |
| Platinum[4] | | | | |
| Pt | *c* | $5.92 + 0.00116T$ | 273–1873 | 1 |
| Potassium | | | | |
| K | *c* | $5.24 + 0.00555T$ | 273–336 | 5 |
| | *l* | 7.7 | 336–373 | 5 |

**TABLE 2-194 Heat Capacities of the Elements and Inorganic Compounds** (*Continued*)

| Substance | State† | Heat capacity at constant pressure ($T$ = K; 0°C = 273.1 K), cal/deg mol | Range of temperature, K | Uncertainty, % |
|---|---|---|---|---|
| Potassium—(*Cont.*) | | | | |
| K | *g* | 4.97 | All | 0 |
| $K_2$ | *g* | 9.00 | 300–2000 | 5 |
| $KAsO_3$ | *c* | 25.3 | 290–372 | ? |
| $KBO_2$ | *c* | $12.6 + 0.0126T$ | 273–1220 | ? |
| $K_2B_4O_7$ | *c* | 51.3 | 290–372 | ? |
| KBr | *c* | $11.49 + 0.00360T$ | 273–543 | 2 |
| KCl | *c* | $10.93 + 0.00376T$ | 273–1043 | 2 |
| $KClO_3$ | *c* | 25.7 | 289–371 | ? |
| $KClO_4$ | *c* | 26.3 | 287–318 | ? |
| $2KCl·CuCl_2.2H_2O$ | *c* | 63 | 292–323 | ? |
| $2KCl·PtCl_4$ | *c* | 55 | 286–319 | ? |
| $2KCl·SnCl_4$ | *c* | 54.5 | 292–323 | ? |
| $2KCl·ZnCl_2$ | *c* | 43.4 | 279–319 | ? |
| $2KCN·Zn(CN)_2$ | *c* | 57.4 | 277–319 | ? |
| $K_2CO_3$ | *c* | 29.9 | 296–372 | ? |
| $K_2CrO_4$ | *c* | 35.9 | 289–371 | ? |
| $K_2Cr_2O_7$ | *c* | $42.80 + 0.0410T$ | 273–671 | 5 |
| | *l* | 96.9 | 671–757 | 5 |
| KF | *c* | $10.8 + 0.00284T$ | 273–1129 | ? |
| $K_4Fe(CN)_6$ | *c* | 80.1 | 273–319 | ? |
| $K_4Fe(CN)_6·3H_2O$ | *c* | 114.5 | 273–310 | ? |
| $KH_2AsO_4$ | *c* | 32 | 289–319 | ? |
| $KH_2PO_4$ | *c* | 28.3 | 290–320 | ? |
| $KHSO_4$ | *c* | 30 | 292–324 | ? |
| $KMnO_4$ | *c* | 28 | 287–318 | ? |
| $KNO_3$ | *c* | $6.42 + 0.0530T$ | 273–401 | 10 |
| | *c* | 28.8 | 401–611 | 5 |
| | *l* | 29.5 | 611–683 | 10 |
| $K_2O·Al_2O_3·3SiO_2$ | *c*, orthoclase | $69.26 + 0.00821T - 2331000/T^2$ | 273–1373 | 1½ |
| | *gls*, orthoclase | $69.81 + 0.01053 - 2403000/T^2$ | 273–1373 | 1½ |
| | *c*, microcline | $65.65 + 0.01102T - 1748000/T^2$ | 273–1373 | 1½ |
| | *gls*, microcline | $64.83 + 0.01438T - 1641000/T^2$ | 273–1373 | 1½ |
| $K_4P_2O_7$ | *c* | 63.1 | 290–371 | ? |
| $K_2SO_4$ | *c* | 33.1 | 287–371 | ? |
| $K_2S_2O_3$ | *c* | 37 | 293–373 | ? |
| $K_2SO_4·Al_2(SO_4)_3·24H_2O$ | *c* | 352 | 292–322 | ? |
| $K_2SO_4·Cr_2(SO_4)_3·24H_2O$ | *c* | 324 | 292–324 | ? |
| $K_2SO_4·MgSO_4·6H_2O$ | *c* | 106 | 292–323 | ? |
| $K_2SO_4·NiSO_4·6H_2O$ | *c* | 107 | 289–319 | ? |
| $K_2SO_4·ZnSO_4·6H_2O$ | *c* | 120 | 293–317 | ? |
| Prometheum | | | | |
| Pr | *c* | | | |
| Radon | | | | |
| Rn | *g* | 4.97 | All | 0 |
| Rhenium | | | | |
| Re | *c* | $6.30 + 0.00053T$ | 273–2273 | ? |
| Rhodium | | | | |
| Rh | *c* | $5.40 + 0.00219T$ | 273–1877 | 2 |
| Rubidium | | | | |
| Rb | *c* | $3.27 + 0.0131T$ | 273–312 | 2 |
| | *l* | 7.85 | 312–373 | 5 |
| RbBr | *c* | $11.6 + 0.00255T$ | 273–954 | ? |
| RbCl | *c* | $11.5 + 0.00249T$ | 273–987 | ? |
| $Rb_2CO_3$ | *c* | 28.4 | 291–320 | ? |
| RbF | *c* | $11.3 + 0.00256T$ | 273–1048 | ? |
| RbI | *c* | $11.6 + 0.00263T$ | 273–913 | ? |
| Scandium | | | | |
| $Sc_2O_3$ | *c* | 21.1 | 273–373 | ? |
| $Sc_2(SO_4)_3$ | *c* | 62.0 | 273–373 | ? |
| Selenium | | | | |
| Se | *c* | $4.53 + 0.00550T$ | 273–490 | 2 |
| | *l* | 8.35 | 490–570 | 3 |
| Silicon | | | | |
| Si | *c* | $5.74 + 0.000617T - 101000/T^2$ | 273–1174 | 2 |
| SiC | *c* | $8.89 + 0.00291T - 284000/T^2$ | 273–1629 | 2 |
| $SiCl_4$ | *l* | 32.4 | 293–373 | ? |
| $SiO_2$ | *c*, quartz, α | $10.87 + 0.008712T - 241200/T^2$ | 273–848 | 1 |
| | *c*, quartz, β | $10.95 + 0.00550T$ | 848–1873 | 3½ |
| | *c*, cristobalite, α | $3.65 + 0.0240T$ | 273–523 | 2½ |
| | *c*, cristobalite, β | $17.09 + 0.000454T - 897200/T^2$ | 523–1973 | 2 |
| | *gls* | $12.80 + 0.00447T - 302000/T^2$ | 273–1973 | 3½ |
| Silver[4] | | | | |
| Ag | *c* | $5.60 + 0.00150T$ | 273–1234 | 1 |
| | *l* | 8.2 | 1234–1573 | 3 |

**TABLE 2-194 Heat Capacities of the Elements and Inorganic Compounds** (*Continued*)

| Substance | State† | Heat capacity at constant pressure ($T$ = K; 0°C = 273.1 K), cal/deg mol | Range of temperature, K | Uncertainty, % |
|---|---|---|---|---|
| Silver—(*Cont.*) | | | | |
| $Ag_3Al$ | *c* | $22.56 + 0.00570T$ | 273–902 | 2 |
| $Ag_2Al$ | *c* | $16.85 + 0.00450T$ | 273–903 | 2 |
| $AgAl_{12}$ | *c* | $58.62 + 0.0575T$ | 273–768 | 5 |
| AgBr | *c* | $8.58 + 0.0141T$ | 273–703 | 6 |
| | *l* | 14.9 | 703–836 | 5 |
| AgCl | *c* | $9.60 + 0.00929T$ | 273–728 | 2 |
| | *l* | 14.05 | 728–806 | 5 |
| AgCNO | *c* | 18.7 | 273–353 | ? |
| AgI | *c*, α | $8.58 + 0.0141T$ | 273–423 | 6 |
| $AgNO_3$ | *c*, α | $18.83 + 0.0160T$ | 273–433 | 2 |
| | *c*, β | 25.7 | 433–482 | 5 |
| | *l* | 30.2 | 482–541 | 5 |
| $Ag_3PO_4$ | *c* | 37.5 | 293–325 | ? |
| $Ag_2S$ | *c*, α | 18.8 | 273–448 | 5 |
| | *c*, β | 21.8 | 448–597 | 5 |
| $Ag_3Sb$ | *c* | $19.53 + 0.0160T$ | 273–694 | 5 |
| $Ag_2Se$ | *c*, α | 20.2 | 273–406 | 5 |
| | *c*, β | 20.4 | 406–460 | 5 |
| Sodium[15] | | | | |
| Na | *c* | $5.01 + 0.00536T$ | 273–371 | 1½ |
| | *l* | 7.50 | 371–451 | 2 |
| | *g* | 4.97 | All | 0 |
| $NaBO_2$ | *c* | $10.4 + 0.0199T$ | 273–1239 | ? |
| $Na_2B_4O_7$ | *c* | 47.9 | 289–371 | ? |
| $Na_2B_4O_7{\cdot}10H_2O$ | *c* | 147 | 292–323 | ? |
| NaBr | *c* | $11.74 + 0.00233T$ | 273–543 | 2 |
| NaCl | *c* | $10.79 + 0.00420T$ | 273–1074 | 2 |
| | *l* | 15.9 | 1073–1205 | 3 |
| $NaClO_3$ | *c* | $9.48 + 0.0468T$ | 273–528 | 3 |
| | *l* | 31.8 | 528–572 | 5 |
| NaCNO | *c* | 13.1 | 273–353 | ? |
| $Na_2CO_3$ | *c* | 28.9 | 288–371 | ? |
| NaF | *c* | $10.4 + 0.00289T$ | 273–1261 | ? |
| $Na_2HPO_4{\cdot}7H_2O$ | *c* | 86.6 | 275–307 | ? |
| $Na_2HPO_4{\cdot}12H_2O$ | *c* | 133.4 | 275–307 | ? |
| NaI | *c* | $12.5 + 0.00162T$ | 273–936 | ? |
| $NaNO_3$ | *c* | $4.56 + 0.0580T$ | 273–583 | 5 |
| | *l* | 37.2 | 583–703 | 10 |
| $Na_2O{\cdot}Al_2O_3{\cdot}3SiO_2$ | *c*, albite | $63.78 + 0.01171T - 1678000/T^2$ | 273–1373 | 1 |
| | *gls* | $61.25 + 0.01768T - 1545000/T^2$ | 273–1173 | 1 |
| $NaPO_3$ | *c* | 22.1 | 290–319 | ? |
| $Na_4P_2O_7$ | *c* | 60.7 | 290–371 | ? |
| $Na_2SO_4$ | *c* | 32.8 | 289–371 | ? |
| $Na_2S_2O_3$ | *c* | 34.9 | 273–307 | ? |
| $Na_2S_2O_3{\cdot}5H_2O$ | *c* | 86.2 | 273–307 | ? |
| Sodium-potassium alloys[15] | *l* | | | |
| Strontium | | | | |
| $SrBr_2$ | *c* | $18.1 + 0.00311T$ | 273–923 | ? |
| $SrBr_2{\cdot}H_2O$ | *c* | 28.9 | 277–370 | ? |
| $SrBr_2{\cdot}6H_2O$ | *c* | 82.1 | 276–327 | ? |
| $SrCl_2$ | *c* | $18.2 + 0.00244T$ | 273–1143 | ? |
| $SrCl_2{\cdot}H_2O$ | *c* | 28.7 | 276–365 | ? |
| $SrCl_2{\cdot}2H_2O$ | *c* | 38.3 | 277–366 | ? |
| $SrCO_3$ | *c* | 21.8 | 281–371 | ? |
| $SrI_2$ | *c* | $18.6 + 0.00304T$ | 273–783 | ? |
| $SrI_2{\cdot}H_2O$ | *c* | 28.5 | 276–363 | ? |
| $SrI_2{\cdot}2H_2O$ | *c* | 39.1 | 275–336 | ? |
| $SrI_2{\cdot}6H_2O$ | *c* | 84.9 | 275–333 | ? |
| $SrMoO_4$ | *c* | 37 | 273–297 | ? |
| $Sr(NO_3)_2$ | *c* | 38.3 | 290–320 | ? |
| $SrSO_4$ | *c* | 26.2 | 293–369 | ? |
| Sulfur[16] | | | | |
| S | *c*, rhombic | $3.63 + 0.00640T$ | 273–368 | 3 |
| | *c*, monoclinic | $4.38 + 0.00440T$ | 368–392 | 3 |
| $S_2$ | *g* | $8.58 + 0.00030T$ | 300–2500 | 5 |
| $S_2Cl_2$ | *l* | 27.5 | 273–332 | ? |
| $SO_2$ | *g* | $7.70 + 0.00530T - 0.00000083T^2$ | 300–2500 | 2½ |
| Tantalum | | | | |
| Ta | *c* | $5.91 + 0.00099T$ | 273–1173 | 2 |
| Tellurium | | | | |
| Te | *c* | $5.19 + 0.00250T$ | 273–600 | 3 |
| Thallium | | | | |
| Tl | *c*, α | $5.32 + 0.00385T$ | 273–500 | 1 |
| | *c*, β | 8.12 | 500–576 | 1 |

**TABLE 2-194 Heat Capacities of the Elements and Inorganic Compounds** (*Concluded*)

| Substance | State† | Heat capacity at constant pressure ($T$ = K; 0°C = 273.1 K), cal/deg mol | Range of temperature, K | Uncertainty, % |
|---|---|---|---|---|
| Thallium—(*Cont.*) | | | | |
| Tl | *l* | 7.12 | 576–773 | 3 |
| TlBr | *c* | 12.53 + 0.00100$T$ | 273–733 | 10 |
| | *l* | 16.0 | 733–800 | 10 |
| TlCl | *c* | 12.56 + 0.00088$T$ | 273–700 | 5 |
| | *l* | 14.2 | 700–803 | 10 |
| Thorium | | | | |
| Th | *c* | 6.40 | 273–373 | ? |
| $ThO_2$ | *c* | 14.6 + 0.00507$T$ | 273–1273 | ? |
| $Th(SO_4)_2$ | *c* | 41.2 | 273–373 | ? |
| Tin[4] | | | | |
| Sn | *c* | 5.05 + 0.00480$T$ | 273–504 | 2 |
| | *l* | 6.6 | 504–1273 | 10 |
| SnAu | *c* | 11.79 + 0.00233$T$ | 273–581 | 1 |
| $SnCl_2$ | *c* | 16.2 + 0.00926$T$ | 273–520 | ? |
| $SnCl_4$ | *l* | 38.4 | 286–371 | ? |
| SnO | *c* | 9.40 + 0.00362$T$ | 273–1273 | ? |
| $SnO_2$ | *c* | 13.94 + 0.00565$T$ – 252000/$T^2$ | 273–1373 | ? |
| SnPt | *c* | 11.49 + 0.00190$T$ | 273–1318 | 1 |
| SnS | *c* | 12.1 + 0.00165$T$ | 273–1153 | ? |
| $SnS_2$ | *c* | 20.5 + 0.00400$T$ | 273–873 | ? |
| Titanium | | | | |
| Ti | *c* | 8.91 + 0.00114$T$ – 433000/$T^2$ | 273–713 | 3 |
| $TiCl_4$ | *l* | 35.7 | 285–372 | ? |
| $TiO_2$ | *c* | 11.81 + 0.00754$T$ – 41900/$T^2$ | 273–713 | 3 |
| Tungsten | | | | |
| W | *c* | 5.65 + 0.00866 | 273–2073 | 1 |
| $WO_3$ | *c* | 16.0 + 0.00774$T$ | 273–1550 | ? |
| Uranium | | | | |
| U | *c* | 6.64 | 273–372 | ? |
| $U_3O_8$ | *c* | 59.8 | 276–314 | ? |
| Vanadium | | | | |
| V | *c* | 5.57 + 0.00097$T$ | 273–1993 | ? |
| Xenon | | | | |
| Xe | *g* | 4.97 | All | 0 |
| Zinc[4] | | | | |
| Zn | *c* | 5.25 + 0.00270$T$ | 273–692 | 1 |
| | *l* | 7.59 + 0.00055$T$ | 692–1122 | 3 |
| $ZnCl_2$ | *c* | 15.9 + 0.00800$T$ | 273–638 | ? |
| ZnO | *c* | 11.40 + 0.00145$T$ – 182400/$T^2$ | 273–1573 | 1 |
| ZnS | *c* | 12.81 + 0.00095$T$ – 194600/$T^2$ | 273–1173 | 5 |
| ZnSb | *c* | 11.5 + 0.00313$T$ | 273–810 | ? |
| $ZnSO_4$ | *c* | 28 | 293–373 | ? |
| $ZnSO_4{\cdot}H_2O$ | *c* | 34.7 | 282 | ? |
| $ZnSO_4{\cdot}6H_2O$ | *c* | 80.8 | 282 | ? |
| $ZnSO_4{\cdot}7H_2O$ | *c* | 100.2 | 273–307 | ? |
| Zirconium | | | | |
| $ZrO_2$ | *c* | 11.62 + 0.01046$T$ – 177700/$T^2$ | 273–1673 | 5 |
| $ZrO_2{\cdot}SiO_2$ | *c* | 26.7 | 297–372 | ? |

[1] See also Table 2-195. Data to 298 K are also given by Scott, *Cryogenic Engineering*, Van Nostrand, Princeton, N.J., 1959.
[2] For liquid and gas data, see Johnson (ed.), WADD-TR-60-56, 1960.
[3] Stalder, NACA Tech. Note 4141, 1957 (Fig. 5), gives data from 400 to 2600°R.
[4] See also Table 2-195.
[5] For data from 400 to 5500°R see Stalder, NACA Tech. Note 4141, 1975 (Fig. 4).
[6] For solid, liquid, and gas data, see Johnson (ed.), WADD-TR-60-56, 1960.
[7] For data from 400 to 2350°R see Stalder, NACA Tech. Note 4141, 1957.
[8] For solid, liquid, and gas data, see Johnson (ed.), WADD-TR-60-56, 1960.
[9] For liquid and gas data, see Johnson (ed.), WADD-TR-60-56, 1960.
[10] For solid, liquid, and gas data, see Johnson (ed.), WADD-TR-60-56, 1960.
[11] See also Table 2-195; Douglas, Ball, et al., *Bur. Stand. J. Res.*, **46** (1951): 334; Busey and Giaque, *J. Am. Chem. Soc.*, **75** (1953): 806; Sheldon, ASME Pap. 49-A-30, 1949.
[12] For solid, liquid, and gas data, see Johnson (ed.), WADD-TR-56-60, 1960.
[13] For solid, liquid, and gas data, see Johnson (ed.), WADD-TR-56-60, 1960.
[14] For solid, liquid, and gas data, see Johnson (ed.), WADD-TR-56-60, 1960. Ozone: For liquid see Brabets and Waterman, *J. Chem. Phys.*, **28** (1958): 1212.
[15] For data on liquid Na-K alloys to 1500°F and for liquid Na to 1460°F, see Lubarsky and Kaufman, NACA Rep. 1270, 1956.
[16] See also Evans and Wagman, *Bur. Stand. J. Res.* **49** (1952): 141; Gratch, OTS PB 124957, 1950; Guthrie, Scott, et al., *J. Am. Chem. Soc.*, **76** (1954): 1488.

**TABLE 2-195 Specific Heat [kJ/(kg·K)] of Selected Elements**

| | Temperature, K | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Symbol | 4 | 6 | 8 | 10 | 20 | 40 | 60 | 80 | 100 | 200 | 250 | 300 | 400 | 600 | 800 |
| Al | 0.00026 | 0.00050 | 0.00088 | 0.00140 | 0.0089 | 0.0775 | 0.214 | 0.357 | 0.481 | 0.797 | 0.859 | 0.902 | 0.949 | 1.042 | 1.134 |
| Be | 0.00008 | | | 0.00028 | 0.0014 | | | | 0.195 | 1.109 | 1.537 | 1.840 | 2.191 | 2.605 | 2.823 |
| Bi | 0.00054 | 0.00220 | 0.00541 | 0.01040 | 0.0340 | 0.0729 | 0.092 | 0.102 | 0.109 | 0.120 | 0.121 | 0.122 | 0.123 | 0.142 | 0.136 |
| Cr | 0.00016 | 0.00029 | 0.00050 | 0.00081 | 0.0021 | 0.0107 | 0.059 | 0.127 | 0.190 | 0.382 | 0.424 | 0.450 | 0.501 | 0.565 | 0.611 |
| Co | 0.00036 | 0.00059 | 0.00085 | 0.00121 | 0.0048 | 0.0404 | 0.110 | 0.184 | 0.234 | 0.376 | 0.406 | 0.426 | 0.451 | 0.509 | 0.543 |
| Cu | 0.00011 | 0.00024 | 0.00048 | 0.00086 | 0.0076 | 0.059 | 0.137 | 0.203 | 0.254 | 0.357 | 0.377 | 0.386 | 0.396 | 0.431 | 0.448 |
| Ge | | | 0.00037 | 0.00081 | 0.0129 | 0.0619 | 0.108 | 0.153 | 0.192 | 0.286 | 0.305 | 0.323 | 0.343 | 0.364 | 0.377 |
| Au | 0.00018 | 0.00047 | 0.00126 | 0.00255 | 0.0163 | 0.0569 | 0.084 | 0.100 | 0.109 | 0.124 | 0.127 | 0.129 | 0.131 | 0.136 | 0.141 |
| Ir | | | | 0.00032 | 0.0021 | | | | 0.090 | 0.122 | 0.128 | 0.131 | 0.133 | 0.140 | 0.146 |
| Fe | 0.00038 | 0.00061 | 0.00090 | 0.00127 | 0.0039 | 0.0276 | 0.086 | 0.154 | 0.216 | 0.384 | 0.422 | 0.450 | 0.491 | 0.555 | 0.692 |
| Pb | 0.00075 | 0.00242 | 0.00747 | 0.01350 | 0.0531 | 0.0944 | 0.108 | 0.114 | 0.118 | 0.125 | 0.127 | 1.129 | 0.132 | 0.142 | |
| Mg | 0.00034 | 0.00080 | 0.00155 | 0.00172 | 0.0148 | 0.138 | 0.336 | 0.513 | 0.648 | 0.929 | 0.985 | 1.005 | 1.082 | 1.177 | 1.263 |
| Hg | 0.00417 | 0.01420 | 0.01820 | 0.02250 | 0.0515 | 0.0895 | 0.107 | 0.116 | 0.121 | 0.136 | 0.141 | 0.139 | 0.136 | 0.135 | 0.104 |
| Mo | 0.00011 | 0.00019 | 0.00032 | 0.00050 | 0.0029 | 0.0236 | 0.061 | 0.105 | 0.140 | 0.223 | 0.241 | 0.248 | 0.261 | 0.280 | 0.292 |
| Ni | 0.00054 | 0.00086 | 0.00121 | 0.00178 | 0.0058 | 0.0380 | 0.103 | 0.173 | 0.232 | 0.383 | 0.416 | 0.444 | 0.490 | 0.590 | 0.530 |
| Pt | 0.00019 | 0.00028 | 0.00067 | 0.00112 | 0.0077 | 0.0382 | 0.069 | 0.088 | 0.101 | 0.127 | 0.132 | 0.134 | 0.136 | 0.140 | 0.146 |
| Ag | 0.00016 | 0.00035 | 0.00093 | 0.00186 | 0.0159 | 0.0778 | 0.133 | 0.166 | 0.187 | 0.225 | 0.232 | 0.236 | 0.240 | 0.251 | 0.264 |
| Sn | 0.00024 | 0.00127 | 0.00423 | 0.00776 | 0.0400 | 0.108 | 0.149 | 0.173 | 0.189 | 0.214 | 0.220 | 0.222 | 0.245 | 0.257 | 0.257 |
| Zn | 0.00011 | 0.00029 | 0.00096 | 0.00250 | 0.0269 | 0.123 | 0.205 | 0.258 | 0.295 | 0.366 | 0.380 | 0.389 | 0.404 | 0.435 | 0.479 |

**TABLE 2-196 Heat Capacities of Inorganic and Organic Liquids**

| Cmpd. no. | Name | Formula | CAS no. | Mol wt | C1 | C2 | C3 | C4 | C5 | $T_{min}$, K | $C_p$ at $T_{min}$ ×1E–05 | $T_{max}$, K | $C_p$ at $T_{max}$ ×1E–05 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Methane (eqn. 2) | $CH_4$ | 74828 | 16.043 | 6.5708E+01 | 3.8883E+04 | –2.5795E+02 | 6.1407E+02 | 0 | 90.69 | 0.5361 | 190 | 14.9780 |
| 2 | Ethane (eqn. 2) | $C_2H_6$ | 74840 | 30.070 | 4.4009E+01 | 8.9718E+04 | 9.1877E+02 | –1.8860E+03 | 0 | 92 | 0.6855 | 290 | 1.2444 |
| 3 | Propane (eqn. 2) | $C_3H_8$ | 74986 | 44.097 | 6.2983E+01 | 1.1363E+05 | 6.3321E+02 | –8.7346E+02 | 0 | 85.47 | 0.8488 | 360 | 2.6079 |
| 4 | *n*-Butane (eqn. 2) | $C_4H_{10}$ | 106978 | 58.123 | 6.4730E+01 | 1.6184E+05 | 9.8341E+02 | –1.4315E+03 | 0 | 134.86 | 1.1380 | 420 | 5.0822 |
| 5 | *n*-Pentane | $C_5H_{12}$ | 109660 | 72.150 | 1.5908E+05 | –2.7050E+02 | 9.9537E–01 | 0 | 0 | 143.42 | 1.4076 | 390 | 2.0498 |
| 6 | *n*-Hexane | $C_6H_{14}$ | 110543 | 86.177 | 1.7212E+05 | –1.8378E+02 | 8.8734E–01 | 0 | 0 | 177.83 | 1.6750 | 460 | 2.7534 |
| 7 | *n*-Heptane (eqn. 2) | $C_7H_{16}$ | 142825 | 100.204 | 6.1260E+01 | 3.1441E+05 | 1.8246E+03 | –2.5479E+03 | 0 | 182.57 | 1.9989 | 520 | 4.0657 |
| 8 | *n*-Octane | $C_8H_{18}$ | 111659 | 114.231 | 2.2483E+05 | –1.8663E+02 | 9.5891E–01 | 0 | 0 | 216.38 | 2.2934 | 460 | 3.4189 |
| 9 | *n*-Nonane | $C_9H_{20}$ | 111842 | 128.258 | 3.8308E+05 | –1.1398E+03 | 2.7101E+00 | 0 | 0 | 219.66 | 2.6348 | 325 | 2.9890 |
| 10 | *n*-Decane | $C_{10}H_{22}$ | 124185 | 142.285 | 2.7862E+05 | –1.9791E+02 | 1.0737E+00 | 0 | 0 | 243.51 | 2.9409 | 460 | 4.1478 |
| 11 | *n*-Undecane | $C_{11}H_{24}$ | 1120214 | 156.312 | 2.9398E+05 | –1.1498E+02 | 9.6936E–01 | 0 | 0 | 247.57 | 3.2493 | 433.42 | 4.2624 |
| 12 | *n*-Dodecane | $C_{12}H_{26}$ | 112403 | 170.338 | 5.0821E+05 | –1.3687E+03 | 3.1015E+00 | 0 | 0 | 263.57 | 3.6292 | 330 | 3.9429 |
| 13 | *n*-Tridecane | $C_{13}H_{28}$ | 629505 | 184.365 | 3.5018E+05 | –1.0470E+02 | 1.0022E+00 | 0 | 0 | 267.76 | 3.9400 | 508.62 | 5.5619 |
| 14 | *n*-Tetradecane | $C_{14}H_{30}$ | 629594 | 198.392 | 3.5314E+05 | 2.9130E+01 | 8.6116E–01 | 0 | 0 | 279.01 | 4.2831 | 526.73 | 6.0741 |
| 15 | *n*-Pentadecane | $C_{15}H_{32}$ | 629629 | 212.419 | 3.4691E+05 | 2.1954E+02 | 6.5632E–01 | 0 | 0 | 283.07 | 4.6165 | 543.84 | 6.6042 |
| 16 | *n*-Hexadecane | $C_{16}H_{34}$ | 544763 | 226.446 | 3.7035E+05 | 2.3147E+02 | 6.8632E–01 | 0 | 0 | 291.31 | 4.9602 | 560.01 | 7.1521 |
| 17 | *n*-Heptadecane | $C_{17}H_{36}$ | 629787 | 240.473 | 3.7697E+05 | 3.4782E+02 | 5.7895E–01 | 0 | 0 | 295.13 | 5.3005 | 575.3 | 7.6869 |
| 18 | *n*-Octadecane | $C_{18}H_{38}$ | 593453 | 254.500 | 3.9943E+05 | 3.7464E+02 | 5.8156E–01 | 0 | 0 | 301.31 | 5.6511 | 589.86 | 8.2276 |
| 19 | *n*-Nonadecane | $C_{19}H_{40}$ | 629925 | 268.527 | 3.4257E+05 | 7.6208E+02 | 2.0481E–01 | 0 | 0 | 305.04 | 5.9409 | 603.05 | 8.7663 |
| 20 | *n*-Eicosane | $C_{20}H_{42}$ | 112958 | 282.553 | 3.5272E+05 | 8.0732E+02 | 2.1220E–01 | 0 | 0 | 309.58 | 6.2299 | 616.93 | 9.3154 |
| 21 | 2-Methylpropane | $C_4H_{10}$ | 75285 | 58.123 | 1.7237E+05 | –1.7839E+03 | 1.4759E+01 | –4.7909E–02 | 5.8050E–05 | 113.54 | 0.9961 | 380 | 2.0725 |
| 22 | 2-Methylbutane | $C_5H_{12}$ | 78784 | 72.150 | 1.0830E+05 | 1.4600E+02 | –2.9200E–01 | 1.5100E–03 | 0 | 113.25 | 1.2328 | 310 | 1.7048 |
| 23 | 2,3-Dimethylbutane | $C_6H_{14}$ | 79298 | 86.177 | 1.2945E+05 | 1.8500E+01 | 6.0800E–01 | 0 | 0 | 145.19 | 1.4495 | 331.13 | 2.0224 |
| 24 | 2-Methylpentane | $C_6H_{14}$ | 107835 | 86.177 | 1.4222E+05 | –4.7830E+01 | 7.3900E–01 | 0 | 0 | 119.55 | 1.4706 | 333.41 | 2.0842 |
| 25 | 2,3-Dimethylpentane[1] | $C_7H_{16}$ | 565593 | 100.204 | 1.4642E+05 | 5.9200E+01 | 6.0400E–01 | 0 | 0 | 90 | 1.5664 | 380 | 2.5613 |
| 26 | 2,3,3-Trimethylpentane | $C_8H_{18}$ | 560214 | 114.231 | 3.8862E+05 | –1.4395E+03 | 3.2187E+00 | 0 | 0 | 280 | 2.3791 | 320 | 2.5757 |
| 27 | 2,2,4-Trimethylpentane | $C_8H_{18}$ | 540841 | 114.231 | 9.5275E+04 | 6.9670E+02 | –1.3765E+00 | 2.1734E–03 | 0 | 165.78 | 1.8285 | 520 | 3.9095 |
| 28 | Ethylene | $C_2H_4$ | 74851 | 28.054 | 2.4739E+05 | –4.4280E+03 | 4.0936E+01 | –1.6970E–01 | 2.6816E–04 | 103.97 | 0.7013 | 252.7 | 0.9758 |
| 29 | Propylene | $C_3H_6$ | 115071 | 42.081 | 1.1720E+05 | –3.8632E+02 | 1.2348E+00 | 0 | 0 | 87.89 | 0.9279 | 298.15 | 1.1178 |
| 30 | 1-Butene | $C_4H_8$ | 106989 | 56.108 | 1.3589E+05 | –4.7739E+02 | 2.1835E+00 | –2.2230E–03 | 0 | 87.8 | 1.0930 | 300 | 1.2917 |
| 31 | *cis*-2-Butene | $C_4H_8$ | 590181 | 56.108 | 1.2668E+05 | –6.5470E+01 | –6.4000E–01 | 2.9120E–03 | 0 | 134.26 | 1.1340 | 350 | 1.5022 |
| 32 | *trans*-2-Butene | $C_4H_8$ | 624646 | 56.108 | 1.1276E+05 | –1.0470E+02 | 5.2140E–01 | 0 | 0 | 167.62 | 1.0986 | 274.03 | 1.2322 |
| 33 | 1-Pentene | $C_5H_{10}$ | 109671 | 70.134 | 1.5467E+05 | –4.2600E+02 | 1.9640E+00 | –1.8038E–03 | 0 | 107.93 | 1.2930 | 310 | 1.5761 |
| 34 | 1-Hexene | $C_6H_{12}$ | 592416 | 84.161 | 1.9263E+05 | –5.7116E+02 | 2.4004E+00 | –1.9758E–03 | 0 | 133.39 | 1.5446 | 336.63 | 1.9700 |
| 35 | 1-Heptene | $C_7H_{14}$ | 592767 | 98.188 | 1.8997E+05 | –1.5670E+02 | 3.4300E–01 | 1.5222E–03 | 0 | 154.27 | 1.7955 | 330 | 2.3032 |
| 36 | 1-Octene | $C_8H_{16}$ | 111660 | 112.215 | 3.7930E+05 | –2.1175E+03 | 8.2362E+00 | –9.0093E–03 | 0 | 171.45 | 2.1295 | 315 | 2.4793 |
| 37 | 1-Nonene | $C_9H_{18}$ | 124118 | 126.242 | 2.5875E+05 | –3.5450E+02 | 1.3126E+00 | 0 | 0 | 191.78 | 2.3904 | 420.02 | 3.4142 |
| 38 | 1-Decene | $C_{10}H_{20}$ | 872059 | 140.269 | 3.1950E+05 | –5.7621E+02 | 1.7087E+00 | 0 | 0 | 206.89 | 2.7343 | 443.75 | 4.0027 |
| 39 | 2-Methylpropene | $C_4H_8$ | 115117 | 56.108 | 8.7680E+04 | 2.1710E+02 | –9.1530E–01 | 2.2660E–03 | 0 | 132.81 | 1.0568 | 343.15 | 1.4596 |
| 40 | 2-Methyl-1-butene[2] | $C_5H_{10}$ | 563462 | 70.134 | 1.4951E+05 | –2.4763E+02 | 9.1849E–01 | 0 | 0 | 135.58 | 1.3282 | 304.31 | 1.5921 |
| 41 | 2-Methyl-2-butene[2] | $C_5H_{10}$ | 513359 | 70.134 | 1.5160E+05 | –2.6672E+02 | 9.0847E–01 | 0 | 0 | 139.39 | 1.3207 | 311.71 | 1.5673 |
| 42 | 1,2-Butadiene | $C_4H_6$ | 590192 | 54.092 | 1.3515E+05 | –3.1114E+02 | 9.7007E–01 | –1.5230E–04 | 0 | 136.95 | 1.1034 | 290 | 1.2279 |
| 43 | 1,3-Butadiene | $C_4H_6$ | 106990 | 54.092 | 1.2886E+05 | –3.2310E+02 | 1.0150E+00 | 3.2000E–05 | 0 | 165 | 1.0333 | 350 | 1.4148 |
| 44 | 2-Methyl-1,3-butadiene | $C_5H_8$ | 78795 | 68.119 | 1.4148E+05 | –2.8870E+02 | 1.0910E+00 | 0 | 0 | 130.32 | 1.2239 | 307.2 | 1.5575 |
| 45 | Acetylene | $C_2H_2$ | 74862 | 26.038 | 2.0011E+05 | –1.1988E+03 | 3.0027E+00 | 0 | 0 | 192.4 | 0.8061 | 250 | 0.8808 |
| 46 | Methylacetylene | $C_3H_4$ | 74997 | 40.065 | 7.9791E+04 | 8.9490E+01 | 0 | 0 | 0 | 200 | 0.9769 | 249.94 | 1.0216 |
| 47 | Dimethylacetylene | $C_4H_6$ | 503173 | 54.092 | 8.8153E+04 | 1.2416E+02 | 0 | 0 | 0 | 240.91 | 1.1806 | 300.13 | 1.2542 |
| 48 | 3-Methyl-1-butyne | $C_5H_8$ | 598232 | 68.119 | 1.0520E+05 | 1.9110E+02 | 0 | 0 | 0 | 200 | 1.4342 | 299.49 | 1.6243 |
| 49 | 1-Pentyne | $C_5H_8$ | 627190 | 68.119 | 8.6200E+04 | 2.5660E+02 | 0 | 0 | 0 | 200 | 1.3752 | 313.33 | 1.6660 |
| 50 | 2-Pentyne | $C_5H_8$ | 627214 | 68.119 | 6.8671E+04 | 2.4666E+02 | 0 | 0 | 0 | 200 | 1.1800 | 329.27 | 1.4989 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 51 | 1-Hexyne | $C_6H_{10}$ | 693027 | 82.145 | 9.3000E+04 | 3.2600E+02 | 0 | 0 | 0 | 200 | 1.5820 | 344.48 | 2.0530 |
| 52 | 2-Hexyne | $C_6H_{10}$ | 764352 | 82.145 | 9.4860E+04 | 2.5415E+02 | 0 | 0 | 0 | 300 | 1.7110 | 357.67 | 1.8576 |
| 53 | 3-Hexyne | $C_6H_{10}$ | 928494 | 82.145 | 8.2795E+04 | 2.8340E+02 | 0 | 0 | 0 | 300 | 1.6781 | 354.35 | 1.8322 |
| 54 | 1-Heptyne | $C_7H_{12}$ | 628717 | 96.172 | 8.5122E+04 | 4.0247E+02 | 0 | 0 | 0 | 192.22 | 1.6248 | 372.93 | 2.3522 |
| 55 | 1-Octyne | $C_8H_{14}$ | 629050 | 110.199 | 9.1748E+04 | 4.7140E+02 | 0 | 0 | 0 | 193.55 | 1.8299 | 399.35 | 2.8000 |
| 56 | Vinylacetylene[3] | $C_4H_4$ | 689974 | 52.076 | 6.8720E+04 | 1.3500E+02 | 0 | 0 | 0 | 200 | 0.9572 | 278.25 | 1.0628 |
| 57 | Cyclopentane | $C_5H_{10}$ | 287923 | 70.134 | 1.2253E+05 | −4.0380E+02 | 1.7344E+00 | −1.0975E−03 | 0 | 179.28 | 0.9956 | 322.4 | 1.3584 |
| 58 | Methylcyclopentane | $C_6H_{12}$ | 96377 | 84.161 | 1.5592E+05 | −4.9000E+02 | 2.1383E+00 | −1.5585E−03 | 0 | 130.73 | 1.2492 | 366.48 | 1.8682 |
| 59 | Ethylcyclopentane | $C_7H_{14}$ | 1640897 | 98.188 | 1.7852E+05 | −5.1835E+02 | 2.3255E+00 | −1.6818E−03 | 0 | 134.71 | 1.4678 | 301.82 | 1.8767 |
| 60 | Cyclohexane | $C_6H_{12}$ | 110827 | 84.161 | −2.2060E+05 | 3.1183E+03 | −9.4216E+00 | 1.0687E−02 | 0 | 279.69 | 1.4836 | 400 | 2.0323 |
| 61 | Methylcyclohexane | $C_7H_{14}$ | 108872 | 98.188 | 1.3134E+05 | −6.3100E+01 | 8.1250E−01 | 0 | 0 | 146.58 | 1.3955 | 320 | 1.9435 |
| 62 | 1,1-Dimethylcyclohexane | $C_8H_{16}$ | 590669 | 112.215 | 1.3450E+05 | 8.7650E+00 | 8.1151E−01 | 0 | 0 | 239.66 | 1.8321 | 392.7 | 2.6309 |
| 63 | Ethylcyclohexane | $C_8H_{16}$ | 1678917 | 112.215 | 1.3236E+05 | 7.2740E+01 | 6.4738E−01 | 0 | 0 | 161.84 | 1.6109 | 404.95 | 2.6798 |
| 64 | Cyclopentene | $C_5H_8$ | 142290 | 68.119 | 1.2538E+05 | −3.4970E+02 | 1.1430E+00 | 0 | 0 | 138.13 | 0.9888 | 317.38 | 1.2953 |
| 65 | 1-Methylcyclopentene | $C_6H_{10}$ | 693890 | 82.145 | 5.3271E+04 | 3.2792E+02 | 0 | 0 | 0 | 200 | 1.1885 | 348.64 | 1.6760 |
| 66 | Cyclohexene | $C_6H_{10}$ | 110838 | 82.145 | 1.0585E+05 | −6.0000E+01 | 6.8000E−01 | 0 | 0 | 169.67 | 1.1525 | 356.12 | 1.7072 |
| 67 | Benzene | $C_6H_6$ | 71432 | 78.114 | 1.2944E+05 | −1.6950E+02 | 6.4781E−01 | 0 | 0 | 278.68 | 1.3251 | 353.24 | 1.5040 |
| 68 | Toluene | $C_7H_8$ | 108883 | 92.141 | 1.4014E+05 | −1.5230E+02 | 6.9500E−01 | 0 | 0 | 178.18 | 1.3507 | 500 | 2.3774 |
| 69 | *o*-Xylene | $C_8H_{10}$ | 95476 | 106.167 | 3.6500E+04 | 1.0175E+03 | −2.6300E+00 | 3.0200E−03 | 0 | 248 | 1.7315 | 415 | 2.2166 |
| 70 | *m*-Xylene | $C_8H_{10}$ | 108383 | 106.167 | 1.7555E+05 | −2.9950E+02 | 1.0880E+00 | 0 | 0 | 225.3 | 1.6330 | 360 | 2.0873 |
| 71 | *p*-Xylene | $C_8H_{10}$ | 106423 | 106.167 | −3.5500E+04 | 1.2872E+03 | −2.5990E+00 | 2.4260E−03 | 0 | 286.41 | 1.7697 | 600 | 3.2520 |
| 72 | Ethylbenzene | $C_8H_{10}$ | 100414 | 106.167 | 1.3316E+05 | 4.4507E+01 | 3.9645E−01 | 0 | 0 | 178.15 | 1.5367 | 409.35 | 2.1781 |
| 73 | Propylbenzene | $C_9H_{12}$ | 103651 | 120.194 | 2.3477E+05 | −8.0022E+02 | 3.4037 | −3.1739E−03 | 0 | 173.59 | 1.8182 | 370 | 2.4389 |
| 74 | 1,2,4-Trimethylbenzene | $C_9H_{12}$ | 95636 | 120.194 | 1.7880E+05 | −1.2847E+02 | 8.3741E−01 | 0 | 0 | 229.33 | 1.9338 | 350 | 2.3642 |
| 75 | Isopropylbenzene | $C_9H_{12}$ | 98828 | 120.194 | 1.8290E+05 | −1.7400E+02 | 9.1200E−01 | 0 | 0 | 177.14 | 1.8069 | 500 | 3.2390 |
| 76 | 1,3,5-Trimethylbenzene | $C_9H_{12}$ | 108678 | 120.194 | 1.4805E+05 | 1.9700E+01 | 6.2260E−01 | 0 | 0 | 228.42 | 1.8503 | 350 | 2.3121 |
| 77 | *p*-Isopropyltoluene | $C_{10}H_{14}$ | 99876 | 134.221 | 1.4560E+05 | 2.4870E+02 | 1.8700E−01 | 0 | 0 | 205.25 | 2.0452 | 450.28 | 2.9550 |
| 78 | Naphthalene | $C_{10}H_8$ | 91203 | 128.174 | 2.9800E+04 | 5.2750E+02 | 0 | 0 | 0 | 353.43 | 2.1623 | 491.14 | 2.8888 |
| 79 | Biphenyl | $C_{12}H_{10}$ | 92524 | 154.211 | 1.2177E+05 | 4.2930E+02 | 0 | 0 | 0 | 342.2 | 2.6868 | 533.37 | 3.5075 |
| 80 | Styrene | $C_8H_8$ | 100425 | 104.152 | 1.1334E+05 | 2.9020E+02 | −6.0510E−01 | 1.3567E−03 | 0 | 242.54 | 1.6749 | 418.31 | 2.2816 |
| 81 | *m*-Terphenyl | $C_{18}H_{14}$ | 92068 | 230.309 | 1.9567E+05 | 5.9407E+02 | 0 | 0 | 0 | 360 | 4.0954 | 650 | 5.8182 |
| 82 | Methanol | $CH_4O$ | 67561 | 32.042 | 1.0580E+05 | −3.6223E+02 | 9.3790E−01 | 0 | 0 | 175.47 | 0.7112 | 400 | 1.1097 |
| 83 | Ethanol | $C_2H_6O$ | 64175 | 46.069 | 1.0264E+05 | −1.3963E+02 | −3.0341E−02 | 2.0386E−03 | 0 | 159.05 | 0.8787 | 390 | 1.6450 |
| 84 | 1-Propanol | $C_3H_8O$ | 71238 | 60.096 | 1.5876E+05 | −6,3500E+02 | 1.9690E+00 | 0 | 0 | 146.95 | 1.0797 | 400 | 2.1980 |
| 85 | 1-Butanol | $C_4H_{10}O$ | 71363 | 74.123 | 1.9120E+05 | −7.3040E+02 | 2.2998E+00 | 0 | 0 | 184.51 | 1.3473 | 390.81 | 2.5701 |
| 86 | 2-Butanol | $C_4H_{10}O$ | 78922 | 74.123 | 2.0670E+05 | −1.0204E+03 | 3.2900E+00 | 0 | 0 | 158.45 | 1.2762 | 372.7 | 2.8340 |
| 87 | 2-Propanol | $C_3H_8O$ | 67630 | 60.096 | 7.2355E+05 | −8.0950E+03 | 3.6662E+01 | −6.6395E−02 | 4.4064E−05 | 185.28 | 1.1189 | 480 | 2.8122 |
| 88 | 2-Methyl-2-propanol | $C_4H_{10}O$ | 75650 | 74.123 | −9.2546E+05 | 7.8949E+03 | −1.7661E+01 | 1.3617E−02 | 0 | 298.96 | 2.2016 | 460 | 2.9455 |
| 89 | 1-Pentanol | $C_5H_{12}O$ | 71410 | 88.150 | 2.0120E+05 | −6.5130E+02 | 2.2750E+00 | 0 | 0 | 200.14 | 1.6198 | 389.15 | 2.9227 |
| 90 | 2-Methyl-1-butanol | $C_5H_{12}O$ | 137326 | 88.150 | 8.2937E+04 | 4.5998E+02 | 0.0000E+00 | 0 | 0 | 250 | 1.9793 | 401.85 | 2.6778 |
| 91 | 3-Methyl-1-butanol | $C_5H_{12}O$ | 123513 | 88.150 | −5.3777E+04 | 8.8342E+02 | 0 | 0 | 0 | 295.52 | 2.0729 | 350 | 2.5542 |
| 92 | 1-Hexanol | $C_6H_{14}O$ | 111273 | 102.177 | 4.8466E+05 | −2.7613E+03 | 6.5555E+00 | 0 | 0 | 228.55 | 1.9599 | 320 | 2.7233 |
| 93 | 1-Heptanol | $C_7H_{16}O$ | 111706 | 116.203 | 4.3790E+05 | −2.0947E+03 | 5.2090E+00 | 0 | 0 | 239.15 | 2.3487 | 370 | 3.7597 |
| 94 | Cyclohexanol | $C_6H_{12}O$ | 108930 | 100.161 | −4.0000E+04 | 8.5300E+02 | 0 | 0 | 0 | 296.6 | 2.1300 | 434 | 3.3020 |
| 95 | Ethylene glycol | $C_2H_6O_2$ | 107211 | 62.068 | 3.5540E+04 | 4.3678E+02 | −1.8486E−01 | 0 | 0 | 260.15 | 1.3666 | 493.15 | 2.0598 |
| 96 | 1,2-Propylene glycol | $C_3H_8O_2$ | 57556 | 76.095 | 5.8080E+04 | 4.4520E+02 | 0 | 0 | 0 | 213.15 | 1.5297 | 460.75 | 2.6321 |
| 97 | Phenol | $C_6H_6O$ | 108952 | 94.113 | 1.0172E+05 | 3.1761E+02 | 0 | 0 | 0 | 314.06 | 2.0147 | 425 | 2.3670 |
| 98 | *o*-Cresol | $C_7H_8O$ | 95487 | 108.140 | −1.8515E+05 | 3.1480E+03 | −8.0367E+00 | 7.2540E−03 | 0 | 304.2 | 2.3297 | 400 | 2.5243 |
| 99 | *m*-Cresol | $C_7H_8O$ | 108394 | 108.140 | −2.4670E+05 | 3.2568E+03 | −7.4202E+00 | 6.0467E−03 | 0 | 285.39 | 2.1895 | 400 | 2.5578 |
| 100 | *p*-Cresol | $C_7H_8O$ | 106445 | 108.140 | 2.5998E+05 | −1.1123E+03 | 4.9427E+00 | −5.4367E−03 | 0 | 307.93 | 2.2740 | 400 | 2.5794 |

**TABLE 2-196 Heat Capacities of Inorganic and Organic Liquids** (*Continued*)

| Cmpd. no. | Name | Formula | CAS no. | Mol wt | C1 | C2 | C3 | C4 | C5 | $T_{min}$, K | $C_p$ at $T_{min}$ ×1E–05 | $T_{max}$, K | $C_p$ at $T_{max}$ ×1E–05 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 101 | Dimethyl ether | $C_2H_6O$ | 115106 | 46.069 | 1.1010E+05 | –1.5747E+02 | 5.1853E–01 | 0 | 0 | 131.65 | 0.9836 | 250 | 1.0314 |
| 102 | Methyl ethyl ether | $C_3H_8O$ | 540670 | 60.096 | 1.2977E+05 | –3.3196E+02 | 1.3869E+00 | 0 | 0 | 218.9 | 1.2356 | 328.35 | 1.7030 |
| 103 | Methyl-*n*-propyl ether | $C_4H_{10}O$ | 557175 | 74.123 | 1.4411E+05 | –1.0209E+02 | 5.8113E–01 | 0 | 0 | 133.97 | 1.4086 | 312.2 | 1.6888 |
| 104 | Methyl isopropyl ether | $C_4H_{10}O$ | 598538 | 74.123 | 1.4344E+05 | –1.5407E+02 | 7.2550E–01 | 0 | 0 | 127.93 | 1.3560 | 310 | 1.6540 |
| 105 | Methyl-*n*-butyl ether | $C_5H_{12}O$ | 628284 | 88.150 | 1.7785E+05 | –1.7157E+02 | 7.4379E–01 | 0 | 0 | 157.48 | 1.6928 | 343.35 | 2.0663 |
| 106 | Methyl isobutyl ether | $C_5H_{12}O$ | 625445 | 88.150 | 5.1380E+04 | 4.5040E+02 | 0 | 0 | 0 | 300 | 1.8650 | 370 | 2.1803 |
| 107 | Methyl tert-butyl ether | $C_5H_{12}O$ | 1634044 | 88.150 | 1.4012E+05 | –9.0000E+00 | 5.6300E–01 | 0 | 0 | 164.55 | 1.5388 | 328.35 | 1.9786 |
| 108 | Diethyl ether | $C_4H_{10}O$ | 60297 | 74.123 | 4.4400E+04 | 1.3010E+03 | –5.5000E+00 | 8.7630E–03 | 0 | 156.92 | 1.4698 | 460 | 3.3202 |
| 109 | Ethyl propyl ether | $C_5H_{12}O$ | 628320 | 88.150 | 1.0368E+05 | 7.2630E+02 | –2.6047E+00 | 4.0957E–03 | 0 | 145.65 | 1.6686 | 320 | 2.0358 |
| 110 | Ethyl isopropyl ether | $C_5H_{12}O$ | 625547 | 88.150 | 1.0625E+05 | 2.9215E+02 | 0 | 0 | 0 | 298.15 | 1.9335 | 326.15 | 2.0153 |
| 111 | Methyl phenyl ether | $C_7H_8O$ | 100663 | 108.140 | 1.5094E+05 | 9.3455E+01 | 2.3602E–01 | 0 | 0 | 298.15 | 1.9978 | 484.2 | 2.5153 |
| 112 | Diphenyl ether | $C_{12}H_{10}O$ | 101848 | 170.211 | 1.3416E+05 | 4.4767E+02 | 0 | 0 | 0 | 300.03 | 2.6847 | 570 | 3.8933 |
| 113 | Formaldehyde[4] | $CH_2O$ | 50000 | 30.026 | 6.1900E+04 | 2.8300E+01 | 0 | 0 | 0 | 204 | 0.6767 | 234 | 0.6852 |
| 114 | Acetaldehyde | $C_2H_4O$ | 75070 | 44.053 | 1.1510E+05 | –4.3300E+02 | 1.4250E+00 | 0 | 0 | 150.15 | 0.8221 | 294 | 1.1097 |
| 115 | 1-Propanal | $C_3H_6O$ | 123386 | 58.080 | 9.9306E+04 | 1.1573E+02 | 0 | 0 | 0 | 200 | 1.2245 | 328.75 | 1.3735 |
| 116 | 1-Butanal | $C_4H_8O$ | 123728 | 72.107 | 6.5682E+04 | 1.3291E+03 | –7.1579E+00 | 1.2755E–02 | 0 | 176.75 | 1.4741 | 300 | 1.6459 |
| 117 | 1-Pentanal | $C_5H_{10}O$ | 110623 | 86.134 | 1.1205E+05 | 2.5778E+02 | 0 | 0 | 0 | 200 | 1.6361 | 376.15 | 2.0901 |
| 118 | 1-Hexanal | $C_6H_{12}O$ | 66251 | 100.161 | 1.1770E+05 | 3.2952E+02 | 0 | 0 | 0 | 217.15 | 1.8926 | 401.45 | 2.4999 |
| 119 | 1-Heptanal | $C_7H_{14}O$ | 111717 | 114.188 | 2.2236E+05 | –1.0517E+02 | 6.5074E–01 | 0 | 0 | 229.8 | 2.3256 | 381.25 | 2.7685 |
| 120 | 1-Octanal | $C_8H_{16}O$ | 124130 | 128.214 | 1.3065E+05 | 4.6361E+02 | 0 | 0 | 0 | 246 | 2.4470 | 447.15 | 3.3795 |
| 121 | 1-Nonanal | $C_9H_{18}O$ | 124196 | 142.241 | 1.3682E+05 | 5.3129E+02 | 0 | 0 | 0 | 255.15 | 2.7238 | 468.15 | 3.8554 |
| 122 | 1-Decanal | $C_{10}H_{20}O$ | 112312 | 156.268 | 1.5046E+05 | 5.8663E+02 | 0 | 0 | 0 | 267.15 | 3.0718 | 488.15 | 4.3682 |
| 123 | Acetone | $C_3H_6O$ | 67641 | 58.080 | 1.3560E+05 | –1.7700E+02 | 2.8370E–01 | 6.8900E–04 | 0 | 178.45 | 1.1696 | 329.44 | 1.3271 |
| 124 | Methyl ethyl ketone | $C_4H_8O$ | 78933 | 72.107 | 1.3230E+05 | 2.0087E+02 | –9.5970E–01 | 1.9533E–03 | 0 | 186.48 | 1.4905 | 373.15 | 1.7511 |
| 125 | 2-Pentanone | $C_5H_{10}O$ | 107879 | 86.134 | 1.9459E+05 | –2.6386E+02 | 7.6808E–01 | 0 | 0 | 196.29 | 1.7239 | 375.46 | 2.0380 |
| 126 | Methyl isopropyl ketone | $C_5H_{10}O$ | 563804 | 86.134 | 1.8361E+05 | –2.6885E+02 | 8.6080E–01 | 0 | 0 | 181.15 | 1.6316 | 367.55 | 2.0108 |
| 127 | 2-Hexanone | $C_6H_{12}O$ | 591786 | 100.161 | 2.7249E+05 | –7.9070E+02 | 2.5834E+00 | –2.0040E–03 | 0 | 220.87 | 2.0228 | 382.62 | 2.3590 |
| 128 | Methyl isobutyl ketone | $C_6H_{12}O$ | 108101 | 100.161 | 1.2492E+05 | 3.0410E+02 | 0 | 0 | 0 | 298.15 | 2.1559 | 390 | 2.4352 |
| 129 | 3-Methyl-2-pentanone | $C_6H_{12}O$ | 565617 | 100.161 | 9.9815E+04 | 3.4672E+02 | 0 | 0 | 0 | 298.15 | 2.0319 | 390.55 | 2.3523 |
| 130 | 3-Pentanone | $C_5H_{10}O$ | 96220 | 86.134 | 1.9302E+05 | –1.7643E+02 | 5.6690E–01 | 0 | 0 | 234.18 | 1.8279 | 375.14 | 2.0661 |
| 131 | Ethyl isopropyl ketone | $C_6H_{12}O$ | 565695 | 100.161 | 8.3630E+04 | 3.9900E+02 | 0 | 0 | 0 | 298.15 | 2.0259 | 425 | 2.5320 |
| 132 | Diisopropyl ketone | $C_7H_{14}O$ | 565800 | 114.188 | 1.7927E+05 | 2.8370E+01 | 5.3750E–01 | 0 | 0 | 204.81 | 2.0763 | 410 | 2.8126 |
| 133 | Cyclohexanone | $C_6H_{10}O$ | 108941 | 98.145 | 1.0980E+05 | 2.6150E+02 | 0 | 0 | 0 | 290 | 1.8563 | 486.5 | 2.3702 |
| 134 | Methyl phenyl ketone | $C_8H_8O$ | 98862 | 120.151 | 7.2692E+04 | 3.3783E+02 | 3.5572E–01 | 0 | 0 | 298.2 | 2.0506 | 532.12 | 3.5318 |
| 135 | Formic acid | $CH_2O_2$ | 64186 | 46.026 | 7.8060E+04 | 7.1540E+01 | 0 | 0 | 0 | 281.45 | 0.9820 | 380 | 1.0525 |
| 136 | Acetic acid | $C_2H_4O_2$ | 64197 | 60.053 | 1.3964E+05 | –3.2080E+02 | 8.9850E–01 | 0 | 0 | 289.81 | 1.2213 | 391.05 | 1.5159 |
| 137 | Propionic acid | $C_3H_6O_2$ | 79094 | 74.079 | 2.1366E+05 | –7.0270E+02 | 1.6605E+00 | 0 | 0 | 252.45 | 1.4209 | 414.32 | 2.0756 |
| 138 | *n*-Butyric acid | $C_4H_8O_2$ | 107926 | 88.106 | 2.3770E+05 | –7.4640E+02 | 1.8290E+00 | 0 | 0 | 267.95 | 1.6902 | 436.42 | 2.6031 |
| 139 | Isobutyric acid | $C_4H_8O_2$ | 79312 | 88.106 | 1.2754E+05 | –6.5350E+01 | 8.2867E–01 | 0 | 0 | 270 | 1.7031 | 427.65 | 2.5114 |
| 140 | Benzoic acid | $C_7H_6O_2$ | 65850 | 122.123 | –5.4800E+03 | 6.4712E+02 | 0 | 0 | 0 | 395.45 | 2.5042 | 450 | 2.8572 |
| 141 | Acetic anhydride | $C_4H_6O_3$ | 108247 | 102.090 | 3.6600E+04 | 5.1100E+02 | 0 | 0 | 0 | 250 | 1.6435 | 350 | 2.1545 |
| 142 | Methyl formate | $C_2H_4O_2$ | 107313 | 60.053 | 1.3020E+05 | –3.9600E+02 | 1.2100E+00 | 0 | 0 | 174.15 | | 304.9 | 1.2195 |
| 143 | Methyl acetate | $C_3H_6O_2$ | 79209 | 74.079 | 6.1260E+04 | 2.7090E+02 | 0 | 0 | 0 | 253.4 | 1.2991 | 373.4 | 1.6241 |
| 144 | Methyl propionate | $C_4H_8O_2$ | 554121 | 88.106 | 7.1140E+04 | 3.3550E+02 | 0 | 0 | 0 | 300 | 1.7179 | 390 | 2.0198 |
| 145 | Methyl-*n*-butyrate | $C_5H_{10}O_2$ | 623427 | 102.133 | 1.0293E+05 | 1.2910E+02 | 6.2516E–01 | 0 | 0 | 277.25 | 1.8678 | 415.87 | 2.6474 |
| 146 | Ethyl formate | $C_3H_6O_2$ | 109944 | 74.079 | 8.0000E+04 | 2.2360E+02 | 0 | 0 | 0 | 254.2 | 1.3684 | 374.2 | 1.6367 |
| 147 | Ethyl acetate | $C_4H_8O_2$ | 141786 | 88.106 | 2.2623E+05 | –6.2480E+02 | 1.4720E+00 | 0 | 0 | 189.6 | 1.6068 | 350.21 | 1.8796 |
| 148 | Ethyl propionate | $C_5H_{10}O_2$ | 105373 | 102.133 | 7.6330E+04 | 4.0010E+02 | 0 | 0 | 0 | 298.15 | 1.9562 | 410 | 2.4037 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 149 | Ethyl-*n*-butyrate | $C_6H_{12}O_2$ | 105544 | 116.160 | 8.2434E+04 | 4.2245E+02 | 2.0992E–01 | 0 | 0 | 285.5 | 2.2015 | 428.25 | 3.0185 |
| 150 | *n*-Propyl formate | $C_4H_8O_2$ | 110747 | 88.106 | 7.5700E+04 | 3.2610E+02 | 0 | 0 | 0 | 298.15 | 1.7293 | 398.15 | 2.0554 |
| 151 | *n*-Propyl acetate | $C_5H_{10}O_2$ | 109604 | 102.133 | 8.3400E+04 | 3.8410E+02 | 0 | 0 | 0 | 274.7 | 1.8891 | 404.7 | 2.3885 |
| 152 | *n*-Butyl acetate | $C_6H_{12}O_2$ | 123864 | 116.160 | 1.1730E+05 | 3.5220E+02 | 0 | 0 | 0 | 289.58 | 2.1929 | 429.58 | 2.6860 |
| 153 | Methyl benzoate | $C_8H_8O_2$ | 93583 | 136.150 | 1.1950E+05 | 2.9400E+02 | 0 | 0 | 0 | 260.75 | 1.9616 | 472.65 | 2.5846 |
| 154 | Ethyl benzoate | $C_9H_{10}O_2$ | 93890 | 150.177 | 1.2450E+05 | 3.7060E+02 | 0 | 0 | 0 | 238.45 | 2.1287 | 486.55 | 3.0482 |
| 155 | Vinyl acetate | $C_4H_6O_2$ | 108054 | 86.090 | 1.3630E+05 | –1.0617E+02 | 7.5175E–01 | 0 | 0 | 259.56 | 1.5939 | 389.35 | 2.0892 |
| 156 | Methylamine | $CH_5N$ | 74895 | 31.057 | 9.2520E+04 | 3.7450E+01 | 0 | 0 | 0 | 179.69 | 0.9925 | 266.82 | 1.0251 |
| 157 | Dimethylamine | $C_2H_7N$ | 124403 | 45.084 | –2.1487E+05 | 3.7872E+03 | –1.3781E+01 | 1.6924E–02 | 0 | 180.96 | 1.1947 | 298.15 | 1.3779 |
| 158 | Trimethylamine | $C_3H_9N$ | 75503 | 59.111 | 1.3605E+05 | –2.8800E+02 | 9.9130E–01 | 0 | 0 | 156.08 | 1.1525 | 276.02 | 1.3208 |
| 159 | Ethylamine | $C_2H_7N$ | 75047 | 45.084 | 1.2170E+05 | 3.8993E+01 | 0 | 0 | 0 | 192.15 | 1.2919 | 289.73 | 1.3300 |
| 160 | Diethylamine | $C_4H_{11}N$ | 109897 | 73.138 | 1.0133E+05 | 2.4318E+02 | 0 | 0 | 0 | 223.35 | 1.5564 | 328.6 | 1.8124 |
| 161 | Triethylamine | $C_6H_{15}N$ | 121448 | 101.192 | 1.1148E+05 | 3.6813E+02 | 0 | 0 | 0 | 200 | 1.8511 | 361.92 | 2.4471 |
| 162 | *n*-Propylamine | $C_3H_9N$ | 107108 | 59.111 | 1.3953E+05 | 7.8000E+01 | 0 | 0 | 0 | 188.36 | 1.5422 | 340 | 1.6605 |
| 163 | di-*n*-Propylamine | $C_6H_{15}N$ | 142847 | 101.192 | 4.9120E+04 | 5.6224E+02 | 0 | 0 | 0 | 277.9 | 2.0537 | 407.9 | 2.7846 |
| 164 | Isopropylamine | $C_3H_9N$ | 75310 | 59.111 | –3.2469E+04 | 1.9771E+03 | –7.0145E+00 | 8.6913E–03 | 0 | 177.95 | 1.4621 | 320 | 1.6671 |
| 165 | Diisopropylamine | $C_6H_{15}N$ | 108189 | 101.192 | 9.8434E+04 | 4.2904E+02 | 0 | 0 | 0 | 275 | 2.1642 | 357.05 | 2.5162 |
| 166 | Aniline | $C_6H_7N$ | 62533 | 93.128 | 1.4150E+05 | 1.7120E+02 | 0 | 0 | 0 | 267.13 | 1.8723 | 457.15 | 2.1976 |
| 167 | *N*-Methylaniline | $C_7H_9N$ | 100618 | 107.155 | 1.2850E+05 | 1.0020E+02 | 3.7400E–01 | 0 | 0 | 216.15 | 1.6763 | 469.02 | 2.5777 |
| 168 | *N,N*-Dimethylaniline | $C_8H_{11}N$ | 121697 | 121.182 | 4.1860E+04 | 5.2750E+02 | 0 | 0 | 0 | 343.58 | 2.2310 | 513.58 | 3.1277 |
| 169 | Ethylene oxide | $C_2H_4O$ | 75218 | 44.053 | 1.4471E+05 | –7.5887E+02 | 2.8261E+00 | –3.0640E–03 | 0 | 160.65 | 0.8303 | 283.85 | 0.8693 |
| 170 | Furan | $C_4H_4O$ | 110009 | 68.075 | 1.1437E+05 | –2.1569E+02 | 7.2691E–01 | 0 | 0 | 187.55 | 0.9949 | 304.5 | 1.1609 |
| 171 | Thiophene | $C_4H_4S$ | 110021 | 84.142 | 8.1350E+04 | 1.2980E+02 | –3.9000E–03 | 0 | 0 | 234.94 | 1.1163 | 357.31 | 1.2723 |
| 172 | Pyridine | $C_5H_5N$ | 110861 | 79.101 | 1.0785E+05 | –3.4787E+01 | 3.9565E–01 | 0 | 0 | 231.51 | 1.2100 | 388.41 | 1.5403 |
| 173 | Formamide[5] | $CH_3NO$ | 75127 | 45.041 | 6.3400E+04 | 1.5060E+02 | 0 | 0 | 0 | 292 | 1.0738 | 493 | 1.3765 |
| 174 | *N,N*-Dimethylformamide | $C_3H_7NO$ | 68122 | 73.095 | 1.4790E+05 | –1.0600E+02 | 3.8400E–01 | 0 | 0 | 273.82 | 1.4767 | 466.44 | 1.8200 |
| 175 | Acetamide | $C_2H_5NO$ | 60355 | 59.068 | 1.0230E+05 | 1.2870E+02 | 0 | 0 | 0 | 354.15 | 1.4788 | 571 | 1.7579 |
| 176 | *N*-Methylacetamide | $C_3H_7NO$ | 79163 | 73.095 | 6.2600E+04 | 2.4340E+02 | 0 | 0 | 0 | 359 | 1.4998 | 538.5 | 1.9367 |
| 177 | Acetonitrile | $C_2H_3N$ | 75058 | 41.053 | 9.7582E+04 | –1.2220E+02 | 3.4085E–01 | 0 | 0 | 229.32 | 0.8748 | 354.75 | 0.9713 |
| 178 | Propionitrile | $C_3H_5N$ | 107120 | 55.079 | 1.1819E+05 | –1.2098E+02 | 4.2075E–01 | 0 | 0 | 180.26 | 1.1005 | 370.5 | 1.3112 |
| 179 | *n*-Butyronitrile | $C_4H_7N$ | 109740 | 69.106 | 1.0400E+05 | 1.7400E+02 | 0 | 0 | 0 | 161.25 | 1.3206 | 390.75 | 1.7199 |
| 180 | Benzonitrile | $C_7H_5N$ | 100470 | 103.123 | 7.6900E+04 | 3.1420E+02 | 0 | 0 | 0 | 260.4 | 1.5872 | 464.15 | 2.2274 |
| 181 | Methyl mercaptan | $CH_4S$ | 74931 | 48.109 | 1.1530E+05 | –2.6323E+02 | 6.0412E–01 | 0 | 0 | 150.18 | 0.8939 | 298.15 | 0.9052 |
| 182 | Ethyl mercaptan | $C_2H_6S$ | 75081 | 62.136 | 1.3467E+05 | –2.3439E+02 | 5.9656E–01 | 0 | 0 | 125.26 | 1.1467 | 315.25 | 1.2007 |
| 183 | *n*-Propyl mercaptan | $C_3H_8S$ | 107039 | 76.163 | 1.6733E+05 | –3.1910E+02 | 8.1270E–01 | 0 | 0 | 159.95 | 1.3708 | 340.87 | 1.5299 |
| 184 | *n*-Butyl mercaptan | $C_4H_{10}S$ | 109795 | 90.189 | 2.3219E+05 | –8.0435E+02 | 2.7063E+00 | –2.3017E–03 | 0 | 157.46 | 1.6365 | 390 | 1.9359 |
| 185 | Isobutyl mercaptan | $C_4H_{10}S$ | 513440 | 90.189 | 1.7336E+05 | –2.1732E+02 | 7.0933E–01 | 0 | 0 | 128.31 | 1.5715 | 361.64 | 1.8754 |
| 186 | sec-Butyl mercaptan[2] | $C_4H_{10}S$ | 513531 | 90.189 | 1.9789E+05 | –4.9154E+02 | 1.7219E+00 | –1.2499E–03 | 0 | 133.02 | 1.6003 | 370 | 1.8844 |
| 187 | Dimethyl sulfide | $C_2H_6S$ | 75183 | 62.136 | 1.4695E+05 | –3.8006E+02 | 1.2035E+00 | –8.4787E–04 | 0 | 174.88 | 1.1276 | 310.48 | 1.1959 |
| 188 | Methyl ethyl sulfide | $C_3H_8S$ | 624895 | 76.163 | 1.6124E+05 | –2.8861E+02 | 7.8179E–01 | 0 | 0 | 167.23 | 1.3484 | 339.8 | 1.5344 |
| 189 | Diethyl sulfide | $C_4H_{10}S$ | 352932 | 90.189 | 2.3852E+05 | –1.0384E+03 | 4.0587E+00 | –4.4691E–03 | 0 | 181.95 | 1.5703 | 322.08 | 1.7579 |
| 190 | Fluoromethane[2] | $CH_3F$ | 593533 | 34.033 | 7.4746E+04 | –1.3232E+02 | 5.3772E–01 | 0 | 0 | 140 | 0.6676 | 220 | 0.7166 |
| 191 | Chloromethane | $CH_3Cl$ | 74873 | 50.488 | 9.6910E+04 | –2.0790E+02 | 3.7456E–01 | 4.8800E–04 | 0 | 175.43 | 0.7460 | 373.15 | 0.9684 |
| 192 | Trichloromethane | $CHCl_3$ | 67663 | 119.377 | 1.2485E+05 | –1.6634E+02 | 4.3209E–01 | 0 | 0 | 233.15 | 1.0956 | 366.48 | 1.2192 |
| 193 | Tetrachloromethane | $CCl_4$ | 56235 | 153.822 | –7.5270E+05 | 8.9661E+03 | –3.0394E+01 | 3.4455E–02 | 0 | 250.33 | 1.2763 | 388.71 | 1.6374 |
| 194 | Bromomethane | $CH_3Br$ | 74839 | 94.939 | 1.2973E+05 | –5.9654E+02 | 2.1600E+00 | –2.4234E–03 | 0 | 184.45 | 0.7798 | 276.71 | 0.7870 |
| 195 | Fluoroethane | $C_2H_5F$ | 353366 | 48.060 | 8.3303E+04 | 6.5454E+01 | 0 | 0 | 0 | 200 | 0.9639 | 281.48 | 1.0173 |
| 196 | Chloroethane | $C_2H_5Cl$ | 75003 | 64.514 | 1.2790E+05 | –3.4515E+02 | 9.1500E–01 | 0 | 0 | 134.8 | 0.9800 | 340 | 1.1632 |
| 197 | Bromoethane | $C_2H_5Br$ | 74964 | 108.966 | 9.4364E+04 | –1.0912E+02 | 4.4032E–01 | 0 | 0 | 160 | 0.8818 | 320 | 1.0453 |

**TABLE 2-196 Heat Capacities of Inorganic and Organic Liquids** (*Concluded*)

| Cmpd. no. | Name | Formula | CAS no. | Mol wt | C1 | C2 | C3 | C4 | C5 | $T_{min}$, K | $C_p$ at $T_{min}$ ×1E–05 | $T_{max}$, K | $C_p$ at $T_{max}$ ×1E–05 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 198 | 1-Chloropropane | $C_3H_7Cl$ | 540545 | 78.541 | 9.6344E+04 | 1.1752E+02 | 0 | 0 | 0 | 230 | 1.2337 | 319.67 | 1.3391 |
| 199 | 2-Chloropropane | $C_3H_7Cl$ | 75296 | 78.541 | 6.9362E+04 | 2.1501E+02 | 0 | 0 | 0 | 200 | 1.1236 | 308.85 | 1.3577 |
| 200 | 1,1-Dichloropropane | $C_3H_6Cl_2$ | 78999 | 112.986 | 7.0010E+04 | 2.6660E+02 | 0 | 0 | 0 | 280 | 1.4466 | 420 | 1.8198 |
| 201 | 1,2-Dichloropropane | $C_3H_6Cl_2$ | 78875 | 112.986 | 1.1094E+05 | 8.3496E+00 | 4.7218E–01 | 0 | 0 | 286 | 1.5195 | 429 | 2.0142 |
| 202 | Vinyl chloride | $C_2H_3Cl$ | 75014 | 62.499 | –1.0320E+04 | 3.2280E+02 | 0 | 0 | 0 | 200 | 0.5424 | 400 | 1.1880 |
| 203 | Fluorobenzene | $C_6H_5F$ | 462066 | 96.104 | –9.9120E+05 | 1.1734E+04 | –4.0669E+01 | 4.7333E–02 | 0 | 239.99 | 1.3675 | 319.99 | 1.5018 |
| 204 | Chlorobenzene | $C_6H_5Cl$ | 108907 | 112.558 | –1.3075E+06 | 1.5338E+04 | –5.3974E+01 | 6.3483E–02 | 0 | 227.95 | 1.3617 | 360 | 1.8101 |
| 205 | Bromobenzene | $C_6H_5Br$ | 108861 | 157.010 | 1.2160E+05 | –9.4500E+00 | 3.5800E–01 | 0 | 0 | 293.15 | 1.4960 | 495.08 | 2.0467 |
| 206 | Air | | 132259100 | 28.951 | –2.1446E+05 | 9.1851E+03 | –1.0612E+02 | 4.1616E–01 | 0 | 75 | 0.5307 | 115 | 0.7132 |
| 207 | Hydrogen (eqn. 2) | $H_2$ | 1333740 | 2.016 | 6.6653E+01 | 6.7659E+03 | –1.2363E+02 | 4.7827E+02 | 0 | 13.95 | 0.1262 | 32 | 1.3122 |
| 208 | Helium-4[6] | He | 7440597 | 4.003 | 3.8722E+05 | –4.6557E+05 | 2.1180E+05 | –4.2494E+04 | 3.2129E+03 | 2.2 | 0.1087 | 4.6 | 0.2965 |
| 209 | Neon | Ne | 7440019 | 20.180 | 1.0341E+06 | –1.3877E+05 | 7.1540E+03 | –1.6255E+02 | 1.3841E+00 | 24.56 | 0.3666 | 40 | 0.6980 |
| 210 | Argon | Ar | 7440371 | 39.948 | 1.3439E+05 | –1.9894E+03 | 1.1043E+01 | 0 | 0 | 83.78 | 0.4523 | 135 | 0.6708 |
| 211 | Fluorine | $F_2$ | 7782414 | 37.997 | –9.4585E+04 | 7.5299E+03 | –1.3960E+02 | 1.1301E+00 | –3.3241E–03 | 58 | 0.5541 | 98 | 0.5966 |
| 212 | Chlorine | $Cl_2$ | 7782505 | 70.905 | 6.3936E+04 | 4.6350E+01 | –1.6230E–01 | 0 | 0 | 172.12 | 0.6711 | 239.12 | 0.6574 |
| 213 | Bromine | $Br_2$ | 7726956 | 159.808 | 3.7570E+04 | 3.2850E+02 | –6.7000E–01 | 0 | 0 | 265.9 | 0.7755 | 305.37 | 0.7541 |
| 214 | Oxygen | $O_2$ | 7782447 | 31.999 | 1.7543E+05 | –6.1523E+03 | 1.1392E+02 | –9.2382E–01 | 2.7963E–03 | 54.36 | 0.5365 | 142 | 0.9066 |
| 215 | Nitrogen | $N_2$ | 7727379 | 28.014 | 2.8197E+05 | –1.2281E+04 | 2.4800E+02 | –2.2182E+00 | 7.4902E–03 | 63.15 | 0.5593 | 112 | 0.7960 |
| 216 | Ammonia (eqn. 2) | $NH_3$ | 7664417 | 17.031 | 6.1289E+01 | 8.0925E+04 | 7.9940E+02 | –2.6510E+03 | 0 | 203.15 | 0.7575 | 401.15 | 4.1847 |
| 217 | Hydrazine | $N_2H_4$ | 302012 | 32.045 | 7.9815E+04 | 5.0929E+01 | 4.3379E–02 | 0 | 0 | 274.69 | 0.9708 | 653.15 | 1.3158 |
| 218 | Nitrous oxide | $N_2O$ | 10024972 | 44.013 | 6.7556E+04 | 5.4373E+01 | 0 | 0 | 0 | 182.3 | 0.7747 | 200 | 0.7843 |
| 219 | Nitric oxide | NO | 10102439 | 30.006 | –2.9796E+06 | 7.6602E+04 | –6.5259E+02 | 1.8879E+00 | 0 | 109.5 | 0.6229 | 150 | 1.9909 |
| 220 | Cyanogen | $C_2N_2$ | 460195 | 52.036 | 3.1322E+06 | –2.4320E+04 | 4.8844E+01 | 0 | 0 | 245.25 | 1.0557 | 300 | 2.3216 |
| 221 | Carbon monoxide (eqn. 2) | CO | 630080 | 28.010 | 6.5429E+01 | 2.8723E+04 | –8.4739E+02 | 1.9596E+03 | 0 | 68.15 | 0.5912 | 132 | 6.4799 |
| 222 | Carbon dioxide | $CO_2$ | 124389 | 44.010 | –8.3043E+06 | 1.0437E+05 | –4.3333E+02 | 6.0052E–01 | 0 | 220 | 0.7827 | 290 | 1.6603 |
| 223 | Carbon disulfide | $CS_2$ | 75150 | 76.143 | 8.5600E+04 | –1.2200E+02 | 5.6050E–01 | –1.4520E–03 | 2.0080E–06 | 161.11 | 0.7577 | 552 | 1.3125 |
| 224 | Hydrogen fluoride | HF | 7664393 | 20.006 | 6.2520E+04 | –2.2302E+02 | 6.2970E–01 | 0 | 0 | 189.79 | 0.4288 | 292.67 | 0.5119 |
| 225 | Hydrogen chloride | HCl | 7647010 | 36.461 | 4.7300E+04 | 9.0000E+01 | 0 | 0 | 0 | 165 | 0.6215 | 185 | 0.6395 |
| 226 | Hydrogen bromide | HBr | 10035106 | 80.912 | 5.7720E+04 | 9.9000E+00 | 0 | 0 | 0 | 185.15 | 0.5955 | 206.45 | 0.5976 |
| 227 | Hydrogen cyanide | HCN | 74908 | 27.026 | 9.5398E+04 | –1.9752E+02 | 3.8830E–01 | 0 | 0 | 259.83 | 0.7029 | 298.85 | 0.7105 |
| 228 | Hydrogen sulfide (eqn. 2) | $H_2S$ | 7783064 | 34.082 | 6.4666E+01 | 4.9354E+04 | 2.2493E+01 | –1.6230E+03 | 0 | 187.68 | 0.6733 | 370 | 4.9183 |
| 229 | Sulfur dioxide | $SO_2$ | 7446095 | 64.065 | 8.5743E+04 | 5.7443E+00 | 0 | 0 | 0 | 197.67 | 0.8688 | 350 | 0.8775 |
| 230 | Sulfur trioxide | $SO_3$ | 7446119 | 80.064 | 2.5809E+05 | 0.0000E+00 | 0 | 0 | 0 | 303.15 | 2.5809 | 303.15 | 2.5809 |
| 231 | Water | $H_2O$ | 7732185 | 18.015 | 2.7637E+05 | –2.0901E+03 | 8.1250E+00 | –1.4116E–02 | 9.3701E–06 | 273.16 | 0.7615 | 533.15 | 0.8939 |

All substances are listed in alphabetical order in Table 2-6*a*.

Compiled from Daubert, T. E., R. P. Danner, H. M. Sibul, and C. C. Stebbins, DIPPR Data Compilation of Pure Compound Properties, Project 801 Sponsor Release, July, 1993, Design Institute for Physical Property Data, AIChE, New York, NY; and from Thermodynamics Research Center, "Selected Values of Properties of Hydrocarbons and Related Compounds," Thermodynamics Research Center Hydrocarbon Project, Texas A&M University, College Station, Texas (extant 1994).

Temperatures are expressed in kelvins; liquid heat capacities are in J/kmol-K.

J/(kmol·K) × 2.390E–04 = cal/(gmol·°C); J/(kmol·K) × 2.390059E–04 = Btu/(lbmol·°F).

Equation 1, heat capacity = C1 + C2 × $T$ + C3 × $T^2$ + C4 × $T^3$ + C5 × $T^4$, should be used except as otherwise specified.

Equation 2 is heat capacity = $C1^2/t + C2 - (2 \times C1 \times C3)t - (C1 \times C4)t^2 - (C3^{2/3})t^3 - (C3 \times C4/2)t^4 - (C4^{2/5})t^5$. $t = (1 - T_r)$ and $T_r$ is the reduced temperature, $T/T_c$.

[1] Coefficients are for the monomer and are hypothetical above 473 K.

[2] For the saturated heat capacity.

[3] Coefficients are hypothetical; compound *decomposes violently* on heating.

[4] Coefficients are hypothetical and are based on predicted data.

[5] Coefficients are hypothetical.

[6] Exhibits superfluid properties below 2.2 K.

**TABLE 2-197 Specific Heats of Organic Solids**

Recalculated from *International Critical Tables*, vol. 5, pp. 101–105

| Compound | Formula | Temperature, °C | sp ht, cal/g °C |
|---|---|---|---|
| Acetic acid | $C_2H_4O_2$ | –200 to +25 | 0.330 + 0.00080*t* |
| Acetone | $C_3H_6O$ | –210 to –80 | 0.540 + 0.0156*t* |
| Aminobenzoic acid (*o*-) | $C_7H_7NO_2$ | 85 to mp | 0.254 + 0.00136*t* |
| (*m*-) | $C_7H_7NO_2$ | 120 to mp | 0.253 + 0.00122*t* |
| (*p*-) | $C_7H_7NO_2$ | 128 to mp | 0.287 + 0.00088*t* |
| Aniline | $C_6H_7N$ | | 0.741 |
| Anthracene | $C_{14}H_{10}$ | 50 | 0.308 |
| | | 100 | 0.350 |
| | | 150 | 0.382 |
| Anthraquinone | $C_{14}H_8O_2$ | 0 to 270 | 0.258 + 0.00069*t* |
| Apiol | $C_{12}H_{14}O_4$ | 10 | 0.299 |
| Azobenzene | $C_{12}H_{10}N_2$ | 28 | 0.330 |
| Benzene | $C_6H_6$ | –250 | 0.0399 |
| | | –225 | 0.0908 |
| | | –200 | 0.124 |
| | | –150 | 0.170 |
| | | –100 | 0.227 |
| | | –50 | 0.299 |
| | | 0 | 0.375 |
| Benzoic acid | $C_7H_6O_2$ | 20 to mp | 0.287 + 0.00050*t* |
| Benzophenone | $C_{13}H_{10}O$ | –150 | 0.115 |
| | | –100 | 0.172 |
| | | –50 | 0.220 |
| | | 0 | 0.275 |
| | | +20 | 0.303 |
| Betol | $C_{17}H_{12}O_3$ | –150 | 0.129 |
| | | –100 | 0.167 |
| | | 0 | 0.248 |
| | | +50 | 0.308 |
| Bromoiodobenzene (*o*-) | $C_6H_4BrI$ | –50 to 0 | 0.143 + 0.00025*t* |
| (*m*-) | $C_6H_4BrI$ | –75 to –15 | 0.143 |
| (*p*-) | $C_6H_4BrI$ | –40 to 50 | 0.116 + 0.00032*t* |
| Bromonaphthalene (β-) | $C_{10}H_7Br$ | 41 | 0.260 |
| Bromophenol | $C_6H_5BrO$ | 32 | 0.263 |
| Camphene | $C_{10}H_{16}$ | 35 | 0.380 |
| Capric acid | $C_{10}H_{20}O_2$ | 8 | 0.695 |
| Caprylic acid | $C_8H_{16}O_2$ | –2 | 0.628 |
| Carbon tetrachloride | $CCl_4$ | –240 | 0.013 |
| | | –200 | 0.081 |
| | | –160 | 0.131 |
| | | –120 | 0.162 |
| | | –80 | 0.182 |
| | | –40 | 0.201 |
| Cerotic acid | $C_{27}H_{54}O_2$ | 15 | 0.387 |
| Chloral alcoholate | $C_4H_7Cl_3O_2$ | 78 | 0.509 |
| hydrate | $C_2H_3Cl_3O_2$ | 32 | 0.213 |
| Chloroacetic acid | $C_2H_3ClO_2$ | 60 | 0.363 |
| Chlorobenzoic acid (*o*-) | $C_7H_5ClO_2$ | 80 to mp | 0.228 + 0.00084*t* |
| (*m*-) | $C_7H_5ClO_2$ | 94 to mp | 0.232 + 0.00073*t* |
| (*p*-) | $C_7H_5ClO_2$ | 180 to mp | 0.242 + 0.00055*t* |
| Chlorobromobenzene (*o*-) | $C_6H_4BrCl$ | –34 | 0.192 |
| (*m*-) | $C_6H_4BrCl$ | –52 | 0.150 |
| (*p*-) | $C_6H_4BrCl$ | –40 | 0.150 |
| Crotonic acid | $C_4H_6O_2$ | 38 to 70 | 0.520 + 0.00020*t* |
| Cyamelide | $C_3H_3N_3O_3$ | 40 | 0.263 |
| Cyanamide | $CH_2N_2$ | 20 | 0.547 |
| Cyanuric acid | $C_3H_3N_3O_3$ | 40 | 0.318 |
| Dextrin | $(C_6H_{10}O_5)x$ | 0 to 90 | 0.291 + 0.00096*t* |
| Dextrose | $C_6H_{12}O_6$ | –250 | 0.016 |
| | | –200 | 0.077 |
| | | –100 | 0.160 |
| | | 0 | 0.277 |
| | | 20 | 0.300 |
| Dibenzyl | $C_{14}H_{14}$ | 28 | 0.363 |
| Dibromobenzene (*o*-) | $C_6H_4Br_2$ | –36 | 0.248 |
| (*m*-) | $C_6H_4Br_2$ | –25 | 0.134 |
| (*p*-) | $C_6H_4Br_2$ | –50 to +50 | 0.139 + 0.00038*t* |
| Dichloroacetic acid | $C_2H_2Cl_2O_2$ | | 0.406 |
| Dichlorobenzene (*o*-) | $C_6H_4Cl_2$ | –48.5 | 0.185 |
| (*m*-) | $C_6H_4Cl_2$ | –52 | 0.186 |
| (*p*-) | $C_6H_4Cl_2$ | –50 to +53 | 0.219 + 0.0021*t* |
| Dicyandiamide | $C_2H_4N_4$ | 0 to 204 | 0.456 |

**TABLE 2-197 Specific Heats of Organic Solids** (*Continued*)
Recalculated from *International Critical Tables*, vol. 5, pp. 101–105

| Compound | Formula | Temperature, °C | sp ht, cal/g °C |
|---|---|---|---|
| Dihydroxybenzene (*o*-) | $C_6H_6O_2$ | –163 to mp | 0.278 + 0.00098*t* |
| (*m*-) | $C_6H_6O_2$ | –160 to mp | 0.269 + 0.00118*t* |
| (*p*-) | $C_6H_6O_2$ | –250 | 0.025 |
| | | –240 | 0.038 |
| | | –220 | 0.061 |
| | | –200 | 0.081 |
| | | –150 to mp | 0.268 + 0.00093*t* |
| Di-iodobenzene (*o*-) | $C_6H_4I_2$ | –50 to +15 | 0.109 + 0.00026*t* |
| (*m*-) | $C_6H_4I_2$ | –52 to –42 | 0.100 + 0.00026*t* |
| (*p*-) | $C_6H_4I_2$ | –50 to +80 | 0.101 + 0.00026*t* |
| Dimethyl oxalate | $C_4H_6O_4$ | 10 to 50 | 0.212 + 0.0044*t* |
| Dimethylpyrene | $C_7H_8O_2$ | 50 | 0.368 |
| Dinitrobenzene (*o*-) | $C_6H_4N_2O_4$ | –160 to mp | 0.252 + 0.00083*t* |
| (*m*-) | $C_6H_4N_2O_4$ | –160 to mp | 0.248 + 0.00077*t* |
| (*p*-) | $C_6H_4N_2O_4$ | 119 to mp | 0.259 + 0.00057*t* |
| Diphenyl | $C_{12}H_{10}$ | 40 | 0.385 |
| Diphenylamine | $C_{12}H_{11}N$ | 26 | 0.337 |
| Dulcitol | $C_6H_{14}O_6$ | 20 | 0.282 |
| Erythritol | $C_4H_{10}O_4$ | 60 | 0.351 |
| Ethyl alcohol | $C_2H_6O$ (crystalline) | –190 | 0.232 |
| | | –180 | 0.248 |
| | | –160 | 0.282 |
| | | –140 | 0.318 |
| | | –130 | 0.376 |
| | (vitreous) | –190 | 0.260 |
| | | –180 | 0.296 |
| | | –175 | 0.380 |
| | | –170 | 0.399 |
| Ethylene glycol | $C_2H_6O_2$ | –190 to –40 | 0.366 + 0.00110*t* |
| Formic acid | $CH_2O_2$ | –22 | 0.387 |
| | | 0 | 0.430 |
| Glutaric acid | $C_5H_8O_4$ | 20 | 0.299 |
| Glycerol | $C_3H_8O_3$ | –265 | 0.009 |
| | | –260 | 0.022 |
| | | –250 | 0.047 |
| | | –220 | 0.085 |
| | | –200 | 0.115 |
| | | –100 | 0.217 |
| | | 0 | 0.330 |
| Hexachloroethane | $C_2Cl_6$ | 25 | 0.174 |
| Hexadecane | $C_{16}H_{34}$ | | 0.495 |
| Hydroxyacetanilide | $C_8H_9NO_2$ | 41 to mp | 0.249 + 0.00154*t* |
| Iodobenzene | $C_6H_5I$ | 40 | 0.191 |
| Isopropyl alcohol | $C_3H_8O$ | –200 to –160 | 0.051 + 0.00165*t* |
| Lactose | $C_{12}H_{22}O_{11}$ | 20 | 0.287 |
| | $C_{12}H_{22}O_{11}·H_2O$ | 20 | 0.299 |
| Lauric acid | $C_{12}H_{24}O_2$ | –30 to +40 | 0.430 + 0.000027*t* |
| Levoglucosane | $C_6H_{10}O_5$ | 40 | 0.607 |
| Levulose | $C_6H_{12}O_6$ | 20 | 0.275 |
| Malonic acid | $C_3H_4O_4$ | 20 | 0.275 |
| Maltose | $C_{12}H_{22}O_{11}$ | 20 | 0.320 |
| Mannitol | $C_6H_{14}O_6$ | 0 to 100 | 0.313 + 0.00025*t* |
| Melamine | $C_3H_6N_6$ | 40 | 0.351 |
| Myristic acid | $C_{14}H_{28}O_2$ | 0 to 35 | 0.381 + 0.00545*t* |
| Naphthalene | $C_{10}H_8$ | –130 to mp | 0.281 + 0.00111*t* |
| Naphthol (α-) | $C_{10}H_8O$ | 50 to mp | 0.240 + 0.00147*t* |
| (β-) | $C_{10}H_8O$ | 61 to mp | 0.252 + 0.00128*t* |
| Naphthylamine (α-) | $C_{10}H_9N$ | 0 to 50 | 0.270 + 0.0031*t* |
| Nitroaniline (*o*-) | $C_6H_6N_2O_2$ | –160 to mp | 0.269 + 0.000920*t* |
| (*m*-) | $C_6H_6N_2O_2$ | –160 to mp | 0.275 + 0.000946*t* |
| (*p*-) | $C_6H_6N_2O_2$ | –160 to mp | 0.276 + 0.001000*t* |
| Nitrobenzoic acid (*o*-) | $C_7H_5NO_4$ | –163 to mp | 0.256 + 0.00085*t* |
| (*m*-) | $C_7H_5NO_4$ | 66 to mp | 0.258 + 0.00091*t* |
| (*p*-) | $C_7H_5NO_4$ | –160 to mp | 0.247 + 0.00077*t* |
| Nitronaphthalene | $C_{10}H_7NO_2$ | 0 to 55 | 0.236 + 0.00215*t* |

**TABLE 2-197 Specific Heats of Organic Solids** (*Concluded*)
Recalculated from *International Critical Tables*, vol. 5, pp. 101–105

| Compound | Formula | Temperature, °C | sp ht, cal/g °C |
|---|---|---|---|
| Oxalic acid | $C_2H_2O_4$ | −200 to +50 | 0.259 + 0.00076*t* |
| | $C_2H_2O_4.2H_2O$ | −200 | 0.117 |
| | | −100 | 0.239 |
| | | 0 | 0.338 |
| | | +50 | 0.385 |
| | | 100 | 0.416 |
| Palmitic acid | $C_{16}H_{32}O_2$ | −180 | 0.167 |
| | | −140 | 0.208 |
| | | −100 | 0.251 |
| | | −50 | 0.306 |
| | | 0 | 0.382 |
| | | +20 | 0.430 |
| Phenol | $C_6H_6O$ | 14 to 26 | 0.561 |
| Phthalic acid | $C_8H_6O_4$ | 20 | 0.232 |
| Picric acid | $C_6H_3N_3O_7$ | −100 | 0.165 |
| | | 0 | 0.240 |
| | | +50 | 0.263 |
| | | 100 | 0.297 |
| | | 120 | 0.332 |
| Propionic acid | $C_3H_6O_2$ | −33 | 0.726 |
| Propyl alcohol (*n*-) | $C_3H_8O$ | −200 | 0.170 |
| | | −175 | 0.363 |
| | | −150 | 0.471 |
| | | −130 | 0.497 |
| Pyrotartaric acid | $C_6H_8O_4$ | 20 | 0.301 |
| Quinhydrone | $C_{12}H_{10}O_4$ | −250 | 0.017 |
| | | −225 | 0.061 |
| | | −200 | 0.098 |
| | | −100 | 0.191 |
| | | 0 | 0.256 |
| Quinone | $C_6H_4O_2$ | −250 | 0.031 |
| | | −225 | 0.082 |
| | | −200 | 0.113 |
| | | −150 to mp | 0.282 + 0.00083*t* |
| Salol | $C_{13}H_{10}O_3$ | 32 | 0.289 |
| Stearic acid | $C_{18}H_{36}O_2$ | 15 | 0.399 |
| Succinic acid | $C_4H_6O_4$ | 0 to 160 | 0.248 + 0.00153*t* |
| Sucrose | $C_{12}H_{22}O_{11}$ | 20 | 0.299 |
| Sugar (cane) | $C_{12}H_{22}O_{11}$ | 22 to 51 | 0.301 |
| Tartaric acid | $C_4H_6O_6$ | 36 | 0.287 |
| Tartaric acid | $C_4H_6O_6{\cdot}H_2O$ | −150 | 0.112 |
| | | −100 | 0.170 |
| | | −50 | 0.231 |
| | | 0 | 0.308 |
| | | +50 | 0.366 |
| Tetrachloroethylene | $C_2Cl_4$ | −40 to 0 | 0.198 + 0.00018*t* |
| Tetryl | $C_7H_5N_5O_8$ | −100 | 0.182 |
| | | −50 | 0.199 |
| | | 0 | 0.212 |
| | | +100 | 0.236 |
| 1 Tetryl + 1 picric acid | $C_{13}H_8N_8O_{15}$ | −100 to +100 | 0.253 + 0.00072*t* |
| 1 Tetryl + 2 TNT | $C_{21}H_{15}N_{11}O_{20}$ | −100 | 0.172 |
| | | 0 | 0.280 |
| | | +50 | 0.325 |
| Thymol | $C_{10}H_{14}O$ | 0 to 49 | 0.315 + 0.0031*t* |
| Toluic acid (*o*-) | $C_8H_8O_2$ | 54 to mp | 0.277 + 0.00120*t* |
| (*m*-) | $C_8H_8O_2$ | 54 to mp | 0.239 + 0.00195*t* |
| (*p*-) | $C_8H_8O_2$ | 130 to mp | 0.271 + 0.00106*t* |
| Toluidine (*p*-) | $C_7H_9N$ | 0 | 0.337 |
| | | 20 | 0.387 |
| | | 40 | 0.440 |
| Trichloroacetic acid | $C_2HCl_3O_2$ | solid | 0.459 |
| Trimethyl carbinol | $C_4H_{10}O$ | −4 | 0.559 |
| Trinitrotoluene | $C_7H_5N_3O_6$ | −100 | 0.170 |
| | | −50 | 0.253 |
| | | 0 | 0.311 |
| | | +100 | 0.385 |
| Trinitroxylene | $C_8H_7N_3O_6$ | −185 to +23 | 0.241 |
| | | 20 to 50 | 0.423 |
| Triphenylmethane | $C_{19}H_{16}$ | 0 to 91 | 0.189 + 0.0027*t* |
| Urea | $CH_4N_2O$ | 20 | 0.320 |

**TABLE 2-198 Heat Capacities of Inorganic and Organic Compounds in the Ideal Gas State**

| Cmpd. no. | Name | Formula | CAS no. | Mol wt. | C1 × 1E–05 | C2 × 1E–05 | C3 × 1E–03 | C4 × 1E–05 | C5 | $T_{min}$, K | $C_p$ at $T_{min}$ × 1E–05 | $T_{max}$, K | $C_p$ at $T_{max}$ × 1E–05 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Methane | $CH_4$ | 74828 | 16.043 | 0.3330 | 0.7993 | 2.0869 | 0.4160 | 991.96 | 50 | 0.3330 | 1500 | 0.8890 |
| 2 | Ethane | $C_2H_6$ | 74840 | 30.070 | 0.4033 | 1.3422 | 1.6555 | 0.7322 | 752.87 | 200 | 0.4256 | 1500 | 1.4562 |
| 3 | Propane | $C_3H_8$ | 74986 | 44.097 | 0.5192 | 1.9245 | 1.6265 | 1.1680 | 723.6 | 200 | 0.5632 | 1500 | 2.0556 |
| 4 | *n*-Butane | $C_4H_{10}$ | 106978 | 58.123 | 0.7134 | 2.4300 | 1.6300 | 1.5033 | 730.42 | 200 | 0.7673 | 1500 | 2.6602 |
| 5 | *n*-Pentane | $C_5H_{12}$ | 109660 | 72.150 | 0.8805 | 3.0110 | 1.6502 | 1.8920 | 747.6 | 200 | 0.9404 | 1500 | 3.2927 |
| 6 | *n*-Hexane | $C_6H_{14}$ | 110543 | 86.177 | 1.0440 | 3.5230 | 1.6946 | 2.3690 | 761.6 | 200 | 1.1117 | 1500 | 3.8620 |
| 7 | *n*-Heptane | $C_7H_{16}$ | 142825 | 100.204 | 1.2015 | 4.0010 | 1.6766 | 2.7400 | 756.4 | 200 | 1.2828 | 1500 | 4.4283 |
| 8 | *n*-Octane | $C_8H_{18}$ | 111659 | 114.231 | 1.3554 | 4.4310 | 1.6356 | 3.0540 | 746.4 | 200 | 1.4529 | 1500 | 4.9764 |
| 9 | *n*-Nonane | $C_9H_{20}$ | 111842 | 128.258 | 1.5175 | 4.9150 | 1.6448 | 3.4700 | 749.6 | 200 | 1.6257 | 1500 | 5.5407 |
| 10 | *n*-Decane | $C_{10}H_{22}$ | 124185 | 142.285 | 1.6720 | 5.3530 | 1.6141 | 3.7820 | 742 | 200 | 1.7967 | 1500 | 6.0932 |
| 11 | *n*-Undecane | $C_{11}H_{24}$ | 1120214 | 156.312 | 1.9529 | 6.0998 | 1.7087 | 4.1302 | 775.4 | 200 | 2.0594 | 1500 | 6.8342 |
| 12 | *n*-Dodecane | $C_{12}H_{26}$ | 112403 | 170.338 | 2.1295 | 6.6330 | 1.7155 | 4.5161 | 777.5 | 200 | 2.2442 | 1500 | 7.4325 |
| 13 | *n*-Tridecane | $C_{13}H_{28}$ | 629505 | 184.365 | 2.1496 | 7.3045 | 1.6695 | 4.9998 | 741.02 | 200 | 2.3156 | 1500 | 8.0251 |
| 14 | *n*-Tetradecane | $C_{14}H_{30}$ | 629594 | 198.392 | 2.3082 | 7.8678 | 1.6823 | 5.4486 | 743.1 | 200 | 2.4864 | 1500 | 8.6225 |
| 15 | *n*-Pentadecane | $C_{15}H_{32}$ | 629629 | 212.419 | 2.4679 | 8.4212 | 1.6865 | 5.8537 | 743.6 | 200 | 2.6586 | 1500 | 9.2209 |
| 16 | *n*-Hexadecane | $C_{16}H_{34}$ | 544763 | 226.446 | 2.6283 | 8.9733 | 1.6912 | 6.2640 | 744.41 | 200 | 2.8312 | 1500 | 9.8182 |
| 17 | *n*-Heptadecane | $C_{17}H_{36}$ | 629787 | 240.473 | 2.7878 | 9.5247 | 1.6935 | 6.6651 | 744.57 | 200 | 3.0034 | 1500 | 10.4160 |
| 18 | *n*-Octadecane | $C_{18}H_{38}$ | 593453 | 254.500 | 2.9502 | 10.0340 | 0.7711 | –4.3012 | 916.73 | 200 | 3.1800 | 1500 | 11.0160 |
| 19 | *n*-Nonadecane | $C_{19}H_{40}$ | 629925 | 268.527 | 3.1062 | 10.5750 | 0.7679 | –4.5661 | –912.03 | 200 | 3.3533 | 1500 | 11.6130 |
| 20 | *n*-Eicosane | $C_{20}H_{42}$ | 112958 | 282.553 | 3.2481 | 11.0900 | 1.6360 | 7.4500 | –726.27 | 200 | 3.5235 | 1500 | 12.2110 |
| 21 | 2-Methylpropane | $C_4H_{10}$ | 75285 | 58.123 | 0.6549 | 2.4776 | 1.5870 | 1.5750 | –706.99 | 200 | 0.7218 | 1500 | 2.6656 |
| 22 | 2-Methylbutane | $C_5H_{12}$ | 78784 | 72.150 | 0.7460 | 3.2650 | 1.5450 | 1.9230 | 666.7 | 200 | 0.8546 | 1500 | 3.3792 |
| 23 | 2,3-Dimethylbutane | $C_6H_{14}$ | 79298 | 86.177 | 0.7772 | 4.0320 | 1.5440 | 2.5080 | –649.95 | 200 | 0.9363 | 1500 | 4.0353 |
| 24 | 2-Methylpentane | $C_6H_{14}$ | 107835 | 86.177 | 0.9030 | 3.8010 | 1.6020 | 2.4530 | –691.6 | 200 | 1.0192 | 1500 | 3.9617 |
| 25 | 2,3-Dimethylpentane | $C_7H_{16}$ | 565593 | 100.204 | 0.8544 | 4.5772 | 1.5181 | 2.9740 | 641.01 | 200 | 1.0550 | 1500 | 4.5983 |
| 26 | 2,3,3-Trimethylpentane | $C_8H_{18}$ | 560214 | 114.231 | 0.9820 | 5.4020 | 1.5310 | 3.4930 | 639.9 | 200 | 1.2194 | 1500 | 5.3754 |
| 27 | 2,2,4-Trimethylpentane | $C_8H_{18}$ | 540841 | 114.231 | 1.1390 | 5.2860 | 1.5940 | 3.3510 | 677.94 | 200 | 1.3139 | 1500 | 5.3769 |
| 28 | Ethylene | $C_2H_4$ | 74851 | 28.054 | 0.3338 | 0.9479 | 1.5960 | 0.5510 | 740.8 | 60 | 0.3338 | 1500 | 1.0987 |
| 29 | Propylene | $C_3H_6$ | 115071 | 42.081 | 0.4339 | 1.5200 | 1.4250 | 0.7860 | 623.9 | 130 | 0.4388 | 1500 | 1.6836 |
| 30 | 1-Butene | $C_4H_8$ | 106989 | 56.108 | 0.5998 | 2.0846 | 1.5884 | 1.2940 | 707.3 | 200 | 0.6547 | 1500 | 2.2853 |
| 31 | *cis*-2-Butene | $C_4H_8$ | 590181 | 56.108 | 0.5765 | 2.1150 | 1.6299 | 1.2872 | 739.1 | 200 | 0.6199 | 1500 | 2.2715 |
| 32 | *trans*-2-Butene | $C_4H_8$ | 624646 | 56.108 | 0.6592 | 2.0700 | 1.6733 | 1.2510 | 742.2 | 200 | 0.7004 | 1500 | 2.2904 |
| 33 | 1-Pentene | $C_5H_{10}$ | 109671 | 70.134 | 0.7595 | 2.5525 | 1.5820 | 1.6660 | 713 | 200 | 0.8273 | 1500 | 2.8467 |
| 34 | 1-Hexene | $C_6H_{12}$ | 592416 | 84.161 | 0.9180 | 3.0220 | 1.5742 | 2.0320 | 715 | 200 | 0.9995 | 1500 | 3.4088 |
| 35 | 1-Heptene | $C_7H_{14}$ | 592767 | 98.188 | 1.0775 | 3.4900 | 1.5705 | 2.4030 | 717.4 | 200 | 1.1723 | 1500 | 3.9706 |
| 36 | 1-Octene | $C_8H_{16}$ | 111660 | 112.215 | 1.2355 | 3.9570 | 1.5640 | 2.7669 | 718.17 | 200 | 1.3440 | 1500 | 4.5322 |
| 37 | 1-Nonene | $C_9H_{18}$ | 124118 | 126.242 | 1.3950 | 4.4255 | 1.5624 | 3.1370 | 719.6 | 200 | 1.5168 | 1500 | 5.0938 |
| 38 | 1-Decene | $C_{10}H_{20}$ | 872059 | 140.269 | 1.7573 | 5.1710 | 1.7664 | 3.6210 | 803.02 | 200 | 1.8333 | 1500 | 5.8682 |
| 39 | 2-Methylpropene | $C_4H_8$ | 115117 | 56.108 | 0.6125 | 2.0660 | 1.5450 | 1.2057 | 676 | 200 | 0.6763 | 1500 | 2.2814 |
| 40 | 2-Methyl-1-butene | $C_5H_{10}$ | 563462 | 70.134 | 0.8703 | 2.5556 | 1.7757 | 1.7636 | 807.82 | 200 | 0.9060 | 1500 | 2.8923 |
| 41 | 2-Methyl-2-butene | $C_5H_{10}$ | 513359 | 70.134 | 0.8192 | 2.6038 | 1.7593 | 1.7195 | 800.93 | 200 | 0.8559 | 1500 | 2.8709 |
| 42 | 1,2-Butadiene | $C_4H_6$ | 590192 | 54.092 | 0.5750 | 1.6476 | 1.5270 | 0.9900 | 677.3 | 200 | 0.6269 | 1500 | 1.9202 |
| 43 | 1,3-Butadiene | $C_4H_6$ | 106990 | 54.092 | 0.5095 | 1.7050 | 1.5324 | 1.3370 | 685.6 | 200 | 0.5756 | 1500 | 1.9555 |
| 44 | 2-Methyl-1,3-butadiene | $C_5H_8$ | 78795 | 68.119 | 0.6527 | 2.2993 | 1.4943 | 1.5164 | –647.15 | 200 | 0.7508 | 1500 | 2.5571 |
| 45 | Acetylene | $C_2H_2$ | 74862 | 26.038 | 0.3199 | 0.5424 | 1.5940 | 0.4325 | 607.1 | 200 | 0.3566 | 1500 | 0.7575 |
| 46 | Methylacetylene | $C_3H_4$ | 74997 | 40.065 | 0.4478 | 1.0917 | 1.5508 | 0.6750 | 658.2 | 200 | 0.4882 | 1500 | 1.3293 |
| 47 | Dimethylacetylene | $C_4H_6$ | 503173 | 54.092 | 0.6534 | 1.6179 | 1.7837 | 1.0242 | 821.4 | 200 | 0.6721 | 1500 | 1.9148 |
| 48 | 3-Methyl-1-butyne | $C_5H_8$ | 598232 | 68.119 | 0.8274 | 2.1377 | 1.7550 | 1.5149 | 782 | 200 | 0.8646 | 1500 | 2.5255 |
| 49 | 1-Pentyne | $C_5H_8$ | 627190 | 68.119 | 0.7530 | 2.0905 | 1.5307 | 1.3780 | 672.8 | 200 | 0.8276 | 1500 | 2.4754 |
| 50 | 2-Pentyne | $C_5H_8$ | 627214 | 68.119 | 0.7074 | 2.2229 | 1.5570 | 1.3125 | 690.78 | 200 | 0.7700 | 1500 | 2.5052 |
| 51 | 1-Hexyne | $C_6H_{10}$ | 693027 | 82.145 | 0.9129 | 2.5577 | 1.5290 | 1.7370 | 683 | 200 | 1.0004 | 1500 | 3.0371 |
| 52 | 2-Hexyne | $C_6H_{10}$ | 764352 | 82.145 | 1.0360 | 3.0090 | 2.1160 | 2.1060 | 902.4 | 300 | 1.2215 | 1500 | 3.1894 |
| 53 | 3-Hexyne | $C_6H_{10}$ | 928494 | 82.145 | 0.9376 | 3.0150 | 1.9057 | 1.9860 | 817 | 300 | 1.1909 | 1500 | 3.1889 |
| 54 | 1-Heptyne | $C_7H_{12}$ | 628717 | 96.172 | 1.0712 | 3.0258 | 1.5273 | 2.0975 | 689.62 | 200 | 1.1721 | 1500 | 3.5985 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 55 | 1-Octyne | $C_8H_{14}$ | 629050 | 110.199 | 1.2307 | 3.4942 | 1.5280 | 2.4617 | 694.81 | 200 | 1.3448 | 1500 | 4.1604 |
| 56 | Vinylacetylene | $C_4H_4$ | 689974 | 52.076 | 0.5598 | 1.2141 | 1.6102 | 0.8908 | –710.4 | 200 | 0.5967 | 1500 | 1.5590 |
| 57 | Cyclopentane | $C_5H_{10}$ | 287923 | 70.134 | 0.4160 | 3.0140 | 1.4617 | 1.8095 | –668.8 | 100 | 0.4165 | 1500 | 2.9298 |
| 58 | Methylcyclopentane | $C_6H_{12}$ | 96377 | 84.161 | 0.6646 | 3.5070 | 1.5892 | 2.3526 | 727.13 | 200 | 0.7510 | 1500 | 3.5495 |
| 59 | Ethylcyclopentane | $C_7H_{14}$ | 1640897 | 98.188 | 0.8205 | 4.0342 | 1.5670 | 2.6697 | 715.52 | 200 | 0.9272 | 1500 | 4.1472 |
| 60 | Cyclohexane | $C_6H_{12}$ | 110827 | 84.161 | 0.4320 | 3.7350 | 1.1920 | 1.6350 | –530.1 | 100 | 0.4366 | 1500 | 3.6516 |
| 61 | Methylcyclohexane | $C_7H_{14}$ | 108872 | 98.188 | 0.9227 | 4.1150 | 1.6504 | 2.9006 | 779.48 | 200 | 0.9953 | 1500 | 4.3180 |
| 62 | 1,1-Dimethylcyclohexane | $C_8H_{16}$ | 590669 | 112.215 | 1.0776 | 4.6718 | 1.6540 | 3.3397 | 792.5 | 200 | 1.1535 | 1500 | 4.9543 |
| 63 | Ethylcyclohexane | $C_8H_{16}$ | 1678917 | 112.215 | 1.1059 | 4.6306 | 1.6628 | 3.2990 | 781.1 | 200 | 1.1875 | 1500 | 4.9184 |
| 64 | Cyclopentene | $C_5H_8$ | 142290 | 68.119 | 0.4807 | 2.5159 | 1.5803 | 1.7454 | 718.37 | 150 | 0.4918 | 1500 | 2.5619 |
| 65 | 1-Methylcyclopentene | $C_6H_{10}$ | 693890 | 82.145 | 0.6941 | 3.0209 | 1.6903 | 2.1209 | 781.56 | 200 | 0.7464 | 1500 | 3.1496 |
| 66 | Cyclohexene | $C_6H_{10}$ | 110838 | 82.145 | 0.5817 | 3.1717 | 1.5435 | 2.1273 | 701.62 | 150 | 0.5978 | 1500 | 3.2132 |
| 67 | Benzene | $C_6H_6$ | 71432 | 78.114 | 0.4442 | 2.3205 | 1.4946 | 1.7213 | –678.15 | 200 | 0.5340 | 1500 | 2.4169 |
| 68 | Toluene | $C_7H_8$ | 108883 | 92.141 | 0.5814 | 2.8630 | 1.4406 | 1.8980 | –650.43 | 200 | 0.7016 | 1500 | 3.0029 |
| 69 | *o*-Xylene | $C_8H_{10}$ | 95476 | 106.167 | 0.8521 | 3.2954 | 1.4944 | 2.1150 | -675.8 | 200 | 0.9643 | 1500 | 3.5965 |
| 70 | *m*-Xylene | $C_8H_{10}$ | 108383 | 106.167 | 0.7568 | 3.3924 | 1.4960 | 2.2470 | –675.9 | 200 | 0.8759 | 1500 | 3.5920 |
| 71 | *p*-Xylene | $C_8H_{10}$ | 106423 | 106.167 | 0.7512 | 3.3970 | 1.4928 | 2.2470 | –675.1 | 200 | 0.8710 | 1500 | 3.5923 |
| 72 | Ethylbenzene | $C_8H_{10}$ | 100414 | 106.167 | 0.7844 | 3.3990 | 1.5590 | 2.4260 | –702 | 200 | 0.8912 | 1500 | 3.6147 |
| 73 | Propylbenzene (eqn. 3) | $C_9H_{12}$ | 103651 | 120.194 | –21.4827 | 3.8070 | 54701 | –0.001713 | 0 | 200 | 1.0802 | 1500 | 4.1537 |
| 74 | 1,2,4-Trimethylbenzene | $C_9H_{12}$ | 95636 | 120.194 | 1.0106 | 3.8314 | 1.5010 | 2.3950 | 678.3 | 200 | 1.1354 | 1500 | 4.1854 |
| 75 | Isopropylbenzene | $C_9H_{12}$ | 98828 | 120.194 | 1.0810 | 3.7932 | 1.7505 | 3.0027 | 794.8 | 200 | 1.1480 | 1500 | 4.1808 |
| 76 | 1,3,5-Trimethylbenzene | $C_9H_{12}$ | 108678 | 120.194 | 0.9154 | 3.9270 | 1.4980 | 2.5090 | 676.9 | 200 | 1.0474 | 1500 | 4.1807 |
| 77 | *p*-Isopropyltoluene | $C_{10}H_{14}$ | 99876 | 134.221 | 1.3186 | 4.3036 | 1.7734 | 3.2570 | 811.9 | 200 | 1.3825 | 1500 | 4.7952 |
| 78 | Naphthalene | $C_{10}H_8$ | 91203 | 128.174 | 0.6805 | 3.5494 | 1.4262 | 2.5984 | 650.1 | 200 | 0.8454 | 1500 | 3.7359 |
| 79 | Biphenyl | $C_{12}H_{10}$ | 92524 | 154.211 | 0.9060 | 4.2634 | 1.4553 | 3.1550 | 661.2 | 200 | 1.0913 | 1500 | 4.5581 |
| 80 | Styrene | $C_8H_8$ | 100425 | 104.152 | 0.8930 | 2.1503 | 0.7720 | 0.9990 | 2442 | 100 | 0.8931 | 1500 | 3.2416 |
| 81 | *m*-Terphenyl | $C_{18}H_{14}$ | 92068 | 230.309 | 1.6397 | 6.0125 | 1.6902 | 5.1314 | 757.5 | 298.15 | 2.4618 | 1500 | 6.6678 |
| 82 | Methanol | $CH_4O$ | 67561 | 32.042 | 0.3925 | 0.8790 | 1.9165 | 0.5365 | 896.7 | 200 | 0.3980 | 1500 | 1.0533 |
| 83 | Ethanol | $C_2H_6O$ | 64175 | 46.069 | 0.4920 | 1.4577 | 1.6628 | 0.9390 | 744.7 | 200 | 0.5224 | 1500 | 1.6576 |
| 84 | 1-Propanol | $C_3H_8O$ | 71238 | 60.096 | 0.6190 | 2.0213 | 1.6293 | 1.2956 | 727.4 | 200 | 0.6665 | 1500 | 2.2458 |
| 85 | 1-Butanol | $C_4H_{10}O$ | 71363 | 74.123 | 0.7454 | 2.5907 | 1.6073 | 1.7320 | 712.4 | 200 | 0.8162 | 1500 | 2.8509 |
| 86 | 2-Butanol | $C_4H_{10}O$ | 78922 | 74.123 | 0.8202 | 2.5220 | 1.6010 | 1.5864 | –704.15 | 200 | 0.8890 | 1500 | 2.8513 |
| 87 | 2-Propanol | $C_3H_8O$ | 67630 | 60.096 | 0.5723 | 1.9100 | 1.4210 | 1.2155 | 626 | 150 | 0.5924 | 1500 | 2.1792 |
| 88 | 2-Methyl-2-propanol | $C_4H_{10}O$ | 75650 | 74.123 | 0.7704 | 2.5390 | 1.5502 | 1.6690 | –679.3 | 200 | 0.8567 | 1500 | 2.8508 |
| 89 | 1-Pentanol | $C_5H_{12}O$ | 71410 | 88.150 | 0.9060 | 3.0620 | 1.6054 | 2.1150 | –717.97 | 200 | 0.9890 | 1500 | 3.4133 |
| 90 | 2-Methyl-1-butanol | $C_5H_{12}O$ | 137326 | 88.150 | 1.0890 | 2.1850 | 0.8530 | 1.4000 | 2906 | 298.15 | 1.3247 | 1500.1 | 3.4718 |
| 91 | 3-Methyl-1-butanol | $C_5H_{12}O$ | 123513 | 88.150 | 1.1060 | 2.2100 | 0.8760 | 1.2200 | 2940 | 298.15 | 1.3213 | 1200.15 | 3.1770 |
| 92 | 1-Hexanol | $C_6H_{14}O$ | 111273 | 102.177 | 1.0625 | 3.5210 | 1.5835 | 2.4620 | 715.75 | 200 | 1.1607 | 1500 | 3.9726 |
| 93 | 1-Heptanol | $C_7H_{16}O$ | 111706 | 116.203 | 1.2215 | 3.9910 | 1.5800 | 2.8350 | 717.7 | 200 | 1.3330 | 1500 | 4.5346 |
| 94 | Cyclohexanol | $C_6H_{12}O$ | 108930 | 100.161 | 0.9043 | 2.5771 | 0.7882 | 1.3068 | 1952.2 | 200 | 0.9648 | 1500 | 3.8251 |
| 95 | Ethylene glycol | $C_2H_6O_2$ | 107211 | 62.068 | 0.8200 | 1.2780 | 1.6980 | 0.9290 | –754 | 200 | 0.8481 | 1500 | 1.8521 |
| 96 | 1,2-Propylene glycol | $C_3H_8O_2$ | 57556 | 76.095 | 2.0114 | 0.8082 | 1.8656 | –2.4404 | 279.98 | 298.15 | 1.0218 | 1000.15 | 2.1175 |
| 97 | Phenol | $C_6H_6O$ | 108952 | 94.113 | 0.4340 | 2.4450 | 1.1520 | 1.5120 | –507 | 100 | 0.4401 | 1500 | 2.6045 |
| 98 | *o*-Cresol | $C_7H_8O$ | 95487 | 108.140 | 0.7988 | 2.8530 | 1.4765 | 2.0420 | –664.7 | 200 | 0.9158 | 1500 | 3.2163 |
| 99 | *m*-Cresol | $C_7H_8O$ | 108394 | 108.140 | 0.7515 | 2.0900 | 0.6666 | 1.2120 | 2214 | 200 | 0.8701 | 1500 | 3.2075 |
| 100 | *p*-Cresol | $C_7H_8O$ | 106445 | 108.140 | 0.7384 | 2.9080 | 1.4559 | 2.0910 | –650.42 | 200 | 0.8707 | 1500 | 3.2102 |
| 101 | Dimethyl ether | $C_2H_6O$ | 115106 | 46.069 | 0.5148 | 1.4420 | 1.6034 | 0.7747 | 725.4 | 200 | 0.5436 | 1500 | 1.6581 |
| 102 | Methyl ethyl ether | $C_3H_8O$ | 540670 | 60.096 | 0.6868 | 1.9959 | 1.5534 | 1.1168 | 692.04 | 200 | 0.7396 | 1500 | 2.2931 |
| 103 | Methyl-*n*-propyl ether | $C_4H_{10}O$ | 557175 | 74.123 | 0.9215 | 2.3943 | 1.6936 | 1.4896 | 797.79 | 298 | 1.1251 | 1200 | 2.6391 |
| 104 | Methyl isopropyl ether | $C_4H_{10}O$ | 598538 | 74.123 | 0.8923 | 2.4765 | 1.6960 | 1.5598 | 791.4 | 200 | 0.9280 | 1500 | 2.8696 |
| 105 | Methyl-*n*-butyl ether | $C_5H_{12}O$ | 628284 | 88.150 | 0.8205 | 3.0869 | 1.3864 | 1.7886 | 613.87 | 300 | 1.3300 | 1200 | 3.1994 |
| 106 | Methyl isobutyl ether | $C_5H_{12}O$ | 625445 | 88.150 | 0.7284 | 3.1713 | 1.3520 | 1.8948 | 585.14 | 300 | 1.3200 | 1200 | 3.1987 |

**TABLE 2-198 Heat Capacities of Inorganic and Organic Compounds in the Ideal Gas State** (*Continued*)

| Cmpd. no. | Name | Formula | CAS no. | Mol wt. | C1 × 1E–05 | C2 × 1E–05 | C3 × 1E–03 | C4 × 1E–05 | C5 | $T_{min}$, K | $C_p$ at $T_{min}$ × 1E–05 | $T_{max}$, K | $C_p$ at $T_{max}$ × 1E–05 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 107 | Methyl tert-butyl ether | $C_5H_{12}O$ | 1634044 | 88.150 | 0.9933 | 3.0667 | 1.7426 | 2.0764 | 795.59 | 200 | 1.0394 | 1500 | 3.4321 |
| 108 | Diethyl ether | $C_4H_{10}O$ | 60297 | 74.123 | 0.8621 | 2.5510 | 1.5413 | 1.4370 | –688.9 | 200 | 0.9316 | 1500 | 2.9244 |
| 109 | Ethyl propyl ether | $C_5H_{12}O$ | 628320 | 88.150 | 1.1320 | 2.9400 | 1.8270 | 2.0550 | –852 | 298.15 | 1.3538 | 1500 | 3.4535 |
| 110 | Ethyl isopropyl ether | $C_5H_{12}O$ | 625547 | 88.150 | 1.0953 | 3.0032 | 1.7988 | 2.1311 | 817.35 | 298.15 | 1.3620 | 1200 | 3.2289 |
| 111 | Methyl phenyl ether | $C_7H_8O$ | 100663 | 108.140 | 0.7637 | 2.9377 | 1.6051 | 2.1700 | 751.2 | 300 | 1.1302 | 1200 | 3.0226 |
| 112 | Diphenyl ether | $C_{12}H_{10}O$ | 101848 | 170.211 | 1.0985 | 4.3412 | 1.6222 | 3.6455 | 743.62 | 300 | 1.7298 | 1200 | 4.5143 |
| 113 | Formaldehyde | $CH_2O$ | 50000 | 30.026 | 0.3327 | 0.4954 | 1.8666 | 0.2808 | 934.9 | 50 | 0.3327 | 1500 | 0.7113 |
| 114 | Acetaldehyde | $C_2H_4O$ | 75070 | 44.053 | 0.4451 | 1.0687 | 1.6141 | 0.6135 | 737.8 | 200 | 0.4660 | 1500 | 1.2994 |
| 115 | 1-Propanal | $C_3H_6O$ | 123386 | 58.080 | 0.7174 | 1.9140 | 2.0144 | 1.1708 | 930.6 | 200 | 0.7266 | 1500 | 2.1149 |
| 116 | 1-Butanal | $C_4H_8O$ | 123728 | 72.107 | 0.8966 | 2.3731 | 1.9754 | 1.5866 | 904.13 | 200 | 0.9119 | 1500 | 2.6775 |
| 117 | 1-Pentanal | $C_5H_{10}O$ | 110623 | 86.134 | 1.0743 | 2.8363 | 1.9549 | 2.0146 | 890.44 | 200 | 1.0960 | 1500 | 3.2404 |
| 118 | 1-Hexanal | $C_6H_{12}O$ | 66251 | 100.161 | 1.2320 | 2.2146 | 0.8400 | 1.2190 | 2205 | 200 | 1.2672 | 1500 | 3.7314 |
| 119 | 1-Heptanal | $C_7H_{14}O$ | 111717 | 114.188 | 1.4040 | 2.5907 | 0.8315 | 1.3120 | 2201 | 200 | 1.4479 | 1500 | 4.2863 |
| 120 | 1-Octanal | $C_8H_{16}O$ | 124130 | 128.214 | 1.6088 | 4.2180 | 1.9126 | 3.2780 | 869 | 200 | 1.6504 | 1500 | 4.9286 |
| 121 | 1-Nonanal | $C_9H_{18}O$ | 124196 | 142.241 | 1.7347 | 4.5115 | 1.7120 | 3.3256 | 810.96 | 200 | 1.8005 | 1500 | 5.4439 |
| 122 | 1-Decanal | $C_{10}H_{20}O$ | 112312 | 156.268 | 1.9641 | 5.1412 | 1.8989 | 4.1278 | 862.51 | 200 | 2.0192 | 1500 | 6.0539 |
| 123 | Acetone | $C_3H_6O$ | 67641 | 58.080 | 0.5704 | 1.6320 | 1.6070 | 0.9680 | 731.5 | 200 | 0.6049 | 1500 | 1.8820 |
| 124 | Methyl ethyl ketone | $C_4H_8O$ | 78933 | 72.107 | 0.7840 | 2.1032 | 1.5488 | 1.1855 | 693 | 200 | 0.8397 | 1500 | 2.4816 |
| 125 | 2-Pentanone | $C_5H_{10}O$ | 107879 | 86.134 | 0.9005 | 2.7085 | 1.6592 | 1.8012 | 743.96 | 200 | 0.9591 | 1500 | 3.0797 |
| 126 | Methyl isopropyl ketone | $C_5H_{10}O$ | 563804 | 86.134 | 1.5914 | 1.7640 | 1.2076 | –407.4000 | 10.503 | 300 | 1.1291 | 1500 | 2.9991 |
| 127 | 2-Hexanone | $C_6H_{12}O$ | 591786 | 100.161 | 1.0940 | 1.8070 | 0.6890 | 1.4740 | 1772 | 200 | 1.1815 | 1200 | 3.3207 |
| 128 | Methyl isobutyl ketone | $C_6H_{12}O$ | 108101 | 100.161 | 1.2270 | 2.1950 | 0.8420 | 1.1910 | 2460 | 298.15 | 1.4755 | 1500.15 | 3.6532 |
| 129 | 3-Methyl-2-pentanone | $C_6H_{12}O$ | 565617 | 100.161 | 1.0028 | 3.3169 | 1.6900 | 2.3000 | 770.7 | 300 | 1.3604 | 1200 | 3.4275 |
| 130 | 3-Pentanone | $C_5H_{10}O$ | 96220 | 86.134 | 0.9690 | 2.4907 | 1.4177 | 1.3010 | 646.7 | 200 | 1.0536 | 1500 | 3.0358 |
| 131 | Ethyl isopropyl ketone | $C_6H_{12}O$ | 565695 | 100.161 | 1.2400 | 3.2000 | 1.9670 | 2.3460 | 896 | 298.15 | 1.4479 | 1200 | 3.4234 |
| 132 | Diisopropyl ketone | $C_7H_{14}O$ | 565800 | 114.188 | 1.0869 | 4.0540 | 1.7802 | 2.9786 | 791.6 | 300 | 1.5102 | 1500 | 4.3093 |
| 133 | Cyclohexanone | $C_6H_{10}O$ | 108941 | 98.145 | 0.5776 | 3.3535 | 1.2202 | 1.5700 | 586.92 | 200 | 0.7321 | 1500 | 3.4870 |
| 134 | Methyl phenyl ketone | $C_8H_8O$ | 98862 | 120.151 | 0.8540 | 2.3340 | 0.8310 | 0.7730 | 2227 | 298.15 | 1.1313 | 1500 | 3.2797 |
| 135 | Formic acid[1] | $CH_2O_2$ | 64186 | 46.026 | 0.3381 | 0.7593 | 1.1925 | 0.3180 | 550 | 50 | 0.3381 | 1500 | 0.9933 |
| 136 | Acetic acid[2] | $C_2H_4O_2$ | 64197 | 60.053 | 0.4020 | 1.3675 | 1.2620 | 0.7003 | 569.7 | 50 | 0.4020 | 1500 | 1.5756 |
| 137 | Propionic acid[2] | $C_3H_6O_2$ | 79094 | 74.079 | 0.6959 | 1.7778 | 1.7098 | 1.2654 | –763.78 | 298.15 | 0.8938 | 1500 | 2.1248 |
| 138 | *n*-Butyric acid[2] | $C_4H_8O_2$ | 107926 | 88.106 | 1.4880 | 1.3522 | 1.1460 | –678.0000 | 6.98 | 298.15 | 1.1533 | 1200.1 | 2.4716 |
| 139 | Isobutyric acid[2] | $C_4H_8O_2$ | 79312 | 88.106 | 0.7469 | 2.4356 | 1.7150 | 1.8484 | 757.75 | 298.15 | 1.0427 | 1200 | 2.5383 |
| 140 | Benzoic acid | $C_7H_6O_2$ | 65850 | 122.123 | 0.7759 | 2.6455 | 1.7925 | 2.2382 | 835.9 | 200 | 0.8126 | 1500 | 2.9712 |
| 141 | Acetic anhydride | $C_4H_6O_3$ | 108247 | 102.090 | 0.7130 | 2.2220 | 1.6203 | 1.6760 | 746.5 | 200 | 0.7665 | 1500 | 2.5675 |
| 142 | Methyl formate | $C_2H_4O_2$ | 107313 | 60.053 | 0.5060 | 1.2190 | 1.6370 | 0.8940 | 743 | 250 | 0.5888 | 1500 | 1.5109 |
| 143 | Methyl acetate | $C_3H_6O_2$ | 79209 | 74.079 | 0.5550 | 1.7820 | 1.2600 | 0.8530 | 562 | 298 | 0.8489 | 1500 | 2.0754 |
| 144 | Methyl propionate | $C_4H_8O_2$ | 554121 | 88.106 | 0.7765 | 2.4420 | 1.7140 | 1.8180 | 716 | 300 | 1.1242 | 1200 | 2.5276 |
| 145 | Methyl *n*-butyrate | $C_5H_{10}O_2$ | 623427 | 102.133 | 0.8940 | 2.9100 | 1.5700 | 2.0730 | 678.3 | 298 | 1.3461 | 1200 | 3.0766 |
| 146 | Ethyl formate | $C_3H_6O_2$ | 109944 | 74.079 | 0.5370 | 1.8860 | 1.2070 | 0.8640 | 496 | 100 | 0.5412 | 1500 | 2.1485 |
| 147 | Ethyl acetate | $C_4H_8O_2$ | 141786 | 88.106 | 0.9981 | 2.0931 | 2.0226 | 1.8030 | 928.05 | 200 | 1.0126 | 1500 | 2.6594 |
| 148 | Ethyl propionate | $C_5H_{10}O_2$ | 105373 | 102.133 | 0.9370 | 2.8290 | 1.6480 | 2.1550 | 724.7 | 300 | 1.3377 | 1200 | 3.0569 |
| 149 | Ethyl *n*-butyrate | $C_6H_{12}O_2$ | 105544 | 116.160 | 1.1150 | 3.3910 | 1.6705 | 2.5180 | 733.6 | 298 | 1.5583 | 1200 | 3.6213 |
| 150 | *n*-Propyl formate | $C_4H_8O_2$ | 110747 | 88.106 | 0.8710 | 2.4470 | 1.9254 | 1.8880 | –821.3 | 298.15 | 1.1022 | 1500 | 2.7484 |
| 151 | *n*-Propyl acetate | $C_5H_{10}O_2$ | 109604 | 102.133 | 1.7994 | 1.7530 | 1.1960 | –4.1200 | 108.2 | 298.15 | 1.3594 | 1500 | 3.2024 |
| 152 | *n*-Butyl acetate | $C_6H_{12}O_2$ | 123864 | 116.160 | 1.1684 | 3.7690 | 1.9560 | 2.8180 | 811.2 | 300 | 1.5358 | 1200 | 3.6724 |
| 153 | Methyl benzoate | $C_8H_8O_2$ | 93583 | 136.150 | 0.9396 | 2.5590 | 0.8250 | 1.3600 | 3000 | 300 | 1.2586 | 1200 | 3.3569 |
| 154 | Ethyl benzoate | $C_9H_{10}O_2$ | 93890 | 150.177 | 1.0944 | 4.1794 | 0.8838 | –1.6090 | –1183.1 | 300 | 1.4598 | 1500 | 4.2540 |
| 155 | Vinyl acetate | $C_4H_6O_2$ | 108054 | 86.090 | 0.5360 | 2.1190 | 1.1980 | 1.1470 | 510 | 100 | 0.5404 | 1500 | 2.3750 |
| 156 | Methylamine | $CH_5N$ | 74895 | 31.057 | 0.4100 | 1.0578 | 1.7080 | 0.6836 | 735 | 150 | 0.4136 | 1500 | 1.2388 |
| 157 | Dimethylamine | $C_2H_7N$ | 124403 | 45.084 | 0.5565 | 1.6384 | 1.7341 | 1.0899 | 793.04 | 200 | 0.5812 | 1500 | 1.8585 |
| 158 | Trimethylamine | $C_3H_9N$ | 75503 | 59.111 | 0.7107 | 1.5051 | 0.7966 | 0.8454 | 2187.6 | 200 | 0.7439 | 1500 | 2.4322 |
| 159 | Ethylamine | $C_2H_7N$ | 75047 | 45.084 | 0.5940 | 1.6180 | 1.8120 | 1.0780 | 820 | 200 | 0.6139 | 1500 | 1.8528 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 160 | Diethylamine | $C_4H_{11}N$ | 109897 | 73.138 | 0.9102 | 2.6740 | 1.7190 | 1.7926 | 794.94 | 200 | 0.9502 | 1500 | 3.0519 |
| 161 | Triethylamine | $C_6H_{15}N$ | 121448 | 101.192 | 1.2766 | 2.5559 | 0.8094 | 1.4829 | 2231.7 | 200 | 1.3278 | 1500 | 4.2046 |
| 162 | *n*-Propylamine | $C_3H_9N$ | 107108 | 59.111 | 0.7608 | 2.1049 | 1.7256 | 1.3936 | 789.03 | 200 | 0.7933 | 1500 | 2.4353 |
| 163 | di-*n*-Propylamine | $C_6H_{15}N$ | 142847 | 101.192 | 1.2114 | 2.6127 | 0.7896 | 1.6903 | 2394.4 | 300 | 1.5900 | 1500 | 4.2484 |
| 164 | Isopropylamine | $C_3H_9N$ | 75310 | 59.111 | 0.6855 | 2.1876 | 1.5831 | 1.3855 | 691.76 | 200 | 0.7510 | 1500 | 2.4540 |
| 165 | Diisopropylamine | $C_6H_{15}N$ | 108189 | 101.192 | 1.1384 | 2.5747 | 0.7384 | 1.6200 | 2143 | 300 | 1.5995 | 1500 | 4.1941 |
| 166 | Aniline | $C_6H_7N$ | 62533 | 93.128 | 0.6533 | 2.5192 | 1.4608 | 1.8870 | –653.1 | 200 | 0.7705 | 1500 | 2.8047 |
| 167 | *N*-Methylaniline | $C_7H_9N$ | 100618 | 107.155 | 0.7796 | 3.0280 | 1.5203 | 2.3280 | 699.8 | 300 | 1.2602 | 1500 | 3.3641 |
| 168 | *N,N*-Dimethylaniline | $C_8H_{11}N$ | 121697 | 121.182 | 0.8742 | 2.7204 | 0.7242 | 1.1300 | 1949 | 300 | 1.3903 | 1500 | 3.8844 |
| 169 | Ethylene oxide | $C_2H_4O$ | 75218 | 44.053 | 0.3346 | 1.2116 | 1.6084 | 0.8241 | 737.3 | 50 | 0.0000<br>0.3346 | 1500 | 1.3297 |
| 170 | Furan | $C_4H_4O$ | 110009 | 68.075 | 0.3727 | 1.6606 | 1.5112 | 1.3145 | 686 | 200 | 0.4376 | 1500 | 1.7940 |
| 171 | Thiophene | $C_4H_4S$ | 110021 | 84.142 | 0.4040 | 1.6270 | 1.4564 | 1.3212 | 649 | 200 | 0.4884 | 1500 | 1.8097 |
| 172 | Pyridine | $C_5H_5N$ | 110861 | 79.101 | 0.4413 | 2.0830 | 1.4783 | 1.5330 | 676.8 | 200 | 0.5220 | 1500 | 2.2194 |
| 173 | Formamide | $CH_3NO$ | 75127 | 45.041 | 0.3822 | 0.9300 | 1.8450 | 0.6900 | 850 | 150 | 0.3833 | 1500 | 1.1203 |
| 174 | *N,N*-Dimethylformamide | $C_3H_7NO$ | 68122 | 73.095 | 0.7220 | 1.7830 | 1.5320 | 1.3100 | 762 | 200 | 0.7594 | 1500 | 2.2596 |
| 175 | Acetamide | $C_2H_5NO$ | 60355 | 59.068 | 0.3420 | 1.2940 | 1.0750 | 0.6400 | 502 | 100 | 0.3448 | 1500 | 1.4997 |
| 176 | *N*-Methylacetamide | $C_3H_7NO$ | 79163 | 73.095 | 0.6116 | 2.0290 | 1.7683 | 1.3302 | 835.5 | 300 | 0.7698 | 1500 | 2.2209 |
| 177 | Acetonitrile | $C_2H_3N$ | 75058 | 41.053 | 0.4191 | 0.8876 | 1.5818 | 0.5032 | 699.8 | 100 | 0.4192 | 1500 | 1.1285 |
| 178 | Propionitrile | $C_3H_5N$ | 107120 | 55.079 | 0.5357 | 1.4617 | 1.5530 | 0.9120 | 678.2 | 200 | 0.5832 | 1500 | 1.7235 |
| 179 | *n*-Butyronitrile | $C_4H_7N$ | 109740 | 69.106 | 0.6906 | 1.9996 | 1.5494 | 1.3146 | 675 | 200 | 0.7607 | 1500 | 2.3273 |
| 180 | Benzonitrile | $C_7H_5N$ | 100470 | 103.123 | 0.7186 | 2.2700 | 1.4669 | 1.6930 | –680.77 | 200 | 0.8053 | 1500 | 2.6706 |
| 181 | Methyl mercaptan | $CH_4S$ | 74931 | 48.109 | 0.4146 | 0.8307 | 1.5890 | 0.4612 | 716.7 | 200 | 0.4329 | 1500 | 1.0781 |
| 182 | Ethyl mercaptan | $C_2H_6S$ | 75081 | 62.136 | 0.5576 | 1.3617 | 1.5221 | 0.8073 | 687.5 | 200 | 0.5970 | 1500 | 1.6729 |
| 183 | *n*-Propyl mercaptan | $C_3H_8S$ | 107039 | 76.163 | 0.7474 | 1.9523 | 1.6310 | 1.2112 | 750.92 | 200 | 0.7848 | 1500 | 2.3216 |
| 184 | *n*-Butyl mercaptan | $C_4H_{10}S$ | 109795 | 90.189 | 0.9248 | 2.7795 | 1.6837 | 1.5974 | 758.68 | 200 | 0.9714 | 1500 | 3.1008 |
| 185 | Isobutyl mercaptan | $C_4H_{10}S$ | 513440 | 90.189 | 0.9142 | 2.4513 | 1.6265 | 1.6157 | 745.8 | 200 | 0.9660 | 1500 | 2.9095 |
| 186 | sec-Butyl mercaptan | $C_4H_{10}S$ | 513531 | 90.189 | 0.9237 | 2.5166 | 1.6109 | 1.5641 | 739.2 | 200 | 0.9763 | 1500 | 2.9615 |
| 187 | Dimethyl sulfide | $C_2H_6S$ | 75183 | 62.136 | 0.6037 | 1.3747 | 1.6410 | 0.7988 | –743.5 | 200 | 0.6298 | 1500 | 1.6949 |
| 188 | Methyl ethyl sulfide | $C_3H_8S$ | 624895 | 76.163 | 0.7508 | 1.9577 | 1.6424 | 1.1949 | 749.19 | 273.16 | 0.9004 | 1500 | 2.3178 |
| 189 | Diethyl sulfide | $C_4H_{10}S$ | 352932 | 90.189 | 0.9429 | 2.6863 | 1.7624 | 1.6752 | –798.3 | 200 | 0.9794 | 1500 | 3.0338 |
| 190 | Fluoromethane | $CH_3F$ | 593533 | 34.033 | 0.3329 | 0.7399 | 1.8639 | 0.4608 | 891.16 | 50 | 0.3329 | 1500 | 0.9024 |
| 191 | Chloromethane | $CH_3Cl$ | 74873 | 50.488 | 0.3409 | 0.7246 | 1.7230 | 0.4480 | 780.5 | 150 | 0.3424 | 1500 | 0.9097 |
| 192 | Trichloromethane | $CHCl_3$ | 67663 | 119.377 | 0.3942 | 0.6573 | 0.9280 | 0.4930 | 399.6 | 100 | 0.4048 | 1500 | 1.0063 |
| 193 | Tetrachloromethane | $CCl_4$ | 56235 | 153.822 | 0.3758 | 0.7054 | 0.5121 | 0.4850 | 236.1 | 100 | 0.4730 | 1500 | 1.0662 |
| 194 | Bromomethane | $CH_3Br$ | 74839 | 94.939 | 0.3377 | 0.7150 | 1.5780 | 0.4175 | 691.4 | 100 | 0.3378 | 1500 | 0.9107 |
| 195 | Fluoroethane | $C_2H_5F$ | 353366 | 48.060 | 0.4437 | 1.3119 | 1.6422 | 0.8544 | 738.77 | 200 | 0.4726 | 1500 | 1.5008 |
| 196 | Chloroethane | $C_2H_5Cl$ | 75003 | 64.514 | 0.4568 | 1.2967 | 1.5992 | 0.8590 | 708.8 | 100 | 0.4569 | 1500 | 1.5112 |
| 197 | Bromoethane | $C_2H_5Br$ | 74964 | 108.966 | 0.4719 | 1.2787 | 1.5957 | 0.8517 | 703.87 | 200 | 0.5089 | 1500 | 1.5121 |
| 198 | 1-Chloropropane | $C_3H_7Cl$ | 540545 | 78.541 | 0.6210 | 1.8430 | 1.6290 | 1.2337 | 724 | 200 | 0.6674 | 1500 | 2.1126 |
| 199 | 2-Chloropropane | $C_3H_7Cl$ | 75296 | 78.541 | 0.6181 | 1.8023 | 1.5438 | 1.1893 | 685.93 | 200 | 0.6768 | 1500 | 2.1023 |
| 200 | 1,1-Dichloropropane | $C_3H_6Cl_2$ | 78999 | 112.986 | 0.7145 | 1.7344 | 1.5240 | 1.2230 | 674.2 | 150 | 0.7268 | 1500 | 2.1609 |
| 201 | 1,2-Dichloropropane | $C_3H_6Cl_2$ | 78875 | 112.986 | 0.7866 | 1.7429 | 1.7157 | 1.2627 | 765.1 | 200 | 0.8217 | 1500 | 2.1894 |
| 202 | Vinyl chloride | $C_2H_3Cl$ | 75014 | 62.499 | 0.4236 | 0.8735 | 1.6492 | 0.6556 | 739.07 | 200 | 0.4457 | 1500 | 1.1423 |
| 203 | Fluorobenzene | $C_6H_5F$ | 462066 | 96.104 | 0.6265 | 2.1646 | 1.5640 | 1.7278 | –724.29 | 200 | 0.6914 | 1500 | 2.4736 |
| 204 | Chlorobenzene | $C_6H_5Cl$ | 108907 | 112.558 | 0.8011 | 2.3100 | 2.1570 | 2.0460 | –897.6 | 200 | 0.8219 | 1500 | 2.5327 |
| 205 | Bromobenzene | $C_6H_5Br$ | 108861 | 157.010 | 0.7210 | 2.0640 | 1.6504 | 1.6870 | 765.3 | 200 | 0.7679 | 1500 | 2.4628 |
| 206 | Air | | 132259100 | 28.951 | 0.2896 | 0.0939 | 3.0120 | 0.0758 | 1484 | 50 | 0.2896 | 1500 | 0.3496 |
| 207 | Hydrogen[3] | $H_2$ | 1333740 | 2.016 | 0.2762 | 0.0956 | 2.4660 | 0.0376 | 567.6 | 250 | 0.2843 | 1500 | 0.3225 |
| 208 | Helium-4 (eqn 2) | He | 7440597 | 4.003 | 0.2079 | 0 | 0 | 0 | 0 | 100 | 0.2079 | 1500 | 0.2079 |
| 209 | Neon | Ne | 7440019 | 20.180 | 0.2079 | 0 | 0 | 0 | 0 | 100 | 0.2079 | 1500 | 0.2079 |
| 210 | Argon | Ar | 7440371 | 39.948 | 0.2079 | 0 | 0 | 0 | 0 | 100 | 0.2079 | 1500 | 0.2079 |
| 211 | Fluorine | $F_2$ | 7782414 | 37.997 | 0.2912 | 0.1013 | 1.4530 | 0.0941 | 662.91 | 50 | 0.2912 | 1500 | 0.3812 |

**TABLE 2-198 Heat Capacities of Inorganic and Organic Compounds in the Ideal Gas State** (*Concluded*)

| Cmpd. no. | Name | Formula | CAS no. | Mol wt. | C1 × 1E–05 | C2 × 1E–05 | C3 × 1E–03 | C4 × 1E–05 | C5 | $T_{min}$, K | $C_p$ at $T_{min}$ × 1E–05 | $T_{max}$, K | $C_p$ at $T_{max}$ × 1E–05 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 212 | Chlorine | $Cl_2$ | 7782505 | 70.905 | 0.2914 | 0.0918 | 0.9490 | 0.1003 | 425 | 50 | 0.2914 | 1500 | 0.3793 |
| 213 | Bromine | $Br_2$ | 7726956 | 159.808 | 0.3011 | 0.0801 | 0.7514 | 0.1078 | 314.6 | 100 | 0.3090 | 1500 | 0.3794 |
| 214 | Oxygen | $O_2$ | 7782447 | 31.999 | 0.2910 | 0.1004 | 2.5265 | 0.0936 | 1153.8 | 50 | 0.2910 | 1500 | 0.3653 |
| 215 | Nitrogen | $N_2$ | 7727379 | 28.014 | 0.2911 | 0.0861 | 1.7016 | 0.0010 | 909.79 | 50 | 0.2911 | 1500 | 0.3484 |
| 216 | Ammonia | $NH_3$ | 7664417 | 17.031 | 0.3343 | 0.4898 | 2.0360 | 0.2256 | 882 | 100 | 0.3343 | 1500 | 0.6647 |
| 217 | Hydrazine | $N_2H_4$ | 302012 | 32.045 | 0.3871 | 0.8576 | 1.7228 | 0.5664 | 733.53 | 200 | 0.4070 | 1500 | 1.0571 |
| 218 | Nitrous oxide | $N_2O$ | 10024972 | 44.013 | 0.2934 | 0.3236 | 1.1238 | 0.2177 | 479.4 | 100 | 0.2948 | 1500 | 0.5828 |
| 219 | Nitric oxide (eqn 2) | NO | 10102439 | 30.006 | 0.3498 | –3.5320E–04 | 7.7290E–05 | –5.7357E–10 | 1.4526E–08 | 100 | 0.3217 | 1500 | 0.3586 |
| 220 | Cyanogen | $C_2N_2$ | 460195 | 52.036 | 0.3545 | 0.5015 | 1.0570 | 0.4520 | –396 | 100 | 0.3648 | 1500 | 0.8100 |
| 221 | Carbon monoxide | CO | 630080 | 28.010 | 0.2911 | 0.0877 | 3.0851 | 0.0846 | 1538.2 | 60 | 0.2911 | 1500 | 0.3521 |
| 222 | Carbon dioxide | $CO_2$ | 124389 | 44.010 | 0.2937 | 0.3454 | 1.4280 | 0.2640 | 588 | 50 | 0.2937 | 5000 | 0.6335 |
| 223 | Carbon disulfide | $CS_2$ | 75150 | 76.143 | 0.3010 | 0.3338 | 0.8960 | 0.2893 | 374.7 | 100 | 0.3100 | 1500 | 0.6148 |
| 224 | Hydrogen fluoride | HF | 7664393 | 20.006 | 0.2913 | 0.0933 | 2.9050 | 0.0020 | 1326 | 50 | 0.2913 | 1500 | 0.3224 |
| 225 | Hydrogen chloride | HCl | 7647010 | 36.461 | 0.2916 | 0.0905 | 2.0938 | –0.0011 | 120 | 50 | 0.2914 | 1500 | 0.3406 |
| 226 | Hydrogen bromide | HBr | 10035106 | 80.912 | 0.2912 | 0.0953 | 2.1420 | 0.0157 | 1400 | 50 | 0.2912 | 1500 | 0.3479 |
| 227 | Hydrogen cyanide | HCN | 74908 | 27.026 | 0.3013 | 0.3171 | 1.6102 | 0.2179 | 626 | 100 | 0.3014 | 1500 | 0.5522 |
| 228 | Hydrogen sulfide | $H_2S$ | 7783064 | 34.082 | 0.3329 | 0.2609 | 0.9134 | –0.1798 | 949.4 | 100 | 0.3329 | 1500 | 0.5143 |
| 229 | Sulfur dioxide | $SO_2$ | 7446095 | 64.065 | 0.3338 | 0.2586 | 0.9328 | 0.1088 | 423.7 | 100 | 0.3354 | 1500 | 0.5695 |
| 230 | Sulfur trioxide | $SO_3$ | 7446119 | 80.064 | 0.3341 | 0.4968 | 0.8732 | 0.2856 | 393.74 | 100 | 0.3408 | 1500 | 0.7967 |
| 231 | Water | $H_2O$ | 7732185 | 18.015 | 0.3336 | 0.2679 | 2.6105 | 0.0890 | 1169 | 100 | 0.3336 | 2273.15 | 0.5276 |

All substances are listed in alphabetical order in Table 2-6*a*.

Compiled from Daubert, T. E., R. P. Danner, H. M. Sibul, and C. C. Stebbins, DIPPR Data Compilation of Pure Compound Properties, Project 801 Sponsor Release, July, 1993, Design Institute for Physical Property Data, AIChE, New York, NY; and from Thermodynamics Research Center, "Selected Values of Properties of Hydrocarbons and Related Compounds," Thermodynamics Research Center Hydrocarbon Project, Texas A&M University, College Station, Texas (extant 1994).

Temperatures are expressed in kelvins; heat capacities, in J/kmol-K.

J/(kmol·K) × 2.390E–04 = cal/(gmol·°C); J/(kmol·K) × 2.390059E–04 = Btu/(lbmol·°F).

Use heat capacity $= C1 + C2\left[\frac{C3}{T}\Big/\sinh\left(\frac{C3}{T}\right)\right]^2 + C4\left[\frac{C5}{T}\Big/\cosh\left(\frac{C5}{T}\right)\right]^2$ unless otherwise specified.

Equation 2 is heat capacity $= C1 + C2 \times T + C3 \times T^2 + C4 \times T^3 + C5 \times T^4$.

Equation 3 is heat capacity $= C1 + C2 \times \ln T + C3/T + C4 \times T$.

[1] For the monomer. Monomer and dimer are in equilibrium below 600 K.

[2] For the monomer.

[3] For equilibrium mixture of *ortho* and *para* hydrogen.

**TABLE 2-199 $C_p/C_v$: Ratios of Specific Heats of Gases at 1-atm Pressure***

| Compound | Formula | Temperature, °C | Ratio of specific heats, $(\gamma) = C_p/C_v$ | Compound | Formula | Temperature, °C | Ratio of specific heats, $(\gamma) = C_p/C_v$ |
|---|---|---|---|---|---|---|---|
| Acetaldehyde | $C_2H_4O$ | 30 | 1.14 | Hydrogen (*Cont.*) | | | |
| Acetic acid | $C_2H_4O_2$ | 136 | 1.15 | iodide | HI | 20–100 | 1.40 |
| Acetylene | $C_2H_2$ | 15 | 1.26 | sulfide | $H_2S$ | 15 | 1.32 |
| | | –71 | 1.31 | | | –45 | 1.30 |
| Air | | 925 | 1.36 | | | –57 | 1.29 |
| | | 17 | 1.403 | | | | |
| | | –78 | 1.408 | Iodine | $I_2$ | 185 | 1.30 |
| | | –118 | 1.415 | Isobutane | $C_4H_{10}$ | 15 | 1.11 |
| Ammonia | $NH_3$ | 15 | 1.310 | | | | |
| Argon | A | 15 | 1.668 | Krypton | Kr | 19 | 1.68 |
| | | –180 | 1.76 (?) | | | | |
| | | 0–100 | 1.67 | Mercury | Hg | 360 | 1.67 |
| | | | | Methane | $CH_4$ | 600 | 1.113 |
| Benzene | $C_6H_6$ | 90 | 1.10 | | | 300 | 1.16 |
| Bromine | $Br_2$ | 20–350 | 1.32 | | | 15 | 1.31 |
| | | | | | | –80 | 1.34 |
| Carbon dioxide | $CO_2$ | 15 | 1.304 | | | –115 | 1.41 |
| | | –75 | 1.37 | Methyl acetate | $C_3H_6O_2$ | 15 | 1.14 |
| disulfide | $CS_2$ | 100 | 1.21 | alcohol | $CH_4O$ | 77 | 1.203 |
| monoxide | CO | 15 | 1.404 | ether | $C_2H_6O$ | 6–30 | 1.11 |
| | | –180 | 1.41 | Methylal | $C_3H_8O_2$ | 13 | 1.06 |
| Chlorine | $Cl_2$ | 15 | 1.355 | | | 40 | 1.09 |
| Chloroform | $CHCl_3$ | 100 | 1.15 | | | | |
| Cyanogen | $(CN)_2$ | 15 | 1.256 | Neon | Ne | 19 | 1.64 |
| Cyclohexane | $C_6H_{12}$ | 80 | 1.08 | Nitric oxide | NO | 15 | 1.400 |
| | | | | | | –45 | 1.39 |
| Dichlorodifluormethane | $CCl_2F_2$ | 25 | 1.139 | | | –80 | 1.38 |
| | | | | Nitrogen | $N_2$ | 15 | 1.404 |
| Ethane | $C_2H_6$ | 100 | 1.19 | | | –181 | 1.47 |
| | | 15 | 1.22 | Nitrous oxide | $N_2O$ | 100 | 1.28 |
| | | –82 | 1.28 | | | 15 | 1.303 |
| Ethyl alcohol | $C_2H_6O$ | 90 | 1.13 | | | –30 | 1.31 |
| ether | $C_4H_{10}O$ | 35 | 1.08 | | | –70 | 1.34 |
| | | 80 | 1.086 | | | | |
| Ethylene | $C_2H_4$ | 100 | 1.18 | Oxygen | $O_2$ | 15 | 1.401 |
| | | 15 | 1.255 | | | –76 | 1.415 |
| | | –91 | 1.35 | | | –181 | 1.45 |
| | | | | | | | |
| Helium | He | –180 | 1.660 | Pentane (*n*-) | $C_5H_{12}$ | 86 | 1.086 |
| Hexane (*n*-) | $C_6H_{14}$ | 80 | 1.08 | Phosphorus | P | 300 | 1.17 |
| Hydrogen | $H_2$ | 15 | 1.410 | Potassium | K | 850 | 1.77 |
| | | –76 | 1.453 | | | | |
| | | –181 | 1.597 | Sodium | Na | 750–920 | 1.68 |
| bromide | HBr | 20 | 1.42 | Sulfur dioxide | $SO_2$ | 15 | 1.29 |
| chloride | HCl | 15 | 1.41 | | | | |
| | | 100 | 1.40 | Xenon | Xe | 19 | 1.66 |
| cyanide | HCN | 65 | 1.31 | | | | |
| | | 140 | 1.28 | | | | |
| | | 210 | 1.24 | | | | |

*From *International Critical Tables*, vol. 5, pp. 80–82.

**TABLE 2-200 Specific Heat Ratio, $C_p/C_v$, for Air**

| | Pressure, bar | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature, K | 1 | 10 | 20 | 40 | 60 | 80 | 100 | 150 | 200 | 250 | 300 | 400 | 500 | 600 | 800 | 1000 |
| 150 | 1.410 | 1.510 | 1.668 | 2.333 | 4.120 | 3.973 | 3.202 | 2.507 | 2.243 | 2.091 | 1.988 | 1.851 | 1.768 | 1.712 | 1.654 | 1.639 |
| 200 | 1.406 | 1.452 | 1.505 | 1.630 | 1.781 | 1.943 | 2.093 | 2.274 | 2.236 | 2.140 | 2.050 | 1.920 | 1.832 | 1.771 | 1.682 | 1.619 |
| 250 | 1.403 | 1.429 | 1.457 | 1.517 | 1.577 | 1.640 | 1.699 | 1.816 | 1.877 | 1.896 | 1.885 | 1.836 | 1.782 | 1.743 | 1.681 | 1.636 |
| 300 | 1.402 | 1.418 | 1.436 | 1.470 | 1.505 | 1.537 | 1.570 | 1.640 | 1.687 | 1.716 | 1.730 | 1.727 | 1.707 | 1.683 | 1.645 | 1.619 |
| 350 | 1.399 | 1.411 | 1.422 | 1.446 | 1.467 | 1.488 | 1.509 | 1.553 | 1.589 | 1.612 | 1.627 | 1.640 | 1.638 | 1.629 | 1.605 | 1.585 |
| 400 | 1.395 | 1.404 | 1.412 | 1.429 | 1.444 | 1.460 | 1.472 | 1.505 | 1.529 | 1.548 | 1.563 | 1.579 | 1.584 | 1.580 | 1.567 | 1.555 |
| 450 | 1.392 | 1.397 | 1.404 | 1.416 | 1.428 | 1.438 | 1.449 | 1.471 | 1.490 | 1.505 | 1.518 | 1.533 | 1.541 | 1.542 | 1.537 | 1.528 |
| 500 | 1.387 | 1.391 | 1.395 | 1.406 | 1.414 | 1.421 | 1.430 | 1.448 | 1.463 | 1.474 | 1.484 | 1.499 | 1.507 | 1.510 | 1.510 | 1.504 |
| 600 | 1.377 | 1.378 | 1.382 | 1.386 | 1.392 | 1.398 | 1.403 | 1.413 | 1.423 | 1.432 | 1.439 | 1.448 | 1.457 | 1.461 | 1.465 | 1.466 |
| 800 | 1.353 | 1.355 | 1.357 | 1.359 | 1.361 | 1.365 | 1.366 | 1.372 | 1.375 | 1.381 | 1.384 | 1.392 | 1.397 | 1.401 | 1.406 | 1.409 |
| 1000 | 1.336 | 1.337 | 1.338 | 1.339 | 1.342 | 1.343 | 1.343 | 1.345 | 1.348 | 1.350 | 1.354 | 1.358 | 1.361 | 1.365 | 1.368 | 1.372 |

Calculated from $C_p$, $C_v$ values of Sychev, V. V., A. A. Vasserman, et al., "Thermodynamic Properties of Air," Standartov, Moscow, 1978 and Hemisphere, New York, 1988 (276 pp.).

# SPECIFIC HEATS OF AQUEOUS SOLUTIONS

## UNITS CONVERSIONS

For this subsection, the following units conversions are applicable:

$$°F = \tfrac{9}{5}\,°C + 32.$$

To convert calories per gram-degree Celsius to British thermal units per pound-degree Fahrenheit, multiply by 1.0.

### TABLE 2-201 Acetic Acid (at 38°C)

| Mole % acetic acid | 0 | 6.98 | 30.9 | 54.5 | 100 |
|---|---|---|---|---|---|
| Cal/g °C | 1.0 | 0.911 | 0.73 | 0.631 | 0.535 |

### TABLE 2-202 Ammonia

| | Specific heat, cal/g °C | | | |
|---|---|---|---|---|
| Mole % $NH_3$ | 2.4°C | 20.6°C | 41°C | 61°C |
| 0 | 1.01 | 1.0 | 0.995 | 1.0 |
| 10.5 | 0.98 | 0.995 | 1.06 | 1.02 |
| 20.9 | .96 | .99 | 1.03 | |
| 31.2 | .956 | 1.0 | | |
| 41.4 | .985 | | | |

### TABLE 2-203 Aniline (at 20°C)

| Mol % aniline | 100 | 95 | 90.5 | 82.3 | 75.2 |
|---|---|---|---|---|---|
| Cal/g °C | 0.497 | 0.52 | 0.53 | 0.56 | 0.581 |

### TABLE 2-204 Copper Sulfate

| Composition | Temperature | Specific heat, cal/g °C |
|---|---|---|
| $CuSO_4 + 50H_2O$ | 12° to 15°C | 0.848 |
| $CuSO_4 + 200H_2O$ | 12° to 14°C | .951 |
| $CuSO_4 + 400H_2O$ | 13° to 17°C | .975 |

### TABLE 2-205 Ethyl Alcohol

| | Specific heat, cal/g °C | | |
|---|---|---|---|
| Mole % $C_2H_5OH$ | 3°C | 23°C | 41°C |
| 4.16 | 1.05 | 1.02 | 1.02 |
| 11.5 | 1.02 | 1.03 | 1.03 |
| 37.0 | 0.805 | 0.86 | 0.875 |
| 61.0 | .67 | .727 | .748 |
| 100.0 | .54 | .577 | .621 |

### TABLE 2-206 Glycerol

| | Specific heat, cal/g °C | |
|---|---|---|
| Mole % $C_3H_5(OH)_3$ | 15°C | 32°C |
| 2.12 | 0.961 | 0.960 |
| 4.66 | .929 | .924 |
| 11.5 | .851 | .841 |
| 22.7 | .765 | .758 |
| 43.9 | .67 | .672 |
| 100.0 | .555 | .576 |

### TABLE 2-207 Hydrochloric Acid

| | Specific heat, cal/g °C | | | | |
|---|---|---|---|---|---|
| Mole % HCl | 0°C | 10°C | 20°C | 40°C | 60°C |
| 0.0 | 1.00 | | | | |
| 9.09 | 0.72 | 0.72 | 0.74 | 0.75 | 0.78 |
| 16.7 | .61 | .605 | .631 | .645 | .67 |
| 20.0 | .58 | .575 | .591 | .615 | .638 |
| 25.9 | .55 | | | | .61 |

## ADDITIONAL REFERENCES

For additional data, see *International Critical Tables,* vol. 5, pp. 115–116, 122–125.

### TABLE 2-208 Methyl Alcohol

| | Specific heat, cal/g °C | | |
|---|---|---|---|
| Mole % $CH_3OH$ | 5°C | 20°C | 40°C |
| 5.88 | 1.02 | 1.0 | 0.995 |
| 12.3 | 0.975 | 0.982 | .98 |
| 27.3 | .877 | .917 | .92 |
| 45.8 | .776 | .811 | .83 |
| 69.6 | .681 | .708 | .726 |
| 100 | .576 | .60 | .617 |

### TABLE 2-209 Nitric Acid

| % $HNO_3$ by Weight | Specific Heat at 20°C, cal/g °C |
|---|---|
| 0 | 1.000 |
| 10 | 0.900 |
| 20 | .810 |
| 30 | .730 |
| 40 | .675 |
| 50 | .650 |
| 60 | .640 |
| 70 | .615 |
| 80 | .575 |
| 90 | .515 |

### TABLE 2-210 Phosphoric Acid*

| $\%H_2PO_4$ | $C_p$ at 21.3°C cal/g °C | $\%H_3PO_4$ | $C_p$ at 21.3°C cal/g °C |
|---|---|---|---|
| 2.50 | 0.9903 | 50.00 | 0.6350 |
| 3.80 | .9970 | 52.19 | .6220 |
| 5.33 | .9669 | 53.72 | .6113 |
| 8.81 | .9389 | 56.04 | .5972 |
| 10.27 | .9293 | 58.06 | .5831 |
| 14.39 | .8958 | 60.23 | .5704 |
| 16.23 | .8796 | 62.10 | .5603 |
| 19.99 | .8489 | 64.14 | .5460 |
| 22.10 | .8300 | 66.13 | .5349 |
| 24.56 | .8125 | 68.14 | .5242 |
| 25.98 | .8004 | 69.97 | .5157 |
| 28.15 | .7856 | 69.50 | .5160 |
| 29.96 | .7735 | 71.88 | .5046 |
| 32.09 | .7590 | 73.71 | .4940 |
| 33.95 | .7432 | 75.79 | .4847 |
| 36.26 | .7270 | 77.69 | .4786 |
| 38.10 | .7160 | 79.54 | .4680 |
| 40.10 | .7024 | 80.00 | .4686 |
| 42.08 | .6877 | 82.00 | .4593 |
| 44.11 | .6748 | 84.00 | .4500 |
| 46.22 | .6607 | 85.98 | .4419 |
| 48.16 | .6475 | 88.01 | .4359 |
| 49.79 | .6370 | 89.72 | .4206 |

*Z. Physik. Chem.,* A167, **42** (1933).

**TABLE 2-211 Potassium Chloride**

| Mole % KCl | Specific heat, cal/g °C | | | |
|---|---|---|---|---|
| | 6°C | 20°C | 33°C | 40°C |
| 0.99 | 0.945 | 0.947 | 0.947 | 0.947 |
| 3.85 | .828 | .831 | .835 | .837 |
| 5.66 | .77 | .775 | .778 | .775 |
| 7.41 | | .727 | | |

**TABLE 2-212 Potassium Hydroxide (at 19°C)**

| Mole % KOH | 0 | 0.497 | 1.64 | 4.76 | 9.09 |
|---|---|---|---|---|---|
| Cal/g °C | 1.0 | 0.975 | 0.93 | 0.814 | 0.75 |

**TABLE 2-213 Normal Propyl Alcohol**

| Mole % $C_3H_7OH$ | Specific heat, cal/g °C | | |
|---|---|---|---|
| | 5°C | 20°C | 40°C |
| 1.55 | 1.03 | 1.02 | 1.01 |
| 5.03 | 1.07 | 1.06 | 1.03 |
| 11.4 | 1.035 | 1.032 | 0.99 |
| 23.1 | 0.877 | 0.90 | .91 |
| 41.2 | .75 | .78 | .815 |
| 73.0 | .612 | .645 | .708 |
| 100.0 | .534 | .57 | .621 |

**TABLE 2-214 Sodium Carbonate***

| % $Na_2CO_3$ by weight | Temperature, °C | | | |
|---|---|---|---|---|
| | 17.6 | 30.0 | 76.6 | 98.0 |
| 0.000 | 0.9992 | 0.9986 | 1.0098 | 1.0084 |
| 1.498 | .9807 | | | |
| 2.000 | | .9786 | | |
| 2.901 | .9597 | | | |
| 4.000 | | .9594 | | |
| 5.000 | .9428 | | 0.9761 | |
| 6.000 | | .9392 | | |
| 8.000 | .9183 | | | |
| 10.000 | .9086 | | .9452 | |
| 13.790 | .8924 | | | |
| 13.840 | | .8881 | | |
| 20.000 | | .8631 | .8936 | |
| 25.000 | | | .8615 | 0.8911 |

*J. Chem. Soc.* 3062–3079 (1931).

**TABLE 2-215 Sodium Chloride**

| Mole % NaCl | Specific heat, cal/g °C | | | |
|---|---|---|---|---|
| | 6°C | 20°C | 33°C | 57°C |
| 0.249 | | 0.99 | | |
| .99 | 0.96 | .97 | 0.97 | |
| 2.44 | .91 | .915 | .915 | 0.923 |
| 9.09 | .805 | .81 | .81 | .82 |

**TABLE 2-216 Sodium Hydroxide (at 20°C)**

| Mole % NaOH | 0 | 0.5 | 1.0 | 9.09 | 16.7 | 28.6 | 37.5 |
|---|---|---|---|---|---|---|---|
| Cal/g °C | 1.0 | 0.985 | 0.97 | 0.835 | 0.80 | 0.784 | 0.782 |

**TABLE 2-217 Sulfuric Acid***

| $\%H_2SO_4$ | $C_p$ at 20°C, cal/g °C | $\%H_2SO_4$ | $C_p$ at 20°C, cal/g °C |
|---|---|---|---|
| 0.34 | 0.9968 | 35.25 | 0.7238 |
| 0.68 | .9937 | 37.69 | .7023 |
| 1.34 | .9877 | 40.49 | .6770 |
| 2.65 | .9762 | 43.75 | .6476 |
| 3.50 | .9688 | 47.57 | .6153 |
| 5.16 | .9549 | 52.13 | .5801 |
| 9.82 | .9177 | 57.65 | .5420 |
| 15.36 | .8767 | 64.47 | .5012 |
| 21.40 | .8339 | 73.13 | .4628 |
| 22.27 | .8275 | 77.91 | .4518 |
| 23.22 | .8205 | 81.33 | .4481 |
| 24.25 | .8127 | 82.49 | .4467 |
| 25.39 | .8041 | 84.48 | .4408 |
| 26.63 | .7945 | 85.48 | .4346 |
| 28.00 | .7837 | 89.36 | .4016 |
| 29.52 | .7717 | 91.81 | .3787 |
| 30.34 | .7647 | 94.82 | .3554 |
| 31.20 | .7579 | 97.44 | .3404 |
| 33.11 | .7422 | 100.00 | .3352 |

*Vinal and Craig, *Bur. Standards J. Research*, **24,** 475 (1940).

**TABLE 2-218 Zinc Sulfate**

| Composition | Temperature | Specific heat, cal/g °C |
|---|---|---|
| $ZnSO_4 + 50H_2O$ | 20° to 52°C | 0.842 |
| $ZnSO_4 + 200H_2O$ | 20° to 52°C | .952 |

# SPECIFIC HEATS OF MISCELLANEOUS MATERIALS

**TABLE 2-219 Specific Heats of Miscellaneous Liquids and Solids**

| Material | Specific heat, cal/g °C |
|---|---|
| Alumina | 0.2 (100°C); 0.274 (1500°C) |
| Alundum | 0.186 (100°C) |
| Asbestos | 0.25 |
| Asphalt | 0.22 |
| Bakelite | 0.3 to 0.4 |
| Brickwork | About 0.2 |
| Carbon | 0.168 (26° to 76°C) |
| | 0.314 (40° to 892°C) |
| | 0.387 (56° to 1450°C) |
| (gas retort) | 0.204 |
| (see under Graphite) | |
| Cellulose | 0.32 |
| Cement, Portland Clinker | 0.186 |
| Charcoal (wood) | 0.242 |
| Chrome brick | 0.17 |
| Clay | 0.224 |
| Coal | 0.26 to 0.37 |
| tar oils | 0.34 (15° to 90°C) |
| Coal tars | 0.35 (40°C); 0.45 (200°C) |
| Coke | 0.265 (21° to 400°C) |
| | 0.359 (21° to 800°C) |
| | 0.403 (21° to 1300°C) |
| Concrete | 0.156 (70° to 312°F); 0.219 (72° to 1472°F) |
| Cryolite | 0.253 (16° to 55°C) |
| Diamond | 0.147 |
| Fireclay brick | 0.198 (100°C); 0.298 (1500°C) |
| Fluorspar | 0.21 (30°C) |
| Gasoline | 0.53 |
| Glass (crown) | 0.16 to 0.20 |
| (flint) | 0.117 |
| (pyrex) | 0.20 |
| (silicate) | 0.188 to 0.204 (0 to 100°C) |
| | 0.24 to 0.26 (0 to 700°C) |
| wool | 0.157 |
| Granite | 0.20 (20° to 100°C) |
| Graphite | 0.165 (26° to 76°C); 0.390 (56° to 1450°C) |
| Gypsum | 0.259 (16° to 46°C) |
| Kerosene | 0.47 |
| Limestone | 0.217 |
| Litharge | 0.055 |
| Magnesia | 0.234 (100°C); 0.188 (1500°C) |
| Magnesite brick | 0.222 (100°C); 0.195 (1500°C) |
| Marble | 0.21 (18°C) |
| Porcelain, fired Berlin | 0.189 (60°C) |
| Porcelain, green Berlin | 0.185 (60°C) |
| Porcelain, fired earthenware | 0.186 (60°C) |
| Porcelain, green earthenware | 0.181 (60°C) |

**TABLE 2-219 Specific Heats of Miscellaneous Liquids and Solids** (*Concluded*)

| Material | Specific heat, cal/g °C |
|---|---|
| Pyrex glass | 0.20 |
| Pyrites (copper) | 0.131 (30°C) |
| Pyrites (iron) | 0.136 (30°C) |
| Pyroxylin plastics | 0.34 to 0.38 |
| Quartz | 0.17 (0°C); 0.28 (350°C) |
| Rubber (vulcanized) | 0.415 |
| Sand | 0.191 |
| Silica | 0.316 |
| Silica brick | 0.202 (100°C); 0.195 (1500°C) |
| Silicon carbide brick | 0.202 (100°C) |
| Silk | 0.33 |
| Steel | 0.12 |
| Stone | about 0.2 |
| Stoneware (common) | 0.188 (60°C) |
| Turpentine | 0.42 (18°C) |
| Wood (Oak) | 0.570 |
| Woods, miscellaneous | 0.45 to 0.65 |
| Wool | 0.325 |
| Zirconium oxide | 0.11 (100°C); 0.179 (1500°C) |

**TABLE 2-219*a* Oils (Animal, Vegetable, Mineral Oils)**

$$C_p[\text{cal/(g} \cdot \text{°C)} = A/\sqrt{d_4^{15}} + B(t - 15)$$

where $d$ = density, g/cm$^3$.

°F = 9⁄5 °C + 32; to convert calories per gram-degree Celsius to British thermal units per pound-degree Fahrenheit, multiply by 1.0; to convert grams per cubic centimeter to pounds per cubic foot, multiply by 62.43.

| Oils | *A* | *B* |
|---|---|---|
| Castor | 0.500 | 0.0007 |
| Citron | (0.438 at 54°C) | |
| Fatty drying | 0.440 | 0.0007 |
| non-drying | 0.450 | 0.0007 |
| semidrying | 0.445 | 0.0007 |
| oils (except castor) | 0.450 | 0.0007 |
| Naphthene base | 0.405 | 0.0009 |
| Olive | (0.47 at 7°C) | |
| Paraffin base | 0.425 | 0.0009 |
| Petroleum oils | 0.415 | 0.0009 |

# HEATS AND FREE ENERGIES OF FORMATION

## UNITS CONVERSIONS

°F = 9⁄5 °C + 32; to convert kilocalories per gram-mole to British thermal units per pound-mole, multiply by $1.799 \times 10^{-3}$.

## TABLE 2-220 Heats and Free Energies of Formation of Inorganic Compounds

The values given in the following table for the heats and free energies of formation of inorganic compounds are derived from (*a*) Bichowsky and Rossini, "Thermochemistry of the Chemical Substances," Reinhold, New York, 1936; (*b*) Latimer, "Oxidation States of the Elements and Their Potentials in Aqueous Solution," Prentice-Hall, New York, 1938; (*c*) the tables of the American Petroleum Institute Research Project 44 at the National Bureau of Standards; and (*d*) the tables of Selected Values of Chemical Thermodynamic Properties of the National Bureau of Standards. The reader is referred to the preceding books and tables for additional details as to methods of calculation, standard states, and so on.

| Compound | State† | Heat of formation‡§ $\Delta H$ (formation) at 25°C, kcal/mole | Free energy of formation‖¶ $\Delta F$ (formation) at 25°C, kcal/mole |
|---|---|---|---|
| Aluminum | | | |
| Al | c | 0.00 | 0.00 |
| $AlBr_3$ | c | −123.4 | |
| | aq | −209.5 | −189.2 |
| $Al_4C_3$ | c | −30.8 | −29.0 |
| $AlCl_3$ | c | −163.8 | |
| | aq, 600 | −243.9 | −209.5 |
| $AlF_3$ | c | −329 | |
| | aq | −360.8 | −312.6 |
| $AlI_3$ | c | −72.8 | |
| | aq | −163.4 | −152.5 |
| AlN | c | −57.7 | −50.4 |
| $Al(NH_4)(SO_4)_2$ | c | −561.19 | −486.17 |
| $Al(NH_4)(SO_4)_2{\cdot}12H_2O$ | c | −1419.36 | −1179.26 |
| $Al(NO_3)_3{\cdot}6H_2O$ | c | −680.89 | −526.32 |
| $Al(NO_3)_3{\cdot}9H_2O$ | c | −897.59 | |
| $Al_2O_3$ | c, corundum | −399.09 | −376.87 |
| $Al(OH)_3$ | c | −304.8 | −272.9 |
| $Al_2O_3{\cdot}SiO_2$ | c, sillimanite | −648.7 | |
| $Al_2O_3{\cdot}SiO_2$ | c, disthene | −642.4 | |
| $Al_2O_3{\cdot}SiO_2$ | c, andalusite | −642.0 | |
| $3Al_2O_3{\cdot}2SiO_2$ | c, mullite | −1874 | |
| $Al_2S_3$ | c | −121.6 | |
| $Al_2(SO_4)_3$ | c | −820.99 | −739.53 |
| | aq | −893.9 | −759.3 |
| $Al_2(SO_4)_3{\cdot}6H_2O$ | c | −1268.15 | −1103.39 |
| $Al_2(SO_4)_3{\cdot}18H_2O$ | c | −2120 | |
| Antimony | | | |
| Sb | c | 0.00 | 0.00 |
| $SbBr_3$ | c | −59.9 | |
| $SbCl_3$ | c | −91.3 | −77.8 |
| $SbCl_5$ | l | −104.8 | |
| $SbF_3$ | c | −216.6 | |
| $SbI_3$ | c | −22.8 | |
| $Sb_2O_3$ | c, I, orthorhombic | −165.4 | −146.0 |
| | c, II, octahedral | −166.6 | |
| $Sb_2O_4$ | c | −213.0 | −186.6 |
| $Sb_2O_5$ | c | −230.0 | −196.1 |
| $Sb_2S_3$ | c, black | −38.2 | −36.9 |
| Arsenic | | | |
| As | c | 0.00 | 0.00 |
| $AsBr_3$ | c | −45.9 | |
| $AsCl_3$ | l | −80.2 | −70.5 |
| $AsF_3$ | l | −223.76 | −212.27 |
| $AsH_3$ | g | 43.6 | 37.7 |
| $AsI_3$ | c | −13.6 | |
| $As_2O_3$ | c | −154.1 | −134.8 |
| $As_2O_5$ | c | −217.9 | −183.9 |
| $As_2S_3$ | c | −20 | −20 |
| | amorphous | −34.76 | |
| Barium | | | |
| Ba | c | 0.00 | 0.00 |
| $BaBr_2$ | c | −180.38 | |
| | aq, 400 | −185.67 | −183.0 |
| $BaCl_2$ | c | −205.25 | |
| | aq, 300 | −207.92 | −196.5 |
| $Ba(ClO_3)_2$ | c | −176.6 | |
| | aq, 1600 | −170.0 | −134.4 |
| $Ba(ClO_4)_2$ | c | −210.2 | |
| | aq, 800 | | −155.3 |
| $Ba(CN)_2$ | c | −48 | |
| $Ba(CNO)_2$ | c | −212.1 | |
| | aq | | −180.7 |
| $BaCN_2$ | c | −63.6 | |
| $BaCO_3$ | c, witherite | −284.2 | −271.4 |
| $BaCrO_4$ | c | −342.2 | |
| Barium (*Cont.*) | | | |
| $BaF_2$ | c | −287.9 | |
| | aq, 1600 | −284.6 | −265.3 |
| $BaH_2$ | c | −40.8 | −31.5 |
| $Ba(HCO_3)_2$ | aq | −459 | −414.4 |
| $BaI_2$ | c | −144.6 | |
| | aq, 400 | −155.17 | −158.52 |
| $Ba(IO_3)_2$ | c | −264.5 | |
| | aq | −237.50 | −198.35 |
| $BaMoO_4$ | c | −370 | |
| $Ba_3N_2$ | c | −90.7 | |
| $Ba(NO_2)_2$ | c | −184.5 | |
| | aq | −179.05 | −150.75 |
| $Ba(NO_3)_2$ | c | −236.99 | −189.94 |
| | aq, 600 | −227.74 | |
| BaO | c | −133.0 | |
| $Ba(OH)_2$ | c | −225.9 | |
| | aq, 400 | −237.76 | −209.02 |
| $BaO{\cdot}SiO_2$ | c | −363 | |
| $Ba_3(PO_4)_2$ | c | −992 | |
| $BaPtCl_6$ | c | −284.9 | |
| BaS | c | −111.2 | |
| $BaSO_3$ | c | −282.5 | |
| $BaSO_4$ | c | −340.2 | −313.4 |
| $BaWO_4$ | c | −402 | |
| Beryllium | | | |
| Be | c | 0.00 | 0.00 |
| $BeBr_2$ | c | −79.4 | |
| | aq | −142 | −127.9 |
| $BeCl_2$ | c | −112.6 | |
| | aq | −163.9 | −141.4 |
| $BeI_2$ | c | −39.4 | |
| | aq | −112 | −103.4 |
| $Be_3N_2$ | c | −134.5 | −122.4 |
| BeO | c | −145.3 | −138.3 |
| $Be(OH)_2$ | c | −215.6 | |
| BeS | c | −56.1 | |
| $BeSO_4$ | c | −281 | |
| | aq | | −254.8 |
| Bismuth | | | |
| Bi | c | 0.00 | 0.00 |
| $BiCl_3$ | c | −90.5 | −76.4 |
| | aq | −101.6 | |
| $BiI_3$ | c | −24 | |
| | aq | −27 | |
| BiO | c | −49.5 | −43.2 |
| $Bi_2O_3$ | c | −137.1 | −117.9 |
| $Bi(OH)_3$ | c | −171.1 | |
| $Bi_2S_3$ | c | −43.9 | −39.1 |
| $Bi_2(SO_4)_3$ | c | −607.1 | |
| Boron | | | |
| B | c | 0.00 | 0.00 |
| $BBr_3$ | l | −52.7 | |
| | g | −44.6 | −50.9 |
| $BCl_3$ | g | −94.5 | −90.8 |
| $BF_3$ | g | −265.2 | −261.0 |
| $B_2H_6$ | g | 7.5 | 19.9 |
| BN | c | −32.1 | −27.2 |
| $B_2O_3$ | c | −302.0 | −282.9 |
| | gls | −297.6 | −280.3 |
| $B(OH)_3$ | c | −260.0 | −229.4 |
| $B_2S_3$ | c | −56.6 | |
| Bromine | | | |
| $Br_2$ | l | 0.00 | 0.00 |
| | g | 7.47 | 0.931 |
| BrCl | g | 3.06 | −0.63 |

*For footnotes see end of table.

**TABLE 2-220 Heats and Free Energies of Formation of Inorganic Compounds** (*Continued*)

| Compound | State† | Heat of formation‡§ $\Delta H$ (formation) at 25°C, kcal/mole | Free energy of formation‖¶ $\Delta F$ (formation) at 25°C, kcal/mole |
|---|---|---|---|
| Cadmium | | | |
| Cd | c | 0.00 | 0.00 |
| $CdBr_2$ | c | −75.8 | −70.7 |
| | aq, 400 | −76.6 | −67.6 |
| $CdCl_2$ | c | −92.149 | −81.889 |
| | aq, 400 | −96.44 | −81.2 |
| $Cd(CN)_2$ | c | 36.2 | |
| $CdCO_3$ | c | −178.2 | −163.2 |
| $CdI_2$ | c | −48.40 | |
| | aq, 400 | −47.46 | −43.22 |
| $Cd_3N_2$ | c | 39.8 | |
| $Cd(NO_3)_2$ | aq, 400 | −115.67 | −71.05 |
| CdO | c | −62.35 | −55.28 |
| $Cd(OH)_2$ | c | −135.0 | −113.7 |
| CdS | c | −34.5 | −33.6 |
| $CdSO_4$ | c | −222.23 | |
| | aq, 400 | −232.635 | −194.65 |
| Calcium | | | |
| Ca | c | 0.00 | 0.00 |
| $CaBr_2$ | c | −162.20 | |
| | aq, 400 | −187.19 | −181.86 |
| $CaC_2$ | c | −14.8 | −16.0 |
| $CaCl_2$ | c | −190.6 | −179.8 |
| | aq | −209.15 | −195.36 |
| $CaCN_2$ | c | −85 | |
| $Ca(CN)_2$ | c | −43.3 | |
| | aq | | −54.0 |
| $CaCO_3$ | c, calcite | −289.5 | −270.8 |
| | c, aragonite | −289.54 | −270.57 |
| $CaCO_3 \cdot MgCO_3$ | c | −558.8 | |
| $CaC_2O_4$ | c | −332.2 | |
| $Ca(C_2H_3O_2)_2$ | c | −356.3 | |
| | aq | −364.1 | −311.3 |
| $CaF_2$ | c | −290.2 | |
| | aq | −286.5 | −264.1 |
| $CaH_2$ | c | −46 | −35.7 |
| $CaI_2$ | c | −128.49 | |
| | aq, 400 | −156.63 | −157.37 |
| $Ca_3N_2$ | c | −103.2 | −88.2 |
| $Ca(NO_3)_2$ | c | −224.05 | −177.38 |
| | aq, 400 | −228.29 | |
| $Ca(NO_3)_2 \cdot 2H_2O$ | c | −367.95 | −293.57 |
| $Ca(NO_3)_2 \cdot 3H_2O$ | c | −439.05 | −351.58 |
| $Ca(NO_3)_2 \cdot 4H_2O$ | c | −509.43 | −409.32 |
| CaO | c | −151.7 | −144.3 |
| $Ca(OH)_2$ | c | −235.58 | −213.9 |
| | aq, 800 | −239.2 | −207.9 |
| $CaO \cdot SiO_2$ | c, II, wollastonite | −377.9 | −357.5 |
| | c, I, pseudo-wollastonite | −376.6 | −356.6 |
| CaS | c | −114.3 | −113.1 |
| $CaSO_4$ | c, insoluble form | −338.73 | −311.9 |
| | c, soluble form α | −336.58 | −309.8 |
| | c, soluble form β | −335.52 | −308.8 |
| $CaSO_4 \cdot \frac{1}{2}H_2O$ | c | −376.13 | |
| $CaSO_4 \cdot 2H_2O$ | c | −479.33 | −425.47 |
| $CaWO_4$ | c | −387 | |
| Carbon | | | |
| C | c, graphite | 0.00 | 0.00 |
| | c, diamond | 0.453 | 0.685 |
| CO | g | −26.416 | −32.808 |
| $CO_2$ | g | −94.052 | −94.260 |
| Cerium | | | |
| Ce | c | 0.00 | 0.00 |
| CeN | c | −78.2 | −70.8 |
| Cesium | | | |
| Cs | c | 0.00 | 0.00 |
| CsBr | c | −97.64 | |
| | aq, 500 | −91.39 | −94.86 |
| CsCl | c | −106.31 | |
| | aq, 400 | −102.01 | −101.61 |
| Cesium (*Cont.*) | | | |
| $Cs_2CO_3$ | c | −271.88 | |
| CsF | c | −131.67 | |
| | aq, 400 | −140.48 | −135.98 |
| CsH | c | −12 | −7.30 |
| $CsHCO_3$ | c | −230.6 | |
| | aq, 2000 | −226.6 | −210.56 |
| CsI | c | −83.91 | |
| | aq, 400 | −75.74 | −82.61 |
| $CsNH_2$ | c | −28.2 | |
| $CsNO_3$ | c | −121.14 | |
| | aq, 400 | −111.54 | −96.53 |
| $Cs_2O$ | c | −82.1 | |
| CsOH | c | −100.2 | |
| | aq, 200 | −117.0 | −107.87 |
| $Cs_2S$ | c | −87 | |
| $Cs_2SO_4$ | c | −344.86 | |
| | aq | −340.12 | −316.66 |
| Chlorine | | | |
| $Cl_2$ | g | 0.00 | 0.00 |
| ClF | g | −25.7 | |
| ClO | g | 33 | |
| $ClO_2$ | g | 24.7 | 29.5 |
| $ClO_3$ | g | 37 | |
| $Cl_2O$ | g | 18.20 | 22.40 |
| $Cl_2O_7$ | g | 63 | |
| Chromium | | | |
| Cr | c | 0.00 | 0.00 |
| $CrBr_3$ | aq | | −122.7 |
| $Cr_3C_2$ | c | −21.008 | −21.20 |
| $Cr_4C$ | c | −16.378 | −16.74 |
| $CrCl_2$ | c | −103.1 | −93.8 |
| | aq | | −102.1 |
| $CrF_2$ | c | −152 | |
| $CrF_3$ | c | −231 | |
| $CrI_2$ | c | −63.7 | |
| | aq | | −64.1 |
| $CrO_3$ | c | −139.3 | |
| $Cr_2O_3$ | c | −268.8 | −249.3 |
| $Cr_2(SO_4)_3$ | aq | | −626.3 |
| Cobalt | | | |
| Co | c | 0.00 | 0.00 |
| $CoBr_2$ | c | −55.0 | |
| | aq | −73.61 | −61.96 |
| $Co_3C$ | c | 9.49 | 7.08 |
| $CoCl_2$ | c | −76.9 | −66.6 |
| | aq, 400 | −95.58 | −75.46 |
| $CoCO_3$ | c | −172.39 | −155.36 |
| $CoF_2$ | aq | −172.98 | −144.2 |
| $CoI_2$ | c | −24.2 | |
| | aq | −43.15 | −37.4 |
| $Co(NO_3)_2$ | c | −102.8 | |
| | aq | −114.9 | −65.3 |
| CoO | c | −57.5 | |
| $Co_3O_4$ | c | −196.5 | |
| $Co(OH)_2$ | c | −131.5 | −108.9 |
| $Co(OH)_3$ | c | −177.0 | −142.0 |
| CoS | c | −22.3 | −19.8 |
| $Co_2S_3$ | c | −40.0 | |
| $CoSO_4$ | c | −216.6 | |
| | aq, 400 | | −188.9 |
| Columbium | | | |
| Cb | c | 0.00 | 0.00 |
| $Cb_2O_5$ | c | −462.96 | |
| Copper | | | |
| Cu | c | 0.00 | 0.00 |
| CuBr | c | −26.7 | −23.8 |
| $CuBr_2$ | c | −34.0 | |
| | aq | −42.4 | −33.25 |
| CuCl | c | −31.4 | −24.13 |
| $CuCl_2$ | c | −48.83 | |
| | aq, 400 | −64.7 | |

**TABLE 2-220 Heats and Free Energies of Formation of Inorganic Compounds** (*Continued*)

| Compound | State† | Heat of formation‡§ $\Delta H$ (formation) at 25°C, kcal/mole | Free energy of formation‖¶ $\Delta F$ (formation) at 25°C, kcal/mole |
|---|---|---|---|
| Copper (*Cont.*) | | | |
| $CuClO_4$ | aq | −28.3 | 1.34 |
| $Cu(ClO_3)_2$ | aq, 400 | | 15.4 |
| $Cu(ClO_4)_2$ | aq | | −5.5 |
| CuI | c | −17.8 | −16.66 |
| $CuI_2$ | c | −4.8 | |
| | aq | −11.9 | −8.76 |
| $Cu_3N$ | c | 17.78 | |
| $Cu(NO_3)_2$ | c | −73.1 | |
| | aq, 200 | −83.6 | −36.6 |
| CuO | c | −38.5 | −31.9 |
| $Cu_2O$ | c | −43.00 | −38.13 |
| $Cu(OH)_2$ | c | −108.9 | −85.5 |
| CuS | c | −11.6 | −11.69 |
| $Cu_2S$ | c | −18.97 | −20.56 |
| $CuSO_4$ | c | −184.7 | −158.3 |
| | aq, 800 | −200.78 | −160.19 |
| $Cu_2SO_4$ | c | −179.6 | |
| | aq | | −152.0 |
| Erbium | | | |
| Er | c | 0.00 | 0.00 |
| $Er(OH)_3$ | c | −326.8 | |
| Fluorine | | | |
| $F_2$ | g | 0.00 | 0.00 |
| $F_2O$ | g | 5.5 | 9.7 |
| Gallium | | | |
| Ga | c | 0.00 | 0.00 |
| $GaBr_3$ | c | −92.4 | |
| $GaCl_3$ | c | −125.4 | |
| GaN | c | −26.2 | |
| $Ga_2O$ | c | −84.3 | |
| $Ga_2O_3$ | c | −259.9 | |
| Germanium | | | |
| Ge | c | 0.00 | 0.00 |
| $Ge_3N_4$ | c | −15.7 | |
| $GeO_2$ | c | −128.6 | |
| Gold | | | |
| Au | c | 0.00 | 0.00 |
| AuBr | c | −3.4 | |
| $AuBr_3$ | c | −14.5 | |
| | aq | −11.0 | 24.47 |
| AuCl | c | −8.3 | |
| $AuCl_3$ | c | −28.3 | |
| | aq | −32.96 | 4.21 |
| AuI | c | 0.2 | −0.76 |
| $Au_2O_3$ | c | 11.0 | 18.71 |
| $Au(OH)_3$ | c | −100.6 | |
| Hafnium | | | |
| Hf | c | 0.00 | 0.00 |
| $HfO_2$ | c | −271.1 | −258.2 |
| Hydrogen | | | |
| $H_3AsO_3$ | aq | −175.6 | −153.04 |
| $H_3AsO_4$ | c | −214.9 | |
| | aq | −214.8 | −183.93 |
| HBr | g | −8.66 | −12.72 |
| | aq, 400 | −28.80 | −24.58 |
| HBrO | aq | −25.4 | −19.90 |
| $HBrO_3$ | aq | −11.51 | 5.00 |
| HCl | g | −22.063 | −22.778 |
| | aq, 400 | −39.85 | −31.330 |
| HCN | g | 31.1 | 27.94 |
| | aq, 100 | 24.2 | 26.55 |
| HClO | aq, 400 | −28.18 | −19.11 |
| $HClO_3$ | aq | −23.4 | −0.25 |
| $HClO_4$ | aq, 660 | −31.4 | −10.70 |
| $HC_2H_3O_2$ | l | −116.2 | −93.56 |
| | aq, 400 | −116.74 | −96.8 |
| $H_2C_2O_4$ | c | −196.7 | |
| | aq, 300 | −194.6 | −165.64 |
| HCOOH | l | −97.8 | −82.7 |
| | aq, 200 | −98.0 | −85.1 |
| Hydrogen (*Cont.*) | | | |
| $H_2CO_3$ | aq | −167.19 | −149.0 |
| HF | g | −64.2 | −64.7 |
| | aq, 200 | −75.75 | |
| HI | g | 6.27 | 0.365 |
| | aq, 400 | −13.47 | −12.35 |
| HIO | aq | −38 | −23.33 |
| $HIO_3$ | c | −56.77 | |
| | aq | −54.8 | −32.25 |
| $HN_3$ | g | 70.3 | 78.50 |
| $HNO_3$ | g | −31.99 | −17.57 |
| | l | −41.35 | −19.05 |
| | aq, 400 | −49.210 | |
| $HNO_3·H_2O$ | l | −112.91 | −78.36 |
| $HNO_3·3H_2O$ | l | −252.15 | −193.70 |
| $H_2O$ | g | −57.7979 | −54.6351 |
| | l | −68.3174 | −56.6899 |
| $H_2O_2$ | l | −45.16 | −28.23 |
| | aq, 200 | −45.80 | −31.47 |
| $H_3PO_2$ | c | −145.5 | |
| | aq | −145.6 | −120.0 |
| $H_3PO_3$ | c | −232.2 | |
| | aq | −232.2 | −204.0 |
| $H_3PO_4$ | c | −306.2 | |
| | aq, 400 | −309.32 | −270.0 |
| $H_2S$ | g | −4.77 | −7.85 |
| | aq, 2000 | −9.38 | |
| $H_2S_2$ | l | −3.6 | |
| $H_2SO_3$ | aq, 200 | −146.88 | −128.54 |
| $H_2SO_4$ | l | −193.69 | |
| | aq, 400 | −212.03 | |
| $H_2Se$ | g | 20.5 | 17.0 |
| | aq | 18.1 | 18.4 |
| $H_2SeO_3$ | c | −126.5 | |
| | aq | −122.4 | −101.36 |
| $H_2SeO_4$ | c | −130.23 | |
| | aq, 400 | −143.4 | |
| $H_2SiO_3$ | c | −267.8 | −247.9 |
| $H_4SiO_4$ | c | −340.6 | |
| $H_2Te$ | g | 36.9 | 33.1 |
| $H_2TeO_3$ | c | −145.0 | −115.7 |
| | aq | −145.0 | |
| $H_2TeO_4$ | aq | −165.6 | |
| Indium | | | |
| In | c | 0.00 | 0.00 |
| $InBr_3$ | c | −97.2 | |
| | aq | −112.9 | −97.2 |
| $InCl_3$ | c | −128.5 | |
| | aq | −145.6 | −117.5 |
| $InI_3$ | c | −56.5 | |
| | aq | −67.2 | −60.5 |
| InN | c | −4.8 | |
| $In_2O_3$ | c | −222.47 | |
| Iodine | | | |
| $I_2$ | c | 0.00 | 0.00 |
| | g | 14.88 | 4.63 |
| IBr | g | 10.05 | 1.24 |
| ICl | g | 4.20 | −1.32 |
| $ICl_3$ | c | −21.8 | −6.05 |
| $I_2O_5$ | c | −42.5 | |
| Iridium | | | |
| Ir | c | 0.00 | 0.00 |
| IrCl | c | −20.5 | −16.9 |
| $IrCl_2$ | c | −40.6 | −32.0 |
| $IrCl_3$ | c | −60.5 | −46.5 |
| $IrF_6$ | l | −130 | |
| $IrO_2$ | c | −40.14 | |
| Iron | | | |
| Fe | c, α | 0.00 | 0.00 |
| $FeBr_2$ | c | −57.15 | |
| | aq, 540 | −78.7 | −69.47 |

**TABLE 2-220 Heats and Free Energies of Formation of Inorganic Compounds** (*Continued*)

| Compound | State† | Heat of formation‡§ $\Delta H$ (formation) at 25°C, kcal/mole | Free energy of formation‖¶ $\Delta F$ (formation) at 25°C, kcal/mole |
|---|---|---|---|
| Iron (*Cont.*) | | | |
| $FeBr_3$ | aq | −95.5 | −76.26 |
| $Fe_3C$ | c | 5.69 | 4.24 |
| $Fe(CO)_5$ | l | −187.6 | |
| $FeCO_3$ | c, siderite | −172.4 | −154.8 |
| $FeCl_2$ | c | −81.9 | −72.6 |
| | aq | −100.0 | −83.0 |
| $FeCl_3$ | c | −96.4 | |
| | aq, 2000 | −128.5 | −96.5 |
| $FeF_2$ | aq, 1200 | −177.2 | −151.7 |
| $FeI_2$ | c | −24.2 | |
| | aq | −47.7 | −45 |
| $FeI_3$ | aq | −49.7 | −39.5 |
| $Fe_4N$ | c | −2.55 | 0.862 |
| $Fe(NO_3)_2$ | aq | −118.9 | −72.8 |
| $Fe(NO_3)_3$ | aq, 800 | −156.5 | −81.3 |
| FeO | c | −64.62 | −59.38 |
| $Fe_2O_3$ | c | −198.5 | −179.1 |
| $Fe_3O_4$ | c | −266.9 | −242.3 |
| $Fe(OH)_2$ | c | −135.9 | −115.7 |
| $Fe(OH)_3$ | c | −197.3 | −166.3 |
| $FeO{\cdot}SiO_2$ | c | −273.5 | |
| $Fe_2P$ | c | −13 | |
| FeSi | c | −19.0 | |
| FeS | c | −22.64 | −23.23 |
| $FeS_2$ | c, pyrites | −38.62 | −35.93 |
| | c, marcasite | −33.0 | |
| $FeSO_4$ | c | −221.3 | −195.5 |
| | aq, 400 | −236.2 | −196.4 |
| $Fe_2(SO_4)_3$ | aq, 400 | −653.3 | −533.4 |
| $FeTiO_3$ | c, ilmenite | −295.51 | −277.06 |
| Lanthanum | | | |
| La | c | 0.00 | 0.00 |
| $LaCl_3$ | c | −253.1 | |
| | aq | −284.7 | |
| $La_3H_8$ | c | −160 | |
| LaN | c | −72.0 | −64.6 |
| $La_2O_3$ | c | −539 | |
| $LaS_2$ | c | −148.3 | |
| $La_2S_3$ | c | −351.4 | |
| $La_2(SO_4)_3$ | aq | −972 | |
| Lead | | | |
| Pb | c | 0.00 | 0.00 |
| $PbBr_2$ | c | −66.24 | −62.06 |
| | aq | −56.4 | −54.97 |
| $PbCO_3$ | c, cerussite | −167.6 | −150.0 |
| $Pb(C_2H_3O_2)_2$ | c | −232.6 | |
| | aq, 400 | −234.2 | −184.40 |
| $PbC_2O_4$ | c | −205.3 | |
| $PbCl_2$ | c | −85.68 | −75.04 |
| | aq | −82.5 | −68.47 |
| $PbF_2$ | c | −159.5 | −148.1 |
| $PbI_2$ | c | −41.77 | −41.47 |
| $Pb(NO_3)_2$ | c | −106.88 | |
| | aq, 400 | −99.46 | −58.3 |
| PbO | c, red | −51.72 | −45.53 |
| | c, yellow | −50.86 | −43.88 |
| $PbO_2$ | c | −65.0 | −52.0 |
| $Pb_3O_4$ | c | −172.4 | −142.2 |
| $Pb(OH)_2$ | c | −123.0 | −102.2 |
| PbS | c | −22.38 | −21.98 |
| $PbSO_4$ | c | −218.5 | −192.9 |
| Lithium | | | |
| Li | c | 0.00 | 0.00 |
| LiBr | c | −83.75 | |
| | aq, 400 | −95.40 | −95.28 |
| $LiBrO_3$ | aq | −77.9 | −65.70 |
| $Li_2C_2$ | c | −13.0 | |
| LiCN | aq | −31.4 | −31.35 |
| LiCNO | aq | −101.2 | −94.12 |
| Lithium (*Cont.*) | | | |
| $LiC_2H_3O_2$ | aq | −183.9 | −160.00 |
| $Li_2CO_3$ | c | −289.7 | −269.8 |
| | aq, 1900 | −293.1 | −267.58 |
| LiCl | c | −97.63 | |
| | aq, 278 | −106.45 | −102.03 |
| $LiClO_3$ | aq | −87.5 | −70.95 |
| $LiClO_4$ | aq | −106.3 | −81.4 |
| LiF | c | −145.57 | |
| | aq, 400 | −144.85 | −136.40 |
| LiH | c | −22.9 | |
| $LiHCO_3$ | aq, 2000 | −231.1 | −210.98 |
| LiI | c | −65.07 | |
| | aq, 400 | −80.09 | −83.03 |
| $LiIO_3$ | aq | −121.3 | −102.95 |
| $Li_3N$ | c | −47.45 | −37.33 |
| $LiNO_3$ | c | −115.350 | |
| | aq, 400 | −115.88 | −96.95 |
| $Li_2O$ | c | −142.3 | |
| $Li_2O_2$ | c | −151.9 | −138.0 |
| | aq | −159 | |
| LiOH | c | −116.58 | −106.44 |
| | aq, 400 | −121.47 | −108.29 |
| $LiOH{\cdot}H_2O$ | c | −188.92 | |
| $Li_2O{\cdot}SiO_2$ | gls | −374 | |
| $Li_2Se$ | c | −84.9 | |
| | aq | −95.5 | −105.64 |
| $Li_2SO_4$ | c | −340.23 | −314.66 |
| | aq, 400 | −347.02 | |
| $Li_2SO_4{\cdot}H_2O$ | c | −411.57 | −375.07 |
| Magnesium | | | |
| Mg | c | 0.00 | 0.00 |
| $Mg(AsO_4)_2$ | c | −731.3 | |
| | aq | −749 | −630.14 |
| $MgBr_2$ | c | −123.9 | |
| | aq, 400 | −167.33 | −156.94 |
| $Mg(CN)_2$ | aq | −39.7 | −29.08 |
| $MgCN_2$ | c | −61 | |
| $Mg(C_2H_3O_2)_2$ | aq | −344.6 | −286.38 |
| $MgCO_3$ | c | −261.7 | −241.7 |
| $MgCl_2$ | c | −153.220 | −143.77 |
| | aq, 400 | −189.76 | |
| $MgCl_2{\cdot}H_2O$ | c | −230.970 | −205.93 |
| $MgCl_2{\cdot}2H_2O$ | c | −305.810 | −267.20 |
| $MgCl_2{\cdot}4H_2O$ | c | −453.820 | −387.98 |
| $MgCl_2{\cdot}6H_2O$ | c | −597.240 | −505.45 |
| $MgF_2$ | c | −263.8 | |
| $MgI_2$ | c | −86.8 | |
| | aq, 400 | −136.79 | −132.45 |
| $MgMoO_4$ | c | −329.9 | |
| $Mg_3N_2$ | c | −115.2 | −100.8 |
| $Mg(NO_3)_2$ | c | −188.770 | −140.66 |
| | aq, 400 | −209.927 | −160.28 |
| $Mg(NO_3)_2{\cdot}2H_2O$ | c | −336.625 | |
| $Mg(NO_3)_2{\cdot}6H_2O$ | c | −624.48 | −496.03 |
| MgO | c | −143.84 | −136.17 |
| $MgO{\cdot}SiO_2$ | c | −347.5 | −326.7 |
| $Mg(OH)_2$ | c, ppt. | −221.90 | −200.17 |
| | c, brucite | −223.9 | −193.3 |
| MgS | c | −84.2 | |
| | aq | −108 | |
| $MgSO_4$ | c | −304.94 | −277.7 |
| | aq, 400 | −325.4 | −283.88 |
| MgTe | c | −25 | |
| $MgWO_4$ | c | −345.2 | |
| Manganese | | | |
| Mn | c, α | 0.00 | 0.00 |
| $MnBr_2$ | c | −91 | |
| | aq | −106 | −97.8 |
| $Mn_3C$ | c | 1.1 | 1.26 |

**TABLE 2-220 Heats and Free Energies of Formation of Inorganic Compounds** (*Continued*)

| Compound | State† | Heat of formation‡§ $\Delta H$ (formation) at 25°C, kcal/mole | Free energy of formation‖¶ $\Delta F$ (formation) at 25°C, kcal/mole |
|---|---|---|---|
| Manganese (*Cont.*) | | | |
| $Mn(C_2H_3O_2)_2$ | c | −270.3 | |
| | aq | −282.7 | −227.2 |
| $MnCO_3$ | c | −211 | −192.5 |
| $MnC_2O_4$ | c | −240.9 | |
| $MnCl_2$ | c | −112.0 | −102.2 |
| | aq, 400 | −128.9 | |
| $MnF_2$ | aq, 1200 | −206.1 | −180.0 |
| $MnI_2$ | c | −49.8 | |
| | aq | −76.2 | −73.3 |
| $Mn_3N_2$ | c | −57.77 | −46.49 |
| $Mn(NO_3)_2$ | c | −134.9 | |
| | aq, 400 | −148.0 | −101.1 |
| $Mn(NO_3)_2.6H_2O$ | c | −557.07 | −441.2 |
| MnO | c | −92.04 | −86.77 |
| $MnO_2$ | c | −124.58 | −111.49 |
| $Mn_2O_3$ | c | −229.5 | −209.9 |
| $Mn_3O_4$ | c | −331.65 | −306.22 |
| $MnO.SiO_2$ | c | −301.3 | −282.1 |
| $Mn(OH)_2$ | c | −163.4 | −143.1 |
| $Mn(OH)_3$ | c | −221 | −190 |
| $Mn_3(PO_4)_2$ | c | −736 | |
| MnSe | c | −26.3 | −27.5 |
| MnS | c, green | −47.0 | −48.0 |
| $MnSO_4$ | c | −254.18 | −228.41 |
| | aq, 400 | −265.2 | |
| $Mn_2(SO_4)_3$ | c | −635 | |
| | aq | −657 | |
| Mercury | | | |
| Hg | l | 0.00 | 0.00 |
| HgBr | g | 23 | 18 |
| $HgBr_2$ | c | −40.68 | −38.8 |
| | aq | −38.4 | −9.74 |
| $Hg(C_2H_3O_2)_2$ | c | −196.3 | |
| | aq | −192.5 | −139.2 |
| $HgCl_2$ | c | −53.4 | −42.2 |
| | aq | −50.3 | −23.25 |
| HgCl | g | 19 | 14 |
| $Hg_2Cl_2$ | c | −63.13 | |
| $Hg(CN)_2$ | c | 62.8 | |
| | aq, 1110 | 66.25 | |
| $HgC_2O_4$ | c | −159.3 | |
| HgH | g | 57.1 | 52.25 |
| $HgI_2$ | c, red | −25.3 | −24.0 |
| HgI | g | 33 | 23 |
| $Hg_2I_2$ | c | −28.88 | −26.53 |
| $Hg(NO_3)_2$ | aq | −56.8 | −13.09 |
| $Hg_2(NO_3)_2$ | aq | −58.5 | −15.65 |
| HgO | c, red | −21.6 | −13.94 |
| | c, yellow ppt. | −20.8 | |
| $Hg_2O$ | c | −21.6 | −12.80 |
| HgS | c, black | −10.7 | −8.80 |
| $HgSO_4$ | c | −166.6 | |
| $Hg_2SO_4$ | c | −177.34 | −149.12 |
| Molybdenum | | | |
| Mo | c | 0.00 | 0.00 |
| $Mo_2C$ | c | 4.36 | 2.91 |
| $Mo_2N$ | c | −8.3 | |
| $MoO_2$ | c | −130 | −118.0 |
| $MoO_3$ | c | −180.39 | −162.01 |
| $MoS_2$ | c | −56.27 | −54.19 |
| $MoS_3$ | c | −61.48 | −57.38 |
| Nickel | | | |
| Ni | c | 0.00 | 0.00 |
| $NiBr_2$ | c | −53.4 | |
| | aq | −72.6 | −60.7 |
| $Ni_3C$ | c | 9.2 | 8.88 |
| $Ni(C_2H_3O_2)_2$ | aq | −249.6 | −190.1 |
| $Ni(CN)_2$ | aq | 230.9 | 66.3 |
| $NiCl_2$ | c | −75.0 | |
| | aq, 400 | −94.34 | −74.19 |
| $NiF_2$ | c | −157.5 | |
| | aq | −171.6 | −142.9 |
| $NiI_2$ | c | −22.4 | |
| | aq | −42.0 | −36.2 |
| $Ni(NO_3)_2$ | c | −101.5 | |
| | aq, 200 | −113.5 | −64.0 |
| NiO | c | −58.4 | −51.7 |
| $Ni(OH)_2$ | c | −129.8 | −105.6 |
| $Ni(OH)_3$ | c | −163.2 | |
| NiS | c | −20.4 | |
| $NiSO_4$ | c | −216 | |
| | aq, 200 | −231.3 | −187.6 |
| Nitrogen | | | |
| $N_2$ | g | 0.00 | 0.00 |
| $NF_3$ | g | −27 | |
| $NH_3$ | g | −10.96 | −3.903 |
| | aq, 200 | −19.27 | |
| $NH_4Br$ | c | −64.57 | |
| | aq | −60.27 | −43.54 |
| $NH_4C_2H_3O_2$ | c | −148.1 | |
| | aq, 400 | −148.58 | −108.26 |
| $NH_4CN$ | c | −0.7 | |
| | aq | 3.6 | 20.4 |
| $NH_4CNS$ | c | −17.8 | |
| | aq | −12.3 | 4.4 |
| $(NH_4)_2CO_3$ | aq | −223.4 | −164.1 |
| $(NH_4)_2C_2O_4$ | c | −266.3 | |
| | aq | −260.6 | −196.2 |
| $NH_4Cl$ | c | −75.23 | −48.59 |
| | aq, 400 | −71.20 | |
| $NH_4ClO_4$ | c | −69.4 | |
| | aq | −63.2 | −21.1 |
| $(NH_4)_2CrO_4$ | c | −276.9 | |
| | aq | −271.3 | −209.3 |
| $NH_4F$ | c | −111.6 | |
| | aq | −110.2 | −84.7 |
| $NH_4I$ | c | −48.43 | |
| | aq | −44.97 | −31.3 |
| $NH_4NO_3$ | c | −87.40 | |
| | aq, 500 | −80.89 | |
| $NH_4OH$ | aq | −87.59 | |
| $(NH_4)_2S$ | aq, 400 | −55.21 | −14.50 |
| $(NH_4)_2SO_4$ | c | −281.74 | −215.06 |
| | aq, 400 | −279.33 | −214.02 |
| $N_2H_4$ | l | 12.06 | |
| $N_2H_4.H_2O$ | l | −57.96 | |
| $N_2H_4.H_2SO_4$ | c | −232.2 | |
| $N_2O$ | g | 19.55 | 24.82 |
| NO | g | 21.600 | 20.719 |
| $NO_2$ | g | 7.96 | 12.26 |
| $N_2O_4$ | g | 2.23 | 23.41 |
| $N_2O_5$ | c | −10.0 | |
| NOBr | l | 11.6 | 19.26 |
| NOCl | g | 12.8 | 16.1 |
| Osmium | | | |
| Os | c | 0.00 | 0.00 |
| $OsO_4$ | c | −93.6 | −70.9 |
| | g | −80.1 | −68.1 |
| Oxygen | | | |
| $O_2$ | g | 0.00 | 0.00 |
| $O_3$ | g | 33.88 | 38.86 |
| Palladium | | | |
| Pd | c | 0.00 | 0.00 |
| PdO | c | −20.40 | |
| Phosphorus | | | |
| P | c, white ("yellow") | 0.00 | 0.00 |
| | c, red ("violet") | −4.22 | −1.80 |
| P | g | 150.35 | 141.88 |

**TABLE 2-220 Heats and Free Energies of Formation of Inorganic Compounds** (*Continued*)

| Compound | State† | Heat of formation‡§ $\Delta H$ (formation) at 25°C, kcal/mole | Free energy of formation‖¶ $\Delta F$ (formation) at 25°C, kcal/mole |
|---|---|---|---|
| Phosphorus (*Cont.*) | | | |
| $P_2$ | g | 33.82 | 24.60 |
| $P_4$ | g | 13.2 | 5.89 |
| $PBr_3$ | l | −45 | |
| $PBr_5$ | c | −60.6 | |
| $PCl_3$ | g | −70.0 | −65.2 |
| | l | −76.8 | −63.3 |
| $PCl_5$ | g | −91.0 | −73.2 |
| $PH_3$ | g | 2.21 | −1.45 |
| $PI_3$ | c | −10.9 | |
| $P_2O_5$ | c | −360.0 | |
| $POCl_3$ | g | −138.4 | −127.2 |
| Platinum | | | |
| Pt | c | 0.00 | 0.00 |
| $PtBr_4$ | c | −40.6 | |
| | aq | −50.7 | |
| $PtCl_2$ | c | −34 | |
| $PtCl_4$ | c | −62.6 | |
| | aq | −82.3 | |
| $PtI_4$ | c | −18 | |
| $Pt(OH)_2$ | c | −87.5 | −67.9 |
| PtS | c | −20.18 | −18.55 |
| $PtS_2$ | c | −26.64 | −24.28 |
| Potassium | | | |
| K | c | 0.00 | 0.00 |
| $K_3AsO_3$ | aq | −323.0 | |
| $K_3AsO_4$ | aq | −390.3 | −355.7 |
| $KH_2AsO_4$ | c | −271.2 | −236.7 |
| KBr | c | −94.06 | −90.8 |
| | aq, 400 | −89.19 | −92.0 |
| $KBrO_3$ | c | −81.58 | −60.30 |
| | aq, 1667 | −71.68 | |
| $KC_2H_3O_2$ | c | −173.80 | |
| | aq, 400 | −177.38 | −156.73 |
| KCl | c | −104.348 | −97.76 |
| | aq, 400 | −100.164 | −98.76 |
| $KClO_3$ | c | −93.5 | −69.30 |
| | aq, 400 | −81.34 | |
| $KClO_4$ | c | −103.8 | −72.86 |
| | aq, 400 | −101.14 | |
| KCN | c | −28.1 | |
| | aq, 400 | −25.3 | −28.08 |
| KCNO | c | −99.6 | |
| | aq | −94.5 | −90.85 |
| KCNS | c | −47.0 | |
| | aq, 400 | −41.07 | −44.08 |
| $K_2CO_3$ | c | −274.01 | |
| | aq, 400 | −280.90 | −264.04 |
| $K_2C_2O_4$ | c | −319.9 | |
| | aq, 400 | −315.5 | −293.1 |
| $K_2CrO_4$ | c | −333.4 | |
| | aq, 400 | −328.2 | −306.3 |
| $K_2Cr_2O_7$ | c | −488.5 | |
| | aq, 400 | −472.1 | −440.9 |
| KF | c | −134.50 | |
| | aq, 180 | −138.36 | −133.13 |
| $K_3Fe(CN)_6$ | c | −48.4 | |
| | aq | −34.5 | |
| $K_4Fe(CN)_6$ | c | −131.8 | |
| | aq | −119.9 | |
| KH | c | −10 | −5.3 |
| $KHCO_3$ | c | −229.8 | |
| | aq, 2000 | −224.85 | −207.71 |
| KI | c | −78.88 | −77.37 |
| | aq, 500 | −73.95 | −79.76 |
| $KIO_3$ | c | −121.69 | −101.87 |
| | aq, 400 | −115.18 | −99.68 |
| $KIO_4$ | aq | −98.1 | |
| $KMnO_4$ | c | −192.9 | −169.1 |
| | aq, 400 | −182.5 | −168.0 |
| $K_2MoO_4$ | aq, 880 | −364.2 | −342.9 |
| Potassium (*Cont.*) | | | |
| $KNH_2$ | c | −28.25 | |
| $KNO_2$ | aq | −86.0 | −75.9 |
| $KNO_3$ | c | −118.08 | −94.29 |
| | aq, 400 | −109.79 | −93.68 |
| $K_2O$ | c | −86.2 | |
| $K_2O{\cdot}Al_2O_3{\cdot}SiO_2$ | c, leucite | −1379.6 | |
| | gls | −1368.2 | |
| $K_2O{\cdot}Al_2O_3{\cdot}SiO_2$ | c, adularia | −1784.5 | |
| | c, microcline | −1784.5 | |
| | gls | −1747 | |
| KOH | c | −102.02 | |
| | aq, 400 | −114.96 | −105.0 |
| $K_3PO_3$ | aq | −397.5 | |
| $K_3PO_4$ | aq | −478.7 | −443.3 |
| $KH_2PO_4$ | c | −362.7 | −326.1 |
| $K_2PtCl_4$ | c | −254.7 | |
| | aq | −242.6 | −226.5 |
| $K_2PtCl_6$ | c | −299.5 | −263.6 |
| | aq, 9400 | −286.1 | |
| $K_2Se$ | c | −74.4 | |
| | aq | −83.4 | −99.10 |
| $K_2SeO_4$ | aq | −267.1 | −240.0 |
| $K_2S$ | c | −121.5 | |
| | aq, 400 | −110.75 | −111.44 |
| $K_2SO_3$ | c | −267.7 | |
| | aq | −269.7 | −251.3 |
| $K_2SO_4$ | c | −342.65 | −314.62 |
| | aq, 400 | −336.48 | −310.96 |
| $K_2SO_4{\cdot}Al_2(SO_4)_3$ | c | −1178.38 | −1068.48 |
| $K_2SO_4{\cdot}Al_2(SO_4)_3{\cdot}$ $24H_2O$ | c | −2895.44 | −2455.68 |
| $K_2S_2O_6$ | c | −418.62 | |
| Rhenium | | | |
| Re | c | 0.00 | 0.00 |
| $ReF_6$ | g | −274 | |
| Rhodium | | | |
| Rh | c | 0.00 | 0.00 |
| RhO | c | −21.7 | |
| $Rh_2O$ | c | −22.7 | |
| $Rh_2O_3$ | c | −68.3 | |
| Rubidium | | | |
| Rb | c | 0.00 | 0.00 |
| RbBr | c | −95.82 | |
| | g | −45.0 | −52.50 |
| | aq, 500 | −90.54 | −93.38 |
| RbCN | aq | −25.9 | |
| $Rb_2CO_3$ | c | −273.22 | |
| | aq, 220 | −282.61 | −263.78 |
| RbCl | c | −105.06 | −98.48 |
| | g | −53.6 | −57.9 |
| | aq, ∞ | −101.06 | −100.13 |
| RbF | c | −133.23 | |
| | aq, 400 | −139.31 | −134.5 |
| $RbHCO_3$ | c | −230.01 | |
| | aq, 2000 | −225.59 | −209.07 |
| RbI | c | −81.04 | |
| | g | −31.2 | −40.5 |
| | aq, 400 | −74.57 | −81.13 |
| $RbNH_2$ | c | −27.74 | |
| $RbNO_3$ | c | −119.22 | |
| | aq, 400 | −110.52 | −95.05 |
| $Rb_2O$ | c | −82.9 | |
| $Rb_2O_2$ | c | −107 | |
| RbOH | c | −101.3 | |
| | aq, 200 | −115.8 | −106.39 |
| Ruthenium | | | |
| Ru | c | 0.00 | 0.00 |
| $RuS_2$ | c | −46.99 | −44.11 |
| Selenium | | | |
| Se | c, I, hexagonal | 0.00 | 0.00 |

**TABLE 2-220 Heats and Free Energies of Formation of Inorganic Compounds** (*Continued*)

| Compound | State† | Heat of formation‡§ $\Delta H$ (formation) at 25°C, kcal/mole | Free energy of formation‖¶ $\Delta F$ (formation) at 25°C, kcal/mole |
|---|---|---|---|
| Selenium (*Cont.*) | | | |
| | c, II, red, monoclinic | 0.2 | |
| $Se_2Cl_2$ | l | −22.06 | −13.73 |
| $SeF_6$ | g | −246 | −222 |
| $SeO_2$ | c | −56.33 | |
| Silicon | | | |
| Si | c | 0.00 | 0.00 |
| $SiBr_4$ | l | −93.0 | |
| SiC | c | −28 | −27.4 |
| $SiCl_4$ | l | −150.0 | −133.9 |
| | g | −142.5 | −133.0 |
| $SiF_4$ | g | −370 | −360 |
| $SiH_4$ | g | −14.8 | −9.4 |
| $SiI_4$ | c | −29.8 | |
| $Si_3N_4$ | c | −179.25 | −154.74 |
| $SiO_2$ | c, cristobalite, 1600° form | −202.62 | |
| | c, cristobalite, 1100° form | −202.46 | |
| | c, quartz | −203.35 | −190.4 |
| | c, tridymite | −203.23 | |
| Silver | | | |
| Ag | c | 0.00 | 0.00 |
| AgBr | c | −23.90 | −23.02 |
| $Ag_2C_2$ | c | 84.5 | |
| $AgC_2H_3O_2$ | c | −95.9 | |
| | aq | −91.7 | −70.86 |
| AgCN | c | 33.8 | 38.70 |
| $Ag_2CO_3$ | c | −119.5 | −103.0 |
| $Ag_2C_2O_4$ | c | −158.7 | |
| AgCl | c | −30.11 | −25.98 |
| AgF | c | −48.7 | |
| | aq, 400 | −53.1 | −47.26 |
| AgI | c | −15.14 | −16.17 |
| $AgIO_3$ | c | −42.02 | −24.08 |
| $AgNO_2$ | c | −11.6 | 3.76 |
| | aq | −2.9 | 9.99 |
| $AgNO_3$ | c | −29.4 | −7.66 |
| | aq, 6500 | −24.02 | −7.81 |
| $Ag_2O$ | c | −6.95 | −2.23 |
| $Ag_2S$ | c | −5.5 | −7.6 |
| $Ag_2SO_4$ | c | −170.1 | −146.8 |
| | aq | −165.8 | −139.22 |
| Sodium | | | |
| Na | c | 0.00 | 0.00 |
| $Na_3AsO_3$ | aq, 500 | −314.61 | |
| $Na_3AsO_4$ | c | −366 | |
| | aq, 500 | −381.97 | −341.17 |
| NaBr | c | −86.72 | |
| | aq, 400 | −86.33 | −87.17 |
| NaBrO | aq | −78.9 | |
| $NaBrO_3$ | aq, 400 | −68.89 | −57.59 |
| $NaC_2H_3O_2$ | c | −170.45 | |
| | aq, 400 | −175.450 | −152.31 |
| NaCN | c | −22.47 | |
| | aq, 200 | −22.29 | −23.24 |
| NaCNO | c | −96.3 | |
| | aq | −91.7 | −86.00 |
| NaCNS | c | −39.94 | |
| | aq, 400 | −38.23 | −39.24 |
| $Na_2CO_3$ | c | −269.46 | −249.55 |
| | aq, 1000 | −275.13 | −251.36 |
| $NaCO_2NH_2$ | c | −142.17 | |
| $Na_2C_2O_4$ | c | −313.8 | |
| | aq, 600 | −309.92 | −283.42 |
| NaCl | c | −98.321 | −91.894 |
| | aq, 400 | −97.324 | −93.92 |
| $NaClO_3$ | c | −83.59 | |
| | aq, 400 | −78.42 | −62.84 |
| $NaClO_4$ | c | −101.12 | |
| | aq, 476 | −97.66 | −73.29 |
| $Na_2CrO_4$ | c | −319.8 | |
| | aq, 800 | −323.0 | −296.58 |
| $Na_2Cr_2O_7$ | aq, 1200 | −465.9 | −431.18 |
| NaF | c | −135.94 | −129.0 |
| | aq, 400 | −135.711 | −128.29 |
| NaH | c | −14 | −9.30 |
| $NaHCO_3$ | c | −226.0 | −202.66 |
| | aq | −222.1 | −202.87 |
| NaI | c | −69.28 | |
| | aq, ∞ | −71.10 | −74.92 |
| $NaIO_3$ | aq, 400 | −112.300 | −94.84 |
| $Na_2MoO_4$ | c | −364 | |
| | aq | −358.7 | −333.18 |
| $NaNO_2$ | c | −86.6 | |
| | aq | −83.1 | −71.04 |
| $NaNO_3$ | c | −111.71 | −87.62 |
| | aq, 400 | −106.880 | −88.84 |
| $Na_2O$ | c | −99.45 | −90.06 |
| $Na_2O_2$ | c | −119.2 | −105.0 |
| $Na_2O{\cdot}SiO_2$ | c | −383.91 | −361.49 |
| $Na_2O{\cdot}Al_2O_3{\cdot}3SiO_2$ | c, natrolite | −1180 | |
| $Na_2O{\cdot}Al_2O_3{\cdot}4SiO_2$ | c | −1366 | |
| NaOH | c | −101.96 | −90.60 |
| | aq, 400 | −112.193 | −100.18 |
| $Na_3PO_3$ | aq, 1000 | −389.1 | |
| $Na_3PO_4$ | c | −457 | |
| | aq, 400 | −471.9 | −428.74 |
| $Na_2PtCl_4$ | aq | −237.2 | −216.78 |
| $Na_2PtCl_6$ | c | −272.1 | |
| | aq | −280.9 | |
| $Na_2Se$ | c | −59.1 | |
| | aq, 440 | −78.1 | −89.42 |
| $Na_2SeO_4$ | c | −254 | |
| | aq, 800 | −261.5 | −230.30 |
| $Na_2S$ | c | −89.8 | |
| | aq, 400 | −105.17 | −101.76 |
| $Na_2SO_3$ | c | −261.2 | −240.14 |
| | aq, 800 | −264.1 | −241.58 |
| $Na_2SO_4$ | c | −330.50 | −302.38 |
| | aq, 1100 | −330.82 | −301.28 |
| $Na_2SO_4{\cdot}10H_2O$ | c | −1033.85 | −870.52 |
| $Na_2WO_4$ | c | −391 | |
| | aq | −381.5 | −345.18 |
| Strontium | | | |
| Sr | c | 0.00 | 0.00 |
| $SrBr_2$ | c | −171.0 | |
| | aq, 400 | −187.24 | −182.36 |
| $Sr(C_2H_3O_2)_2$ | c | −358.0 | |
| | aq | −364.4 | −311.80 |
| $Sr(CN)_2$ | aq | −59.5 | −54.50 |
| $SrCO_3$ | c | −290.9 | −271.9 |
| $SrCl_2$ | c | −197.84 | |
| | aq, 400 | −209.20 | −195.86 |
| $SrF_2$ | c | −289.0 | |
| $Sr(HCO_3)_2$ | aq | −459.1 | −413.76 |
| $SrI_2$ | c | −136.1 | |
| | aq, 400 | −156.70 | −157.87 |
| $Sr_3N_2$ | c | −91.4 | −76.5 |
| $Sr(NO_3)_2$ | c | −233.2 | |
| | aq, 400 | −228.73 | −185.70 |
| SrO | c | −140.8 | −133.7 |
| $SrO{\cdot}SiO_2$ | gls | −364 | |
| $SrO_2$ | c | −153.3 | −139.0 |
| $Sr_2O$ | c | −153.6 | |
| $Sr(OH)_2$ | c | −228.7 | |
| | aq, 800 | −239.4 | −208.27 |
| $Sr_3(PO_4)_2$ | c | −980 | |
| | aq | −985 | −881.54 |
| SrS | c | −113.1 | |

**TABLE 2-220 Heats and Free Energies of Formation of Inorganic Compounds** (*Continued*)

| Compound | State† | Heat of formation‡§ $\Delta H$ (formation) at 25°C, kcal/mole | Free energy of formation‖¶ $\Delta F$ (formation) at 25°C, kcal/mole |
|---|---|---|---|
| Strontium (*Cont.*) | | | |
| | aq | −120.4 | −109.78 |
| $SrSO_4$ | c | −345.3 | |
| | aq, 400 | −345.0 | −309.30 |
| $SrWO_4$ | c | −393 | |
| Sulfur | | | |
| S | c, rhombic | 0.00 | 0.00 |
| | c, monoclinic | −0.071 | 0.023 |
| | l, λ | 0.257 | 0.072 |
| | l, λμ equilibrium | | 0.071 |
| | g | 53.25 | 43.57 |
| $S_2$ | g | 31.02 | 19.36 |
| $S_6$ | g | 27.78 | 13.97 |
| $S_8$ | g | 27.090 | 12.770 |
| $S_2Br_2$ | l | −4 | |
| $SCl_4$ | l | −13.7 | |
| $S_2Cl_2$ | l | −14.2 | −5.90 |
| $S_2Cl_4$ | l | −24.1 | |
| $SF_6$ | g | −262 | −237 |
| SO | g | 19.02 | 12.75 |
| $SO_2$ | g | −70.94 | −71.68 |
| $SO_3$ | g | −94.39 | −88.59 |
| | l | −103.03 | −88.28 |
| | c, α | −105.09 | −88.22 |
| | c, β | −105.92 | −88.34 |
| | c, γ | −109.34 | −88.98 |
| $SO_2Cl_2$ | g | −82.04 | −74.06 |
| | l | −89.80 | −75.06 |
| Tantalum | | | |
| Ta | c | 0.00 | 0.00 |
| TaN | c | −51.2 | −45.11 |
| $Ta_2O_5$ | c | −486.0 | −453.7 |
| Tellurium | | | |
| Te | c | 0.00 | 0.00 |
| $TeBr_4$ | c | −49.3 | |
| $TeCl_4$ | c | −77.4 | −57.4 |
| $TeF_6$ | g | −315 | −292 |
| $TeO_2$ | c | −77.56 | −64.66 |
| Thallium | | | |
| Tl | c | 0.00 | 0.00 |
| TlBr | c | −41.5 | −39.43 |
| | aq | −28.0 | −32.34 |
| TlCl | c | −49.37 | −44.46 |
| | aq | −38.4 | −39.09 |
| $TlCl_3$ | c | −82.4 | |
| | aq | −91.0 | −44.25 |
| TlF | aq | −77.6 | −73.46 |
| TlI | c | −31.1 | −31.3 |
| | aq | −12.7 | −20.09 |
| $TlNO_3$ | c | −58.2 | −36.32 |
| | aq | −48.4 | −34.01 |
| $Tl_2O$ | c | −43.18 | |
| $Tl_2O_3$ | c | −120 | |
| TlOH | c | −57.44 | −45.54 |
| | aq | −53.9 | −45.35 |
| $Tl_2S$ | c | −22 | |
| $Tl_2SO_4$ | c | −222.8 | −197.79 |
| | aq, 800 | −214.1 | −191.62 |
| Thorium | | | |
| Th | c | 0.00 | 0.00 |
| $ThBr_4$ | c | −281.5 | |
| | aq | −352.0 | −295.31 |
| $ThC_2$ | c | −45.1 | |
| $ThCl_4$ | c | −335 | |
| | aq | −392 | −322.32 |
| $ThI_4$ | aq | −292.0 | −246.33 |
| $Th_3N_4$ | c | −309.0 | −282.3 |
| $ThO_2$ | c | −291.6 | −280.1 |
| $Th(OH)_4$ | c, "soluble" | −336.1 | |
| $Th(SO_4)_2$ | c | −632 | |
| | aq | −668.1 | −549.2 |
| Tin | | | |
| Sn | c, II, tetragonal | 0.00 | 0.00 |
| | c, III, "gray," cubic | 0.6 | 1.1 |
| $SnBr_2$ | c | −61.4 | |
| | aq | −60.0 | −55.43 |
| $SnBr_4$ | c | −94.8 | |
| | aq | −110.6 | −97.66 |
| $SnCl_2$ | c | −83.6 | |
| | aq | −81.7 | −68.94 |
| $SnCl_4$ | l | −127.3 | −110.4 |
| | aq | −157.6 | −124.67 |
| $SnI_2$ | c | −38.9 | |
| | aq | −33.3 | −30.95 |
| SnO | c | −67.7 | −60.75 |
| $SnO_2$ | c | −138.1 | −123.6 |
| $Sn(OH)_2$ | c | −136.2 | −115.95 |
| $Sn(OH)_4$ | c | −268.9 | −226.00 |
| SnS | c | −18.61 | |
| Titanium | | | |
| Ti | c | 0.00 | 0.00 |
| TiC | c | −110 | −109.2 |
| $TiCl_4$ | l | −181.4 | −165.5 |
| TiN | c | −80.0 | −73.17 |
| $TiO_2$ | c, III, rutil | −225.0 | −211.9 |
| | amorphous | −214.1 | −201.4 |
| Tungsten | | | |
| W | c | 0.00 | 0.00 |
| $WO_2$ | c | −130.5 | −118.3 |
| $WO_3$ | c | −195.7 | −177.3 |
| $WS_2$ | c | −84 | |
| Uranium | | | |
| U | c | 0.00 | 0.00 |
| $UC_2$ | c | −29 | |
| $UCl_3$ | c | −213 | |
| $UCl_4$ | c | −251 | |
| $U_3N_4$ | c | −274 | −249.6 |
| $UO_2$ | c | −256.6 | −242.2 |
| $UO_2(NO_3)_2{\cdot}6H_2O$ | c | −756.8 | −617.8 |
| $UO_3$ | c | −291.6 | |
| $U_3O_8$ | c | −845.1 | |
| Vanadium | | | |
| V | c | 0.00 | 0.00 |
| $VCl_2$ | c | −147 | |
| $VCl_3$ | l | −187 | |
| $VCl_4$ | l | −165 | |
| VN | c | −41.43 | −35.08 |
| $V_2O_2$ | c | −195 | |
| $V_2O_3$ | c | −296 | −277 |
| $V_2O_4$ | c | −342 | −316 |
| $V_2O_5$ | c | −373 | −342 |
| Zinc | | | |
| Zn | c | 0.00 | 0.00 |
| ZnSb | c | −3.6 | −3.88 |
| $ZnBr_2$ | c | −77.0 | −72.9 |
| | aq, 400 | −93.6 | |
| $Zn(C_2H_3O_2)_2$ | c | −259.4 | |
| | aq, 400 | −269.4 | −214.4 |
| $Zn(CN)_2$ | c | 17.06 | |
| $ZnCO_3$ | c | −192.9 | −173.5 |
| $ZnCl_2$ | c | −99.9 | −88.8 |
| | aq, 400 | −115.44 | |
| $ZnF_2$ | aq | −192.9 | −166.6 |
| $ZnI_2$ | c | −50.50 | −49.93 |
| | aq | −61.6 | |
| $Zn(NO_3)_2$ | aq, 400 | −134.9 | −87.7 |
| ZnO | c, hexagonal | −83.36 | −76.19 |
| $ZnO{\cdot}SiO_2$ | c | −282.6 | |
| $Zn(OH)_2$ | c, rhombic | −153.66 | |
| ZnS | c, wurtzite | −45.3 | −44.2 |
| $ZnSO_4$ | c | −233.4 | |
| | aq, 400 | −252.12 | −211.28 |

**TABLE 2-220 Heats and Free Energies of Formation of Inorganic Compounds** (*Concluded*)

| Compound | State† | Heat of formation‡§ $\Delta H$ (formation) at 25°C, kcal/mole | Free energy of formation‖¶ $\Delta F$ (formation) at 25°C, kcal/mole | Compound | State† | Heat of formation‡§ $\Delta H$ (formation) at 25°C, kcal/mole | Free energy of formation‖¶ $\Delta F$ (formation) at 25°C, kcal/mole |
|---|---|---|---|---|---|---|---|
| Zirconium | | | | Zirconium (*Cont.*) | | | |
| Zr | c | 0.00 | 0.00 | $ZrO_2$ | c, monoclinic | –258.5 | –244.6 |
| ZrC | c | –29.8 | –34.6 | $Zr(OH)_4$ | c | –411.0 | |
| $ZrCl_4$ | c | –268.9 | | $ZrO(OH)_2$ | c | –337 | –307.6 |
| ZrN | c | –82.5 | –75.9 | | | | |

† The physical state is indicated as follows: *c,* crystal (solid); *l,* liquid; *g,* gas; *gls,* glass or solid supercooled liquid; *aq,* in aqueous solution. A number following the symbol *aq* applies only to the values of the heats of formation (not to those of free energies of formation); and indicates the number of moles of water per mole of solute; when no number is given, the solution is understood to be dilute. For the free energy of formation of a substance in aqueous solution, the concentration is always that of the hypothetical solution of unit molality.

‡ The increment in heat content, $\Delta H$, in the reaction of forming the given substance from its elements in their standard states. When $\Delta H$ is negative, heat is evolved in the process, and, when positive, heat is absorbed.

§ The heat of solution in water of a given solid, liquid, or gaseous compound is given by the difference in the value for the heat of formation of the given compound in the solid, liquid, or gaseous state and its heat of formation in aqueous solution. The following two examples serve as an illustration of the procedure: (1) For NaCl(*c*) and NaCl(*aq,* $400H_2O$), the values of $\Delta H$(formation) are, respectively, –98.321 and –97.324 kg-cal per mole. Subtraction of the first value from the second gives $\Delta H = 0.998$ kg-cal per mole for the reaction of dissolving crystalline sodium chloride in 400 moles of water. When this process occurs at a constant pressure of 1 atm, 0.998 kg-cal of energy are absorbed. (2) For HCl(*g*) and HCl(*aq,* $400H_2O$), the values for $\Delta H$(formation) are, respectively, –22.06 and –39.85 kg-cal per mole. Subtraction of the first from the second gives $\Delta H = -17.79$ kg-cal per mole for the reaction of dissolving gaseous hydrogen chloride in 400 moles of water. At a constant pressure of 1 atm, 17.79 kg-cal of energy are evolved in this process.

‖ The increment in the free energy, $\Delta F$, in the reaction of forming the given substance in its standard state from its elements in their standard states. The standard states are: for a gas, fugacity (approximately equal to the pressure) of 1 atm; for a pure liquid or solid, the substance at a pressure of 1 atm; for a substance in aqueous solution, the hypothetical solution of unit molality, which has all the properties of the infinitely dilute solution except the property of concentration.

¶ The free energy of solution of a given substance from its normal standard state as a solid, liquid, or gas to the hypothetical one molal state in aqueous solution may be calculated in a manner similar to that described in footnote § for calculating the heat of solution.

# HEATS OF COMBUSTION

**TABLE 2-221 Enthalpies and Gibbs Energies of Formation, Entropies, and Net Enthalpies of Combustion of Inorganic and Organic Compounds at 298.15 K**

| Cmpd. no. | Name | Formula | CAS no. | Mol wt | Ideal gas enthalpy of formation, J/kmol × 1E-07 | Ideal gas Gibbs energy of formation, J/kmol × 1E-07 | Ideal gas entropy, J/(kmol·K) × 1E-05 | Standard net enthalpy of combustion, J/kmol × 1E-09 |
|---|---|---|---|---|---|---|---|---|
| 1 | Methane | $CH_4$ | 74828 | 16.043 | –7.4520 | –5.0490 | 1.8627 | –0.8026 |
| 2 | Ethane | $C_2H_6$ | 74840 | 30.070 | –8.3820 | –3.1920 | 2.2912 | –1.4286 |
| 3 | Propane | $C_3H_8$ | 74986 | 44.097 | –10.4680 | –2.4390 | 2.7020 | –2.0431 |
| 4 | *n*-Butane | $C_4H_{10}$ | 106978 | 58.123 | –12.5790 | –1.6700 | 3.0991 | –2.6573 |
| 5 | *n*-Pentane | $C_5H_{12}$ | 109660 | 72.150 | –14.6760 | –0.8813 | 3.4945 | –3.2449 |
| 6 | *n*-Hexane | $C_6H_{14}$ | 110543 | 86.177 | –16.6940 | –0.0066 | 3.8874 | –3.8551 |
| 7 | *n*-Heptane | $C_7H_{16}$ | 142825 | 100.204 | –18.7650 | 0.8165 | 4.2798 | –4.4647 |
| 8 | *n*-Octane | $C_8H_{18}$ | 111659 | 114.231 | –20.8750 | 1.6000 | 4.6723 | –5.0742 |
| 9 | *n*-Nonane | $C_9H_{20}$ | 111842 | 128.258 | –22.8740 | 2.4980 | 5.0640 | –5.6846 |
| 10 | *n*-Decane | $C_{10}H_{22}$ | 124185 | 142.285 | –24.9460 | 3.3180 | 5.4570 | –6.2942 |
| 11 | *n*-Undecane | $C_{11}H_{24}$ | 1120214 | 156.312 | –27.0430 | 4.1160 | 5.8493 | –6.9036 |
| 12 | *n*-Dodecane | $C_{12}H_{26}$ | 112403 | 170.338 | –29.0720 | 4.9810 | 6.2415 | –7.5137 |
| 13 | *n*-Tridecane | $C_{13}H_{28}$ | 629505 | 184.365 | –31.1770 | 5.7710 | 6.6337 | –8.1229 |
| 14 | *n*-Tetradecane | $C_{14}H_{30}$ | 629594 | 198.392 | –33.2440 | 6.5990 | 7.0259 | –8.7328 |
| 15 | *n*-Pentadecane | $C_{15}H_{32}$ | 629629 | 212.419 | –35.3110 | 7.4260 | 7.4181 | –9.3424 |
| 16 | *n*-Hexadecane | $C_{16}H_{34}$ | 544763 | 226.446 | –37.4170 | 8.2160 | 7.8102 | –9.9515 |
| 17 | *n*-Heptadecane | $C_{17}H_{36}$ | 629787 | 240.473 | –39.4450 | 9.0830 | 8.2023 | –10.5618 |
| 18 | *n*-Octadecane | $C_{18}H_{38}$ | 593453 | 254.500 | –41.5120 | 9.9100 | 8.5945 | –11.1715 |
| 19 | *n*-Nonadecane | $C_{19}H_{40}$ | 629925 | 268.527 | –43.5790 | 10.7400 | 8.9866 | –11.7812 |
| 20 | *n*-Eicosane | $C_{20}H_{42}$ | 112958 | 282.553 | –45.6460 | 11.5700 | 9.3787 | –12.3908 |
| 21 | 2-Methylpropane | $C_4H_{10}$ | 75285 | 58.123 | –13.4180 | –2.0760 | 2.9539 | –2.6490 |
| 22 | 2-Methylbutane | $C_5H_{12}$ | 78784 | 72.150 | –15.3700 | –1.4050 | 3.4374 | –3.2395 |
| 23 | 2,3-Dimethylbutane | $C_6H_{14}$ | 79298 | 86.177 | –17.6800 | –0.3125 | 3.6592 | –3.8476 |
| 24 | 2-Methylpentane | $C_6H_{14}$ | 107835 | 86.177 | –17.4550 | –0.5338 | 3.8089 | –3.8492 |
| 25 | 2,3-Dimethylpentane | $C_7H_{16}$ | 565593 | 100.204 | –19.4100 | 0.5717 | 4.1455 | –4.4608 |
| 26 | 2,3,3-Trimethylpentane | $C_8H_{18}$ | 560214 | 114.231 | –21.8450 | 1.8280 | 4.2702 | –5.0688 |
| 27 | 2,2,4-Trimethylpentane | $C_8H_{18}$ | 540841 | 114.231 | –22.4010 | 1.3940 | 4.2296 | –5.0653 |
| 28 | Ethylene | $C_2H_4$ | 74851 | 28.054 | 5.2510 | 6.8440 | 2.1920 | –1.3230 |
| 29 | Propylene | $C_3H_6$ | 115071 | 42.081 | 1.9710 | 6.2150 | 2.6660 | –1.9257 |

**TABLE 2-221 Enthalpies and Gibbs Energies of Formation, Entropies, and Net Enthalpies of Combustion of Inorganic and Organic Compounds** (*Continued*)

| Cmpd. no. | Name | Formula | CAS no. | Mol wt | Ideal gas enthalpy of formation, J/kmol × 1E-07 | Ideal gas Gibbs energy of formation, J/kmol × 1E-07 | Ideal gas entropy, J/(kmol·K) × 1E-05 | Standard net enthalpy of combustion, J/kmol × 1E-09 |
|---|---|---|---|---|---|---|---|---|
| 30 | 1-Butene | $C_4H_8$ | 106989 | 56.108 | −0.0540 | 7.0270 | 3.0775 | −2.5408 |
| 31 | *cis*-2-Butene | $C_4H_8$ | 590181 | 56.108 | −0.7400 | 6.5360 | 3.0120 | −2.5339 |
| 32 | *trans*-2-Butene | $C_4H_8$ | 624646 | 56.108 | −1.1000 | 6.3160 | 2.9650 | −2.5303 |
| 33 | 1-Pentene | $C_5H_{10}$ | 109671 | 70.134 | −2.1300 | 7.8450 | 3.4699 | −3.1296 |
| 34 | 1-Hexene | $C_6H_{12}$ | 592416 | 84.161 | −4.2000 | 8.7390 | 3.8389 | −3.7394 |
| 35 | 1-Heptene | $C_7H_{14}$ | 592767 | 98.188 | −6.2800 | 9.4830 | 4.2549 | −4.3489 |
| 36 | 1-Octene | $C_8H_{16}$ | 111660 | 112.215 | −8.3600 | 10.3000 | 4.6469 | −4.9606 |
| 37 | 1-Nonene | $C_9H_{18}$ | 124118 | 126.242 | −10.4000 | 11.1500 | 5.0399 | −5.5684 |
| 38 | 1-Decene | $C_{10}H_{20}$ | 872059 | 140.269 | −12.4700 | 11.9800 | 5.4319 | −6.1781 |
| 39 | 2-Methylpropene | $C_4H_8$ | 115117 | 56.108 | −1.7100 | 5.8080 | 2.9309 | −2.5242 |
| 40 | 2-Methyl-1-butene | $C_5H_{10}$ | 563462 | 70.134 | −3.5300 | 6.6680 | 3.3950 | −3.1159 |
| 41 | 2-Methyl-2-butene | $C_5H_{10}$ | 513359 | 70.134 | −4.1800 | 6.0450 | 3.3860 | −3.1088 |
| 42 | 1,2-Butadiene | $C_4H_6$ | 590192 | 54.092 | 16.2300 | 19.8600 | 2.9300 | −2.4617 |
| 43 | 1,3-Butadiene | $C_4H_6$ | 106990 | 54.092 | 10.9240 | 14.9720 | 2.7889 | −2.4090 |
| 44 | 2-Methyl-1,3-butadiene | $C_5H_8$ | 78795 | 68.119 | 7.5730 | 14.5896 | 3.1564 | −2.9842 |
| 45 | Acetylene | $C_2H_2$ | 74862 | 26.038 | 22.8200 | 21.0680 | 2.0081 | −1.2570 |
| 46 | Methylacetylene | $C_3H_4$ | 74997 | 40.065 | 18.4900 | 19.3840 | 2.4836 | −1.8487 |
| 47 | Dimethylacetylene | $C_4H_6$ | 503173 | 54.092 | 14.5700 | 18.4900 | 2.8330 | −2.4189 |
| 48 | 3-Methyl-1-butyne | $C_5H_8$ | 598232 | 68.119 | 13.8000 | 20.7200 | 3.1890 | −3.0460 |
| 49 | 1-Pentyne | $C_5H_8$ | 627190 | 68.119 | 14.4400 | 21.0300 | 3.2980 | −3.0510 |
| 50 | 2-Pentyne | $C_5H_8$ | 627214 | 68.119 | 12.5100 | 19.0700 | 3.3084 | −3.0291 |
| 51 | 1-Hexyne | $C_6H_{10}$ | 693027 | 82.145 | 12.3700 | 21.8500 | 3.6940 | −3.6610 |
| 52 | 2-Hexyne | $C_6H_{10}$ | 764352 | 82.145 | 10.5000 | 19.9000 | 3.7200 | −3.6400 |
| 53 | 3-Hexyne | $C_6H_{10}$ | 928494 | 82.145 | 10.6000 | 19.9000 | 3.7600 | −3.6400 |
| 54 | 1-Heptyne | $C_7H_{12}$ | 628717 | 96.172 | 10.3000 | 22.7000 | 4.0850 | −4.2717 |
| 55 | 1-Octyne | $C_8H_{14}$ | 629050 | 110.199 | 8.2300 | 23.5000 | 4.4780 | −4.8815 |
| 56 | Vinylacetylene | $C_4H_4$ | 689974 | 52.076 | 30.4600 | 30.6000 | 2.7940 | −2.3620 |
| 57 | Cyclopentane | $C_5H_{10}$ | 287923 | 70.134 | −7.7030 | 3.8850 | 2.9290 | −3.0709 |
| 58 | Methylcyclopentane | $C_6H_{12}$ | 96377 | 84.161 | −10.6200 | 3.6300 | 3.3990 | −3.6741 |
| 59 | Ethylcyclopentane | $C_7H_{14}$ | 1640897 | 98.188 | −12.6900 | 4.4800 | 3.7830 | −4.2839 |
| 60 | Cyclohexane | $C_6H_{12}$ | 110827 | 84.161 | −12.3300 | 3.1910 | 2.9728 | −3.6560 |
| 61 | Methylcyclohexane | $C_7H_{14}$ | 108872 | 98.188 | −15.4800 | 2.7330 | 3.4330 | −4.2571 |
| 62 | 1,1-Dimethylcyclohexane | $C_8H_{16}$ | 590669 | 112.215 | −18.1000 | 3.5229 | 3.6501 | −4.8639 |
| 63 | Ethylcyclohexane | $C_8H_{16}$ | 1678917 | 112.215 | −17.1500 | 3.9550 | 3.8260 | −4.8705 |
| 64 | Cyclopentene | $C_5H_8$ | 142290 | 68.119 | 3.3100 | 11.0500 | 2.9127 | −2.9393 |
| 65 | 1-Methylcyclopentene | $C_6H_{10}$ | 693890 | 82.145 | −0.3800 | 10.3800 | 3.2640 | −3.5340 |
| 66 | Cyclohexene | $C_6H_{10}$ | 110838 | 82.145 | −0.4600 | 10.7700 | 3.1052 | −3.5320 |
| 67 | Benzene | $C_6H_6$ | 71432 | 78.114 | 8.2880 | 12.9600 | 2.6930 | −3.1360 |
| 68 | Toluene | $C_7H_8$ | 108883 | 92.141 | 5.0170 | 12.2200 | 3.2099 | −3.7340 |
| 69 | *o*-Xylene | $C_8H_{10}$ | 95476 | 106.167 | 1.9080 | 12.2000 | 3.5383 | −4.3330 |
| 70 | *m*-Xylene | $C_8H_{10}$ | 108383 | 106.167 | 1.7320 | 11.8760 | 3.5854 | −4.3318 |
| 71 | *p*-Xylene | $C_8H_{10}$ | 106423 | 106.167 | 1.8030 | 12.1400 | 3.5223 | −4.3330 |
| 72 | Ethylbenzene | $C_8H_{10}$ | 100414 | 106.167 | 2.9920 | 13.0730 | 3.6063 | −4.3450 |
| 73 | Propylbenzene | $C_9H_{12}$ | 103651 | 120.194 | 0.7910 | 13.8090 | 3.9843 | −4.9542 |
| 74 | 1,2,4-Trimethylbenzene | $C_9H_{12}$ | 95636 | 120.194 | −1.3800 | 11.7100 | 3.9610 | −4.9307 |
| 75 | Isopropylbenzene | $C_9H_{12}$ | 98828 | 120.194 | 0.4000 | 13.7900 | 3.8600 | −4.9510 |
| 76 | 1,3,5-Trimethylbenzene | $C_9H_{12}$ | 108678 | 120.194 | −1.5900 | 11.8100 | 3.8560 | −4.9291 |
| 77 | *p*-Isopropyltoluene | $C_{10}H_{14}$ | 99876 | 134.221 | −2.9000 | 13.3520 | 4.2630 | −5.5498 |
| 78 | Naphthalene | $C_{10}H_8$ | 91203 | 128.174 | 15.0580 | 22.4080 | 3.3315 | −4.9809 |
| 79 | Biphenyl | $C_{12}H_{10}$ | 92524 | 154.211 | 18.2420 | 28.0230 | 3.9367 | −6.0317 |
| 80 | Styrene | $C_8H_8$ | 100425 | 104.152 | 14.7400 | 21.3900 | 3.4510 | −4.2190 |
| 81 | *m*-Terphenyl | $C_{18}H_{14}$ | 92068 | 230.309 | 27.6600 | 42.3000 | 5.2630 | −9.0530 |
| 82 | Methanol | $CH_4O$ | 67561 | 32.042 | −20.0940 | −16.2320 | 2.3988 | −0.6382 |
| 83 | Ethanol | $C_2H_6O$ | 64175 | 46.069 | −23.4950 | −16.7850 | 2.8064 | −1.2350 |
| 84 | 1-Propanol | $C_3H_8O$ | 71238 | 60.096 | −25.5200 | −15.9900 | 3.2247 | −1.8438 |
| 85 | 1-Butanol | $C_4H_{10}O$ | 71363 | 74.123 | −27.4600 | −15.0300 | 3.6148 | −2.4560 |
| 86 | 2-Butanol | $C_4H_{10}O$ | 78922 | 74.123 | −29.2900 | −16.9600 | 3.6469 | −2.4408 |
| 87 | 2-Propanol | $C_3H_8O$ | 67630 | 60.096 | −27.2700 | −17.3470 | 3.0920 | −1.8300 |
| 88 | 2-Methyl-2-propanol | $C_4H_{10}O$ | 75650 | 74.123 | −31.2400 | −17.7600 | 3.2630 | −2.4239 |
| 89 | 1-Pentanol | $C_5H_{12}O$ | 71410 | 88.150 | −29.8737 | −14.6022 | 4.0250 | −3.0605 |
| 90 | 2-Methyl-1-butanol | $C_5H_{12}O$ | 137326 | 88.150 | −30.2085 | −14.6709 | 3.9351 | −3.0620 |
| 91 | 3-Methyl-1-butanol | $C_5H_{12}O$ | 123513 | 88.150 | −30.2100 | −14.5000 | 3.8770 | −3.0623 |
| 92 | 1-Hexanol | $C_6H_{14}O$ | 111273 | 102.177 | −31.6500 | −13.4400 | 4.4010 | −3.6766 |
| 93 | 1-Heptanol | $C_7H_{16}O$ | 111706 | 116.203 | −33.6400 | −12.5300 | 4.7919 | −4.2860 |
| 94 | Cyclohexanol | $C_6H_{12}O$ | 108930 | 100.161 | −28.6200 | −10.9500 | 3.2770 | −3.4639 |
| 95 | Ethylene glycol | $C_2H_6O_2$ | 107211 | 62.068 | −38.7500 | −30.2600 | 3.2350 | −1.0590 |
| 96 | 1,2-Propylene glycol | $C_3H_8O_2$ | 57556 | 76.095 | −42.1500 | −30.4000 | 3.5200 | −1.6476 |

**TABLE 2-221 Enthalpies and Gibbs Energies of Formation, Entropies, and Net Enthalpies of Combustion of Inorganic and Organic Compounds** (*Continued*)

| Cmpd. no. | Name | Formula | CAS no. | Mol wt | Ideal gas enthalpy of formation, J/kmol × 1E-07 | Ideal gas Gibbs energy of formation, J/kmol × 1E-07 | Ideal gas entropy, J/(kmol·K) × 1E-05 | Standard net enthalpy of combustion, J/kmol × 1E-09 |
|---|---|---|---|---|---|---|---|---|
| 97 | Phenol | $C_6H_6O$ | 108952 | 94.113 | −9.6399 | −3.2637 | 3.1481 | −2.9210 |
| 98 | *o*-Cresol | $C_7H_8O$ | 95487 | 108.140 | −12.8570 | −3.5430 | 3.5259 | −3.5280 |
| 99 | *m*-Cresol | $C_7H_8O$ | 108394 | 108.140 | −13.2300 | −4.0190 | 3.5604 | −3.5278 |
| 100 | *p*-Cresol | $C_7H_8O$ | 106445 | 108.140 | −12.5350 | −3.1660 | 3.5075 | −3.5226 |
| 101 | Dimethyl ether | $C_2H_6O$ | 115106 | 46.069 | −18.4100 | −11.2800 | 2.6670 | −1.3284 |
| 102 | Methyl ethyl ether | $C_3H_8O$ | 540670 | 60.096 | −21.6400 | −11.7100 | 3.0881 | −1.9314 |
| 103 | Methyl *n*-propyl ether | $C_4H_{10}O$ | 557175 | 74.123 | −23.8200 | −11.1000 | 3.5200 | −2.5174 |
| 104 | Methyl isopropyl ether | $C_4H_{10}O$ | 598538 | 74.123 | −25.2000 | −12.1800 | 3.4160 | −2.5311 |
| 105 | Methyl *n*-butyl ether | $C_5H_{12}O$ | 628284 | 88.150 | −25.8100 | −10.1700 | 3.9010 | −3.1282 |
| 106 | Methyl isobutyl ether | $C_5H_{12}O$ | 625445 | 88.150 | −26.6000 | −10.7000 | 3.8100 | −3.1220 |
| 107 | Methyl tert-butyl ether | $C_5H_{12}O$ | 1634044 | 88.150 | −28.3500 | −11.7500 | 3.5780 | −3.1049 |
| 108 | Diethyl ether | $C_4H_{10}O$ | 60297 | 74.123 | −25.2100 | −12.2100 | 3.4230 | −2.5035 |
| 109 | Ethyl propyl ether | $C_5H_{12}O$ | 628320 | 88.150 | −27.2200 | −11.5200 | 3.8810 | −3.1200 |
| 110 | Ethyl isopropyl ether | $C_5H_{12}O$ | 625547 | 88.150 | −28.5800 | −12.6400 | 3.8000 | −3.1030 |
| 111 | Methyl phenyl ether | $C_7H_8O$ | 100663 | 108.140 | −6.7900 | 2.2700 | 3.6100 | −3.6072 |
| 112 | Diphenyl ether | $C_{12}H_{10}O$ | 101848 | 170.211 | 5.2000 | 17.5000 | 4.1300 | −5.8939 |
| 113 | Formaldehyde | $CH_2O$ | 50000 | 30.026 | −10.8600 | −10.2600 | 2.1866 | −0.5268 |
| 114 | Acetaldehyde | $C_2H_4O$ | 75070 | 44.053 | −16.6200 | −13.3100 | 2.6420 | −1.1045 |
| 115 | 1-Propanal | $C_3H_6O$ | 123386 | 58.080 | −18.6300 | −12.4600 | 3.0440 | −1.6857 |
| 116 | 1-Butanal | $C_4H_8O$ | 123728 | 72.107 | −20.7000 | −11.6300 | 3.4365 | −2.3035 |
| 117 | 1-Pentanal | $C_5H_{10}O$ | 110623 | 86.134 | −22.7800 | −10.7100 | 3.8289 | −2.9100 |
| 118 | 1-Hexanal | $C_6H_{12}O$ | 66251 | 100.161 | −24.8600 | −10.0050 | 4.2214 | −3.5200 |
| 119 | 1-Heptanal | $C_7H_{14}O$ | 111717 | 114.188 | −26.9400 | −9.1910 | 4.6138 | −4.1360 |
| 120 | 1-Octanal | $C_8H_{16}O$ | 124130 | 128.214 | −29.0200 | −8.3770 | 5.0063 | −4.7400 |
| 121 | 1-Nonanal | $C_9H_{18}O$ | 124196 | 142.241 | −31.0900 | −7.5530 | 5.3988 | −5.3500 |
| 122 | 1-Decanal | $C_{10}H_{20}O$ | 112312 | 156.268 | −33.1700 | −6.7390 | 5.7912 | −5.9590 |
| 123 | Acetone | $C_3H_6O$ | 67641 | 58.080 | −21.5700 | −15.1300 | 2.9540 | −1.6590 |
| 124 | Methyl ethyl ketone | $C_4H_8O$ | 78933 | 72.107 | −23.9000 | −14.7000 | 3.3940 | −2.2680 |
| 125 | 2-Pentanone | $C_5H_{10}O$ | 107879 | 86.134 | −25.9200 | −13.8300 | 3.7860 | −2.8796 |
| 126 | Methyl isopropyl ketone | $C_5H_{10}O$ | 563804 | 86.134 | −26.2400 | −13.9000 | 3.6990 | −2.8770 |
| 127 | 2-Hexanone | $C_6H_{12}O$ | 591786 | 100.161 | −27.9826 | −13.0081 | 4.1786 | −3.4900 |
| 128 | Methyl isobutyl ketone | $C_6H_{12}O$ | 108101 | 100.161 | −28.8000 | −13.5000 | 4.0700 | −3.4900 |
| 129 | 3-Methyl-2-pentanone | $C_6H_{12}O$ | 565617 | 100.161 | −28.1000 | −12.9000 | 4.1200 | −3.4900 |
| 130 | 3-Pentanone | $C_5H_{10}O$ | 96220 | 86.134 | −25.7900 | −13.4400 | 3.7000 | −2.8804 |
| 131 | Ethyl isopropyl ketone | $C_6H_{12}O$ | 565695 | 100.161 | −28.6100 | −13.3000 | 4.0690 | −3.4860 |
| 132 | Diisopropyl ketone | $C_7H_{14}O$ | 565800 | 114.188 | −31.1400 | −13.2000 | 4.5700 | −4.0950 |
| 133 | Cyclohexanone | $C_6H_{10}O$ | 108941 | 98.145 | −22.6100 | −8.6620 | 3.2200 | −3.2990 |
| 134 | Methyl phenyl ketone | $C_8H_8O$ | 98862 | 120.151 | −8.6700 | −0.1364 | 3.8450 | −3.9730 |
| 135 | Formic acid | $CH_2O_2$ | 64186 | 46.026 | −37.8600 | −35.1000 | 2.4870 | −0.2115 |
| 136 | Acetic acid | $C_2H_4O_2$ | 64197 | 60.053 | −43.2800 | −37.4600 | 2.8250 | −0.8146 |
| 137 | Propionic acid | $C_3H_6O_2$ | 79094 | 74.079 | −45.3500 | −36.6700 | 3.2300 | −1.3950 |
| 138 | *n*-Butyric acid | $C_4H_8O_2$ | 107926 | 88.106 | −47.5800 | −36.0000 | 3.6200 | −2.0077 |
| 139 | Isobutyric acid | $C_4H_8O_2$ | 79312 | 88.106 | −48.4100 | −36.2100 | 3.4120 | −2.0004 |
| 140 | Benzoic acid | $C_7H_6O_2$ | 65850 | 122.123 | −29.4100 | −21.4200 | 3.6900 | −3.0951 |
| 141 | Acetic anhydride | $C_4H_6O_3$ | 108247 | 102.090 | −57.2500 | −47.3400 | 3.8990 | −1.6750 |
| 142 | Methyl formate | $C_2H_4O_2$ | 107313 | 60.053 | −35.2400 | −29.5000 | 2.8520 | −0.8924 |
| 143 | Methyl acetate | $C_3H_6O_2$ | 79209 | 74.079 | −41.1900 | −32.4200 | 3.1980 | −1.4610 |
| 144 | Methyl propionate | $C_4H_8O_2$ | 554121 | 88.106 | −42.7500 | −31.1000 | 3.5960 | −2.0780 |
| 145 | Methyl *n*-butyrate | $C_5H_{10}O_2$ | 623427 | 102.133 | −45.0700 | −30.5300 | 3.9880 | −2.6860 |
| 146 | Ethyl formate | $C_3H_6O_2$ | 109944 | 74.079 | −38.8300 | −30.3100 | 3.2820 | −1.5070 |
| 147 | Ethyl acetate | $C_4H_8O_2$ | 141786 | 88.106 | −44.4500 | −32.8000 | 3.5970 | −2.0610 |
| 148 | Ethyl propionate | $C_5H_{10}O_2$ | 105373 | 102.133 | −46.3600 | −31.9300 | 4.0250 | −2.6740 |
| 149 | Ethyl *n*-butyrate | $C_6H_{12}O_2$ | 105544 | 116.160 | −48.5500 | −31.2200 | 4.4170 | −3.2840 |
| 150 | *n*-Propyl formate | $C_4H_8O_2$ | 110747 | 88.106 | −40.7600 | −29.3600 | 3.6780 | −2.0410 |
| 151 | *n*-Propyl acetate | $C_5H_{10}O_2$ | 109604 | 102.133 | −46.4800 | −32.0400 | 4.0230 | −2.6720 |
| 152 | *n*-Butyl acetate | $C_6H_{12}O_2$ | 123864 | 116.160 | −48.5600 | −31.2600 | 4.4250 | −3.2800 |
| 153 | Methyl benzoate | $C_8H_8O_2$ | 93583 | 136.150 | −28.7900 | −18.1000 | 4.1400 | −3.7720 |
| 154 | Ethyl benzoate | $C_9H_{10}O_2$ | 93890 | 150.177 | −32.6000 | −19.0500 | 4.5500 | −4.4100 |
| 155 | Vinyl acetate | $C_4H_6O_2$ | 108054 | 86.090 | −31.4900 | −22.7900 | 3.2800 | −1.9500 |
| 156 | Methylamine | $CH_5N$ | 74895 | 31.057 | −2.2970 | 3.2070 | 2.4330 | −0.9751 |
| 157 | Dimethylamine | $C_2H_7N$ | 124403 | 45.084 | −1.8450 | 6.8390 | 2.7296 | −1.6146 |
| 158 | Trimethylamine | $C_3H_9N$ | 75503 | 59.111 | −2.4310 | 9.8990 | 2.8700 | −2.2449 |
| 159 | Ethylamine | $C_2H_7N$ | 75047 | 45.084 | −4.7150 | 3.6160 | 2.8480 | −1.5874 |
| 160 | Diethylamine | $C_4H_{11}N$ | 109897 | 73.138 | −7.1420 | 7.3080 | 3.5220 | −2.8003 |
| 161 | Triethylamine | $C_6H_{15}N$ | 121448 | 101.192 | −9.5800 | 11.4100 | 4.0540 | −4.0405 |
| 162 | *n*-Propylamine | $C_3H_9N$ | 107108 | 59.111 | −7.0500 | 4.1700 | 3.2420 | −2.1650 |

**TABLE 2-221 Enthalpies and Gibbs Energies of Formation, Entropies, and Net Enthalpies of Combustion of Inorganic and Organic Compounds** (*Continued*)

| Cmpd. no. | Name | Formula | CAS no. | Mol wt | Ideal gas enthalpy of formation, J/kmol × 1E-07 | Ideal gas Gibbs energy of formation, J/kmol × 1E-07 | Ideal gas entropy, J/(kmol·K) × 1E-05 | Standard net enthalpy of combustion, J/kmol × 1E-09 |
|---|---|---|---|---|---|---|---|---|
| 163 | di-*n*-Propylamine | $C_6H_{15}N$ | 142847 | 101.192 | −11.6000 | 8.6800 | 4.2900 | −4.0189 |
| 164 | Isopropylamine | $C_3H_9N$ | 75310 | 59.111 | −8.3800 | 3.1920 | 3.1240 | −2.1566 |
| 165 | Diisopropylamine | $C_6H_{15}N$ | 108189 | 101.192 | −15.0000 | 5.7900 | 4.1200 | −3.9900 |
| 166 | Aniline | $C_6H_7N$ | 62533 | 93.128 | 8.7100 | 16.6800 | 3.1980 | −3.2390 |
| 167 | *N*-Methylaniline | $C_7H_9N$ | 100618 | 107.155 | 8.8000 | 20.2000 | 3.4100 | −3.9000 |
| 168 | *N*,*N*-Dimethylaniline | $C_8H_{11}N$ | 121697 | 121.182 | 10.0500 | 24.7728 | 3.6600 | −4.5250 |
| 169 | Ethylene oxide | $C_2H_4O$ | 75218 | 44.053 | −5.2630 | −1.3230 | 2.4299 | −1.2180 |
| 170 | Furan | $C_4H_4O$ | 110009 | 68.075 | −3.4800 | 0.0823 | 2.6714 | −1.9959 |
| 171 | Thiophene | $C_4H_4S$ | 110021 | 84.142 | 11.5440 | 12.6620 | 2.7865 | −2.4352 |
| 172 | Pyridine | $C_5H_5N$ | 110861 | 79.101 | 14.0370 | 19.0490 | 2.8278 | −2.6721 |
| 173 | Formamide | $CH_3NO$ | 75127 | 45.041 | −19.2200 | −14.7100 | 2.4857 | −0.5021 |
| 174 | *N*,*N*-Dimethylformamide | $C_3H_7NO$ | 68122 | 73.095 | −19.1700 | −8.8400 | 3.2600 | −1.7887 |
| 175 | Acetamide | $C_2H_5NO$ | 60355 | 59.068 | −23.8300 | −15.9600 | 2.7220 | −1.0741 |
| 176 | *N*-Methylacetamide | $C_3H_7NO$ | 79163 | 73.095 | −24.0000 | −13.5000 | 3.2000 | −1.7100 |
| 177 | Acetonitrile | $C_2H_3N$ | 75058 | 41.053 | 7.4040 | 9.1868 | 2.4329 | −1.1904 |
| 178 | Propionitrile | $C_3H_5N$ | 107120 | 55.079 | 5.1800 | 9.7495 | 2.8614 | −1.8007 |
| 179 | *n*-Butyronitrile | $C_4H_7N$ | 109740 | 69.106 | 3.4058 | 10.8658 | 3.2543 | −2.4148 |
| 180 | Benzonitrile | $C_7H_5N$ | 100470 | 103.123 | 21.8823 | 26.0872 | 3.2104 | −3.5224 |
| 181 | Methyl mercaptan | $CH_4S$ | 74931 | 48.109 | −2.2900 | −0.9800 | 2.5500 | −1.1517 |
| 182 | Ethyl mercaptan | $C_2H_6S$ | 75081 | 62.136 | −4.6300 | −0.4814 | 2.9610 | −1.7366 |
| 183 | *n*-Propyl mercaptan | $C_3H_8S$ | 107039 | 76.163 | −6.7500 | 0.2583 | 3.3650 | −2.3458 |
| 184 | *n*-Butyl mercaptan | $C_4H_{10}S$ | 109795 | 90.189 | −8.7800 | 1.1390 | 3.7520 | −2.9554 |
| 185 | Isobutyl mercaptan | $C_4H_{10}S$ | 513440 | 90.189 | −9.6900 | 0.5982 | 3.6280 | −2.9490 |
| 186 | sec-Butyl mercaptan | $C_4H_{10}S$ | 513531 | 90.189 | −9.6600 | 0.5120 | 3.6670 | −2.9490 |
| 187 | Dimethyl sulfide | $C_2H_6S$ | 75183 | 62.136 | −3.7240 | 0.7302 | 2.8585 | −1.7449 |
| 188 | Methyl ethyl sulfide | $C_3H_8S$ | 624895 | 76.163 | −5.9600 | 1.1470 | 3.3320 | −2.3531 |
| 189 | Diethyl sulfide | $C_4H_{10}S$ | 352932 | 90.189 | −8.3470 | 1.7780 | 3.6800 | −2.9607 |
| 190 | Fluoromethane | $CH_3F$ | 593533 | 34.033 | −23.4300 | −21.0400 | 2.2273 | −0.5219 |
| 191 | Chloromethane | $CH_3Cl$ | 74873 | 50.488 | −8.1960 | −5.8440 | 2.3418 | −0.6754 |
| 192 | Trichloromethane | $CHCl_3$ | 67663 | 119.377 | −10.2900 | −7.0100 | 2.9560 | −0.3800 |
| 193 | Tetrachloromethane | $CCl_4$ | 56235 | 153.822 | −9.5810 | −5.3540 | 3.0991 | −0.2653 |
| 194 | Bromomethane | $CH_3Br$ | 74839 | 94.939 | −3.7700 | −2.8190 | 2.4580 | −0.7054 |
| 195 | Fluoroethane | $C_2H_5F$ | 353366 | 48.060 | −26.4400 | −21.2300 | 2.6440 | −1.1270 |
| 196 | Chloroethane | $C_2H_5Cl$ | 75003 | 64.514 | −11.2260 | −6.0499 | 2.7578 | −1.2849 |
| 197 | Bromoethane | $C_2H_5Br$ | 74964 | 108.966 | −6.3600 | −2.5820 | 2.8730 | −1.2850 |
| 198 | 1-Chloropropane | $C_3H_7Cl$ | 540545 | 78.541 | −13.3180 | −5.2610 | 3.1547 | −1.8670 |
| 199 | 2-Chloropropane | $C_3H_7Cl$ | 75296 | 78.541 | −14.4770 | −6.1360 | 3.0594 | −1.8630 |
| 200 | 1,1-Dichloropropane | $C_3H_6Cl_2$ | 78999 | 112.986 | −15.0800 | −6.5200 | 3.4480 | −1.7200 |
| 201 | 1,2-Dichloropropane | $C_3H_6Cl_2$ | 78875 | 112.986 | −16.2800 | −8.0180 | 3.5480 | −1.7070 |
| 202 | Vinyl chloride | $C_2H_3Cl$ | 75014 | 62.499 | 2.8450 | 4.1950 | 2.7354 | −1.1780 |
| 203 | Fluorobenzene | $C_6H_5F$ | 462066 | 96.104 | −11.6566 | −6.9036 | 3.0263 | −2.8145 |
| 204 | Chlorobenzene | $C_6H_5Cl$ | 108907 | 112.558 | 5.1090 | 9.8290 | 3.1403 | −2.9760 |
| 205 | Bromobenzene | $C_6H_5Br$ | 108861 | 157.010 | 10.5018 | 13.8532 | 3.2439 | −3.0192 |
| 206 | Air | | 132259100 | 28.951 | 0 | 0 | 1.9900 | 0 |
| 207 | Hydrogen | $H_2$ | 1333740 | 2.016 | 0 | 0 | 1.3057 | −0.2418 |
| 208 | Helium-4 | He | 7440597 | 4.003 | 0 | 0 | 1.2604 | 0 |
| 209 | Neon | Ne | 7440019 | 20.180 | 0 | 0 | 1.4622 | 0 |
| 210 | Argon | Ar | 7440371 | 39.948 | 0 | 0 | 1.5474 | 0 |
| 211 | Fluorine | $F_2$ | 7782414 | 37.997 | 0 | 0 | 2.0268 | 0 |
| 212 | Chlorine | $Cl_2$ | 7782505 | 70.905 | 0 | 0 | 2.2297 | 0 |
| 213 | Bromine | $Br_2$ | 7726956 | 159.808 | 3.0910 | 0.3140 | 2.4535 | 0 |
| 214 | Oxygen | $O_2$ | 7782447 | 31.999 | 0 | 0 | 2.0504 | 0 |
| 215 | Nitrogen | $N_2$ | 7727379 | 28.014 | 0 | 0 | 1.9150 | 0 |
| 216 | Ammonia | $NH_3$ | 7664417 | 17.031 | −4.5898 | −1.6400 | 1.9266 | −0.3168 |
| 217 | Hydrazine | $N_2H_4$ | 302012 | 32.045 | 9.5353 | 15.9170 | 2.3861 | −5.3420 |
| 218 | Nitrous oxide | $N_2O$ | 10024972 | 44.013 | 8.2050 | 10.4160 | 2.1985 | −0.0820 |
| 219 | Nitric oxide | NO | 10102439 | 30.006 | 9.0250 | 8.6570 | 2.1060 | −0.0902 |
| 220 | Cyanogen | $C_2N_2$ | 460195 | 52.036 | 30.9072 | 29.7553 | 2.4146 | −1.0961 |
| 221 | Carbon monoxide | CO | 630080 | 28.010 | −11.0530 | −13.7150 | 1.9756 | −0.2830 |
| 222 | Carbon dioxide | $CO_2$ | 124389 | 44.010 | −39.3510 | −39.4370 | 2.1368 | 0 |
| 223 | Carbon disulfide | $CS_2$ | 75150 | 76.143 | 11.6900 | 6.6800 | 2.3790 | −1.0769 |
| 224 | Hydrogen fluoride | HF | 7664393 | 20.006 | −27.3300 | −27.5400 | 1.7367 | 0.1524 |
| 225 | Hydrogen chloride | HCl | 7647010 | 36.461 | −9.2310 | −9.5300 | 1.8679 | −0.0286 |
| 226 | Hydrogen bromide | HBr | 10035106 | 80.912 | −3.6290 | −5.3340 | 1.9859 | −0.0690 |
| 227 | Hydrogen cyanide | HCN | 74908 | 27.026 | 13.5143 | 12.4725 | 2.0172 | −0.6233 |

**TABLE 2-221 Enthalpies and Gibbs Energies of Formation, Entropies, and Net Enthalpies of Combustion of Inorganic and Organic Compounds** (*Concluded*)

| Cmpd. no. | Name | Formula | CAS no. | Mol wt | Ideal gas enthalpy of formation, J/kmol × 1E-07 | Ideal gas Gibbs energy of formation, J/kmol × 1E-07 | Ideal gas entropy, J/(kmol·K) × 1E-05 | Standard net enthalpy of combustion, J/kmol × 1E-09 |
|---|---|---|---|---|---|---|---|---|
| 228 | Hydrogen sulfide | $H_2S$ | 7783064 | 34.082 | –2.0630 | –3.3440 | 2.0560 | –0.5180 |
| 229 | Sulfur dioxide | $SO_2$ | 7446095 | 64.065 | –29.6840 | –30.0120 | 2.4810 | 0 |
| 230 | Sulfur trioxide | $SO_3$ | 7446119 | 80.064 | –39.5720 | –37.0950 | 2.5651 | 0.0989 |
| 231 | Water | $H_2O$ | 7732185 | 18.015 | –24.1814 | –22.8590 | 1.8872 | 0 |

All substances are listed in alphabetical order in Table 2-6*a*.

Compiled from Daubert, T. E., R. P. Danner, H. M. Sibul, and C. C. Stebbins, DIPPR Data Compilation of Pure Compound Properties, Project 801 Sponsor Release, July, 1993, Design Institute for Physical Property Data, AIChE, New York, NY; and from Thermodynamics Research Center, "Selected Values of Properties of Hydrocarbons and Related Compounds," Thermodynamics Research Center Hydrocarbon Project, Texas A&M University, College Station, Texas (extant 1994).

The compounds are considered to be formed from the elements in their standard states at 298.15 K and 101,325 $P_a$. These include C (graphite) and S (rhombic).

Enthalpy of combustion is the net value for the compound in its standard state at 298.15K and 101,325 Pa.

Products of combustion are taken to be $CO_2$ (gas), $H_2O$ (gas), $F_2$ (gas), $Cl_2$ (gas), $Br_2$ (gas), $I_2$ (gas), $SO_2$ (gas), $N_2$ (gas), $H_3PO_4$ (solid), and $SiO_2$ (crystobalite).

J/kmol × 2.390E-04 = cal/gmol; J/kmol × 4.302106E-04 = Btu/lbmol.

J/(kmol·K) × 2.390E-04 = cal/(gmol·°C); J/(kmol·K) × 2.390059E-04 = Btu/(lbmol·°F).

**TABLE 2-222 Ideal Gas Sensible Enthalpies, $h_T - h_{298}$ (kJ/kgmol), of Combustion Products**

| Temperature, K | CO | $CO_2$ | H | OH | $H_2$ | N | NO | $NO_2$ | $N_2$ | $N_2O$ | O | $O_2$ | $SO_2$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 200 | –2858 | –3414 | –2040 | –2976 | –2774 | –2040 | –2951 | –3495 | –2857 | –3553 | –2186 | –2868 | –3736 | –3282 |
| 240 | –1692 | –2079 | –1209 | –1756 | –1656 | –1209 | –1743 | –2104 | –1692 | –2164 | –1285 | –1703 | –2258 | –1948 |
| 260 | –1110 | –1383 | –793 | –1150 | –1091 | –793 | –1142 | –1392 | –1110 | –1438 | –840 | –1118 | –1496 | –1279 |
| 280 | –529 | –665 | –377 | –546 | –522 | –378 | –543 | –672 | –528 | –692 | –398 | –533 | –718 | –609 |
| 298.15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 300 | 54 | 69 | 38 | 55 | 53 | 38 | 55 | 68 | 54 | 72 | 41 | 54 | 74 | 62 |
| 320 | 638 | 823 | 454 | 654 | 630 | 454 | 652 | 816 | 636 | 854 | 478 | 643 | 881 | 735 |
| 340 | 1221 | 1594 | 870 | 1251 | 1209 | 870 | 1248 | 1571 | 1219 | 1654 | 913 | 1234 | 1702 | 1410 |
| 360 | 1805 | 2382 | 1285 | 1847 | 1791 | 1286 | 1845 | 2347 | 1802 | 2470 | 1346 | 1828 | 2538 | 2088 |
| 380 | 2389 | 3184 | 1701 | 2442 | 2373 | 1701 | 2442 | 3130 | 2386 | 3302 | 1777 | 2425 | 3387 | 2769 |
| 400 | 2975 | 4003 | 2117 | 3035 | 2959 | 2117 | 3040 | 3927 | 2971 | 4149 | 2207 | 3025 | 4250 | 3452 |
| 420 | 3563 | 4835 | 2532 | 3627 | 3544 | 2533 | 3638 | 4735 | 3557 | 5010 | 2635 | 3629 | 5126 | 4139 |
| 440 | 4153 | 5683 | 2948 | 4219 | 4131 | 2949 | 4240 | 5557 | 4143 | 5884 | 3063 | 4236 | 6015 | 4829 |
| 460 | 4643 | 6544 | 3364 | 4810 | 4715 | 3364 | 4844 | 6392 | 4731 | 6771 | 3490 | 4847 | 6917 | 5523 |
| 480 | 5335 | 7416 | 3779 | 5401 | 5298 | 3780 | 5450 | 7239 | 5320 | 7670 | 3918 | 5463 | 7831 | 6222 |
| 500 | 5931 | 8305 | 4196 | 5992 | 5882 | 4196 | 6059 | 8099 | 5911 | 8580 | 4343 | 6084 | 8758 | 6925 |
| 550 | 7428 | 10572 | 5235 | 7385 | 6760 | 5235 | 7592 | 10340 | 7395 | 10897 | 5402 | 7653 | 11123 | 8699 |
| 600 | 8942 | 12907 | 6274 | 8943 | 8811 | 6274 | 9144 | 12555 | 8894 | 13295 | 6462 | 9244 | 13544 | 10501 |
| 650 | 10477 | 15303 | 7314 | 10423 | 10278 | 7314 | 10716 | 14882 | 10407 | 15744 | 7515 | 10859 | 16022 | 12321 |
| 700 | 12023 | 17754 | 8353 | 11902 | 11749 | 8353 | 12307 | 17250 | 11937 | 18243 | 8570 | 12499 | 18548 | 14192 |
| 750 | 13592 | 20260 | 9392 | 13391 | 13223 | 9329 | 13919 | 19671 | 13481 | 20791 | 9620 | 14158 | 21117 | 16082 |
| 800 | 15177 | 22806 | 10431 | 14880 | 14702 | 10431 | 15548 | 22136 | 15046 | 23383 | 10671 | 15835 | 23721 | 18002 |
| 850 | 16781 | 25398 | 11471 | 16384 | 16186 | 11471 | 17195 | 24641 | 16624 | 26014 | 11718 | 17531 | 26369 | 19954 |
| 900 | 18401 | 28030 | 12510 | 17888 | 17676 | 12510 | 18858 | 27179 | 18223 | 28681 | 12767 | 19241 | 29023 | 21938 |
| 950 | 20031 | 30689 | 13550 | 19412 | 19175 | 13550 | 20537 | 29749 | 19834 | 31381 | 13812 | 20965 | 31714 | 23954 |
| 1000 | 21690 | 33397 | 14589 | 20935 | 20680 | 14589 | 22229 | 32344 | 21463 | 34110 | 14860 | 22703 | 34428 | 26000 |
| 1100 | 25035 | 38884 | 16667 | 24024 | 23719 | 16667 | 25653 | 37605 | 24760 | 39647 | 16950 | 26212 | 39914 | 30191 |
| 1200 | 28430 | 44473 | 18746 | 27160 | 26797 | 18746 | 29120 | 42946 | 28109 | 45274 | 19039 | 29761 | 45464 | 34506 |
| 1300 | 31868 | 50148 | 20824 | 30342 | 29918 | 20824 | 32626 | 48351 | 31503 | 50976 | 21126 | 33344 | 51069 | 38942 |
| 1400 | 35343 | 55896 | 22903 | 33569 | 33082 | 22903 | 36164 | 53808 | 34936 | 56740 | 23212 | 36957 | 56718 | 43493 |
| 1500 | 38850 | 61705 | 24982 | 36839 | 36290 | 24982 | 39729 | 59309 | 38405 | 62557 | 25296 | 40599 | 62404 | 48151 |
| 1600 | 42385 | 67569 | 27060 | 40151 | 39541 | 27060 | 43319 | 64846 | 41904 | 68420 | 27381 | 44266 | 68123 | 52908 |
| 1700 | 45945 | 73480 | 29139 | 43502 | 42835 | 29139 | 46929 | 70414 | 45429 | 74320 | 29464 | 47958 | 73870 | 57758 |
| 1800 | 49526 | 79431 | 31217 | 46889 | 46169 | 31218 | 50557 | 76007 | 48978 | 80254 | 31547 | 51673 | 79642 | 62693 |
| 1900 | 53126 | 85419 | 33296 | 50310 | 49541 | 33296 | 54201 | 81624 | 52548 | 86216 | 33630 | 55413 | 85436 | 67706 |
| 2000 | 56744 | 91439 | 35375 | 53762 | 52951 | 35375 | 57859 | 87259 | 56137 | 92203 | 35713 | 59175 | 91250 | 72790 |
| 2100 | 60376 | 97488 | 37453 | 57243 | 56397 | 37454 | 61530 | 92911 | 59742 | 98212 | 37796 | 62961 | 97081 | 77941 |
| 2200 | 64021 | 103562 | 39532 | 60752 | 59876 | 39534 | 65212 | 98577 | 63361 | 104240 | 39878 | 66769 | 102929 | 83153 |
| 2300 | 67683 | 109660 | 41610 | 64285 | 63387 | 41614 | 68904 | 104257 | 66995 | 110284 | 41962 | 70600 | 108792 | 88421 |
| 2400 | 71324 | 115779 | 43689 | 67841 | 66928 | 43695 | 72606 | 109947 | 70640 | 116344 | 44045 | 74453 | 114669 | 93741 |
| 2500 | 74985 | 121917 | 45768 | 71419 | 70498 | 45777 | 76316 | 115648 | 74296 | 122417 | 46130 | 78328 | 120559 | 99108 |
| 2600 | 78673 | 128073 | 47846 | 75017 | 74096 | 47860 | 80034 | 121357 | 77963 | 128501 | 48216 | 82224 | 126462 | 104520 |
| 2700 | 82369 | 134246 | 49925 | 78633 | 77720 | 49945 | 83759 | 127075 | 81639 | 134596 | 50303 | 86141 | 132376 | 109973 |
| 2800 | 86074 | 140433 | 52004 | 82267 | 81369 | 52033 | 87491 | 132799 | 85323 | 140701 | 52391 | 90079 | 138302 | 115464 |
| 2900 | 89786 | 146636 | 54082 | 85918 | 85043 | 54124 | 91229 | 138530 | 89015 | 146814 | 54481 | 94036 | 144238 | 120990 |
| 3000 | 93504 | 152852 | 56161 | 89584 | 88740 | 56218 | 94973 | 144267 | 92715 | 152935 | 56574 | 98013 | 150184 | 126549 |
| 3500 | 112185 | 184109 | 66554 | 108119 | 107555 | 66769 | 113768 | 173020 | 111306 | 183636 | 67079 | 118165 | 180057 | 154768 |
| 4000 | 130989 | 215622 | 75947 | 126939 | 126874 | 77532 | 132671 | 201859 | 130027 | 214453 | 77675 | 188705 | 210145 | 183552 |
| 4500 | 149895 | 247354 | 87340 | 145991 | 146660 | 88614 | 151662 | 230756 | 148850 | 245348 | 88386 | 159572 | 240427 | 212764 |
| 5000 | 168890 | 279283 | 97733 | 165246 | 166876 | 100111 | 170730 | 259692 | 167763 | 276299 | 99222 | 180749 | 270893 | 242313 |

Converted and usually rounded off from JANAF Thermochemical Tables, NSRDS-NBS-37, 1971 (1141 pp.)

**TABLE 2-223 Ideal Gas Entropies, $s°$, kJ/kgmol·K, of Combustion Products**

| Temperature, K | CO | $CO_2$ | H | OH | $H_2$ | N | NO | $NO_2$ | $N_2$ | $N_2O$ | O | $O_2$ | $SO_2$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 200 | 186.0 | 200.0 | 106.4 | 171.6 | 119.4 | 145.0 | 198.7 | 225.9 | 180.0 | 205.6 | 152.2 | 193.5 | 233.0 | 175.5 |
| 240 | 191.3 | 206.0 | 110.1 | 177.1 | 124.5 | 148.7 | 204.1 | 232.2 | 185.2 | 211.9 | 156.2 | 198.7 | 239.9 | 181.4 |
| 260 | 193.7 | 208.8 | 111.8 | 179.5 | 126.8 | 150.4 | 206.6 | 235.0 | 187.6 | 214.8 | 158.0 | 201.1 | 242.8 | 184.1 |
| 280 | 195.3 | 211.5 | 113.3 | 181.8 | 129.2 | 151.9 | 208.8 | 237.7 | 189.8 | 217.5 | 159.7 | 203.3 | 245.8 | 186.6 |
| 298.15 | 197.7 | 213.8 | 114.7 | 183.7 | 130.7 | 153.3 | 210.8 | 240.0 | 191.6 | 220.0 | 161.1 | 205.1 | 248.2 | 188.8 |
| 300 | 197.8 | 214.0 | 114.8 | 183.9 | 130.9 | 153.4 | 210.9 | 240.3 | 191.8 | 220.2 | 161.2 | 205.3 | 248.5 | 189.0 |
| 320 | 199.7 | 216.5 | 116.2 | 185.9 | 132.8 | 154.8 | 212.9 | 242.7 | 193.7 | 222.7 | 162.6 | 207.2 | 251.1 | 191.2 |
| 340 | 201.5 | 218.8 | 117.4 | 187.7 | 134.5 | 156.0 | 214.7 | 245.0 | 195.5 | 225.2 | 163.9 | 209.0 | 253.6 | 193.3 |
| 360 | 203.2 | 221.0 | 118.6 | 189.4 | 136.2 | 157.2 | 216.4 | 247.2 | 197.2 | 227.5 | 165.2 | 210.7 | 256.0 | 195.2 |
| 380 | 204.7 | 223.2 | 119.7 | 191.0 | 137.7 | 158.3 | 218.0 | 249.3 | 198.7 | 229.7 | 166.3 | 212.5 | 258.2 | 197.1 |
| 400 | 206.2 | 225.3 | 120.8 | 192.5 | 139.2 | 159.4 | 219.5 | 251.3 | 200.2 | 231.9 | 167.4 | 213.8 | 260.4 | 198.8 |
| 420 | 207.7 | 227.3 | 121.8 | 194.0 | 140.6 | 160.4 | 221.0 | 253.2 | 201.5 | 234.0 | 168.4 | 215.3 | 262.5 | 200.5 |
| 440 | 209.0 | 229.3 | 122.8 | 195.3 | 141.9 | 161.4 | 222.3 | 255.1 | 202.9 | 236.0 | 169.4 | 216.7 | 264.6 | 202.0 |
| 460 | 210.4 | 231.2 | 123.7 | 196.6 | 143.2 | 162.3 | 223.7 | 257.0 | 204.2 | 238.0 | 170.4 | 218.0 | 266.6 | 203.6 |
| 480 | 211.6 | 233.1 | 124.6 | 197.9 | 144.5 | 163.1 | 225.0 | 258.8 | 205.5 | 239.9 | 171.3 | 219.4 | 268.5 | 205.1 |
| 500 | 212.8 | 234.9 | 125.5 | 199.1 | 145.7 | 164.0 | 226.3 | 260.6 | 206.7 | 241.8 | 172.2 | 220.7 | 270.5 | 206.5 |
| 550 | 215.7 | 239.2 | 127.5 | 201.8 | 148.6 | 166.0 | 229.1 | 264.7 | 209.4 | 246.2 | 174.2 | 223.7 | 274.9 | 210.5 |
| 600 | 218.3 | 243.3 | 129.3 | 204.4 | 151.1 | 167.8 | 231.9 | 268.8 | 212.2 | 250.4 | 176.1 | 226.5 | 279.2 | 213.1 |
| 650 | 220.8 | 247.1 | 131.0 | 206.8 | 153.4 | 169.4 | 234.4 | 272.6 | 214.6 | 254.3 | 177.7 | 229.1 | 283.1 | 215.9 |
| 700 | 223.1 | 250.8 | 132.5 | 209.0 | 155.6 | 171.0 | 236.8 | 276.0 | 216.9 | 258.0 | 179.3 | 231.5 | 286.9 | 218.7 |
| 750 | 225.2 | 255.4 | 133.9 | 211.1 | 157.6 | 172.5 | 239.0 | 279.3 | 219.0 | 261.5 | 180.7 | 233.7 | 290.4 | 221.3 |
| 800 | 227.3 | 257.5 | 135.2 | 213.0 | 159.5 | 173.8 | 241.1 | 282.5 | 221.0 | 264.8 | 182.1 | 235.9 | 293.8 | 223.8 |
| 850 | 229.2 | 260.6 | 136.4 | 214.8 | 161.4 | 175.1 | 243.0 | 285.5 | 223.0 | 268.0 | 183.4 | 237.9 | 297.0 | 226.2 |
| 900 | 231.1 | 263.6 | 137.7 | 216.5 | 163.1 | 176.3 | 245.0 | 288.4 | 224.8 | 271.1 | 184.6 | 239.9 | 300.1 | 228.5 |
| 950 | 232.8 | 266.5 | 138.8 | 218.1 | 164.7 | 177.4 | 246.8 | 291.3 | 226.5 | 274.0 | 185.7 | 241.8 | 303.0 | 230.6 |
| 1000 | 234.5 | 269.3 | 139.9 | 219.7 | 166.2 | 178.5 | 248.4 | 293.9 | 228.2 | 276.8 | 186.8 | 243.6 | 305.8 | 232.7 |
| 1100 | 237.7 | 274.5 | 141.9 | 222.7 | 169.1 | 180.4 | 251.8 | 298.9 | 231.3 | 282.1 | 188.8 | 246.9 | 311.0 | 236.7 |
| 1200 | 240.7 | 279.4 | 143.7 | 225.4 | 171.8 | 182.2 | 254.8 | 303.6 | 234.2 | 287.0 | 190.6 | 250.0 | 315.8 | 240.5 |
| 1300 | 243.4 | 283.9 | 145.3 | 228.0 | 174.3 | 183.9 | 257.6 | 307.9 | 236.9 | 291.5 | 192.3 | 252.9 | 320.3 | 244.0 |
| 1400 | 246.0 | 288.2 | 146.9 | 230.3 | 176.6 | 185.4 | 260.2 | 311.9 | 239.5 | 295.8 | 193.8 | 255.6 | 324.5 | 247.4 |
| 1500 | 248.4 | 292.2 | 148.3 | 232.6 | 178.8 | 186.9 | 262.7 | 315.7 | 241.9 | 299.8 | 195.3 | 258.1 | 328.4 | 250.6 |
| 1600 | 250.7 | 296.0 | 149.6 | 234.7 | 180.9 | 188.2 | 265.0 | 319.3 | 244.1 | 303.6 | 196.6 | 260.4 | 332.1 | 253.7 |
| 1700 | 252.9 | 299.6 | 150.9 | 236.8 | 182.9 | 189.5 | 267.2 | 322.7 | 246.3 | 307.2 | 197.9 | 262.7 | 335.6 | 256.6 |
| 1800 | 254.9 | 303.0 | 152.1 | 238.7 | 184.8 | 190.7 | 269.3 | 325.9 | 248.3 | 310.6 | 199.1 | 264.8 | 338.9 | 259.5 |
| 1900 | 256.8 | 306.2 | 153.2 | 240.6 | 186.7 | 191.8 | 271.3 | 328.9 | 250.2 | 313.8 | 200.2 | 266.8 | 342.0 | 262.2 |
| 2000 | 258.7 | 309.3 | 154.3 | 242.3 | 188.4 | 192.9 | 273.1 | 331.8 | 252.1 | 316.9 | 201.3 | 268.7 | 345.0 | 264.8 |
| 2100 | 260.5 | 312.2 | 155.3 | 244.0 | 190.1 | 193.9 | 274.9 | 334.5 | 253.8 | 319.8 | 202.3 | 270.6 | 347.9 | 267.3 |
| 2200 | 262.2 | 315.1 | 156.3 | 245.7 | 191.7 | 194.8 | 276.6 | 337.2 | 255.5 | 322.6 | 203.2 | 272.4 | 350.6 | 269.7 |
| 2300 | 263.8 | 317.8 | 157.2 | 247.2 | 193.3 | 195.8 | 278.3 | 339.7 | 257.1 | 325.3 | 204.2 | 274.1 | 353.2 | 272.0 |
| 2400 | 265.4 | 320.4 | 158.1 | 248.7 | 194.8 | 196.7 | 279.8 | 342.1 | 258.7 | 327.9 | 205.0 | 275.7 | 355.7 | 274.3 |
| 2500 | 266.9 | 322.9 | 158.9 | 250.2 | 196.2 | 197.5 | 281.4 | 344.5 | 260.2 | 330.4 | 205.9 | 277.3 | 358.1 | 276.5 |
| 2600 | 268.3 | 325.3 | 159.7 | 251.6 | 197.7 | 198.3 | 282.8 | 346.7 | 261.6 | 332.7 | 206.7 | 278.8 | 360.4 | 278.6 |
| 2700 | 269.7 | 327.6 | 160.5 | 253.0 | 199.0 | 199.1 | 284.2 | 348.9 | 263.0 | 335.0 | 207.5 | 280.3 | 362.6 | 380.7 |
| 2800 | 271.0 | 329.9 | 161.3 | 254.3 | 200.3 | 199.9 | 285.6 | 350.9 | 264.3 | 337.3 | 208.3 | 281.7 | 364.8 | 282.7 |
| 2900 | 272.3 | 332.1 | 162.0 | 255.6 | 201.6 | 200.6 | 286.9 | 352.9 | 265.6 | 339.4 | 209.0 | 283.1 | 366.9 | 284.6 |
| 3000 | 273.6 | 334.2 | 162.7 | 256.8 | 202.9 | 201.3 | 288.2 | 354.9 | 266.9 | 341.5 | 209.7 | 284.4 | 368.9 | 286.5 |
| 3500 | 279.4 | 343.8 | 165.9 | 262.5 | 208.7 | 204.6 | 294.0 | 363.8 | 272.6 | 350.9 | 212.9 | 290.7 | 378.1 | 295.2 |
| 4000 | 284.4 | 352.2 | 168.7 | 267.6 | 213.8 | 207.4 | 299.0 | 371.5 | 277.6 | 359.2 | 215.8 | 296.2 | 386.1 | 302.9 |
| 4500 | 288.8 | 359.7 | 171.1 | 272.1 | 218.5 | 210.1 | 303.5 | 378.3 | 282.1 | 366.5 | 218.3 | 301.1 | 393.3 | 309.8 |
| 5000 | 292.8 | 366.4 | 173.3 | 276.1 | 222.8 | 212.5 | 307.5 | 384.4 | 286.0 | 373.0 | 220.6 | 305.5 | 399.7 | 316.0 |

Usually rounded off from JANAF Thermochemical Tables, NSRDS-NBS-37, 1971 (1141 pp.). Equilibrium constants can be calculated by combining $\Delta h_f^\circ$ values from Table 2-221, $h_T - h_{298}$ from Table 2-222, and $s°$ values from the above, using the formula $\ln k_p = -\Delta G/(RT)$, where $\Delta G = \Delta h_f^\circ + (h_T - h_{298}) - T s_T^\circ$.

# HEATS OF SOLUTION

## TABLE 2-224 Heats of Solution of Inorganic Compounds in Water

Heat evolved, in kilogram-calories per gram formula weight, on solution in water at 18°C. Computed from data in Bichowsky and Rossini, *Thermochemistry of Chemical Substances,* Reinhold, New York, 1936.

| Substance | Dilution* | Formula | Heat, kg-cal/ g-mole |
|---|---|---|---|
| Aluminum bromide | aq | $AlBr_3$ | +85.3 |
| chloride | 600 | $AlCl_3$ | +77.9 |
| | 600 | $AlCl_3·6H_2O$ | +13.2 |
| fluoride | aq | $AlF_3$ | +31 |
| | aq | $AlF_3·½H_2O$ | +19.0 |
| | aq | $AlF_3·3½H_2O$ | −1.7 |
| iodide | aq | $AlI_3$ | +89.0 |
| sulfate | aq | $Al_2(SO_4)_3$ | +126 |
| | aq | $Al_2(SO_4)_3·6H_2O$ | +56.2 |
| | aq | $Al_2(SO_4)_3·18H_2O$ | +6.7 |
| Ammonium bromide | aq | $NH_4Br$ | −4.45 |
| chloride | ∞ | $NH_4Cl$ | −3.82 |
| chromate | aq | $(NH_4)_2CrO_4$ | −5.82 |
| dichromate | 600 | $(NH_4)_2Cr_2O_7$ | −12.9 |
| iodide | aq | $NH_4I$ | −3.56 |
| nitrate | ∞ | $NH_4NO_3$ | −6.47 |
| perborate | aq | $NH_4BO_3·H_2O$ | −9.0 |
| sulfate | ∞ | $(NH_4)_2SO_4$ | −2.75 |
| sulfate, acid | 800 | $NH_4HSO_4$ | +0.56 |
| sulfite | aq | $(NH_4)_2SO_3$ | −1.2 |
| | aq | $(NH_4)_2SO_3·H_2O$ | −4.13 |
| Antimony fluoride | aq | $SbF_3$ | −1.7 |
| iodide | aq | $SbI_3$ | −0.8 |
| Arsenic acid | aq | $H_3AsO_4$ | −0.4 |
| Barium bromate | ∞ | $Ba(BrO_3)_2·H_2O$ | −15.9 |
| bromide | ∞ | $BaBr_2$ | +5.3 |
| | ∞ | $BaBr_2·H_2O$ | −0.8 |
| | ∞ | $BaBr_2·2H_2O$ | −3.87 |
| chlorate | ∞ | $Ba(ClO_3)_2$ | −6.7 |
| | ∞ | $Ba(ClO_3)_2·H_2O$ | −10.6 |
| chloride | ∞ | $BaCl_2$ | +2.4 |
| | ∞ | $BaCl_2·H_2O$ | −2.17 |
| | ∞ | $BaCl_2·2H_2O$ | −4.5 |
| cyanide | aq | $Ba(CN)_2$ | +1.5 |
| | aq | $Ba(CN)_2·H_2O$ | −2.4 |
| | aq | $Ba(CN)_2·2H_2O$ | −4.9 |
| iodate | ∞ | $Ba(IO_3)_2$ | −9.1 |
| | ∞ | $Ba(IO_3)_2·H_2O$ | −11.3 |
| iodide | ∞ | $BaI_2$ | +10.5 |
| | ∞ | $BaI_2·H_2O$ | +2.7 |
| | ∞ | $BaI_2·2H_2O$ | +0.14 |
| | ∞ | $BaI_2·2½H_2O$ | −0.58 |
| | ∞ | $BaI_2·7H_2O$ | −6.61 |
| nitrate | ∞ | $Ba(NO_3)_2$ | −10.2 |
| perchlorate | ∞ | $Ba(ClO_4)_2$ | −2.8 |
| | ∞ | $Ba(ClO_4)_2·3H_2O$ | −10.5 |
| sulfide | ∞ | $BaS$ | +7.2 |
| Beryllium bromide | aq | $BeBr_2$ | +62.6 |
| chloride | aq | $BeCl_2$ | +51.1 |
| iodide | aq | $BeI_2$ | +72.6 |
| sulfate | aq | $BeSO_4$ | +18.1 |
| | aq | $BeSO_4·H_2O$ | +13.5 |
| | aq | $BeSO_4·2H_2O$ | +7.9 |
| | aq | $BeSO_4·4H_2O$ | +1.1 |
| Bismuth iodide | aq | $BiI_3$ | +3 |
| Boric acid | aq | $H_3BO_3$ | −5.4 |
| Cadmium bromide | 400 | $CdBr_2$ | +0.4 |
| | 400 | $CdBr_2·4H_2O$ | −7.3 |
| chloride | 400 | $CdCl_2$ | +3.1 |
| | 400 | $CdCl_2·H_2O$ | +0.6 |
| | 400 | $CdCl_2·2½H_2O$ | −3.00 |
| nitrate | 400 | $Cd(NO_3)_2·H_2O$ | +4.17 |
| | 400 | $Cd(NO_3)_2·4H_2O$ | −5.08 |
| sulfate | 400 | $CdSO_4$ | +10.69 |
| | 400 | $CdSO_4·H_2O$ | +6.05 |
| | 400 | $CdSO_4·2⅔H_2O$ | +2.51 |
| Calcium acetate | ∞ | $Ca(C_2H_3O_2)_2$ | +7.6 |
| | ∞ | $Ca(C_2H_3O_2)_2·H_2O$ | +6.5 |
| Calcium—(*Cont.*) | | | |
| bromide | ∞ | $CaBr_2$ | +24.86 |
| | ∞ | $CaBr_2·6H_2O$ | −0.9 |
| chloride | ∞ | $CaCl_2$ | +4.9 |
| | ∞ | $CaCl_2·H_2O$ | +12.3 |
| | ∞ | $CaCl_2·2H_2O$ | +12.5 |
| | ∞ | $CaCl_2·4H_2O$ | +2.4 |
| | ∞ | $CaCl_2·6H_2O$ | −4.11 |
| formate | 400 | $Ca(CHO_2)_2$ | +0.7 |
| iodide | ∞ | $CaI_2$ | +28.0 |
| | ∞ | $CaI_2·8H_2O$ | +1.8 |
| nitrate | ∞ | $Ca(NO_3)_2$ | +4.1 |
| | ∞ | $Ca(NO_3)_2·H_2O$ | +0.7 |
| | ∞ | $Ca(NO_3)_2·2H_2O$ | −3.2 |
| | ∞ | $Ca(NO_3)_2·3H_2O$ | −4.2 |
| | ∞ | $Ca(NO_3)_2·4H_2O$ | −7.99 |
| phosphate, mono- | aq | $Ca(H_2PO_4)_2·H_2O$ | −0.6 |
| dibasic | aq | $CaHPO_4·2H_2O$ | −1 |
| sulfate | ∞ | $CaSO_4$ | +5.1 |
| | ∞ | $CaSO_4·½H_2O$ | +3.6 |
| | ∞ | $CaSO_4·2H_2O$ | −0.18 |
| Chromous chloride | aq | $CrCl_2$ | +18.6 |
| | | $CrCl_2·3H_2O$ | +5.3 |
| | | $CrCl_2·4H_2O$ | +2.0 |
| iodide | aq | $CrI_2$ | +5.7 |
| Cobaltous bromide | aq | $CoBr_2$ | +18.4 |
| | aq | $CoBr_2·6H_2O$ | −1.25 |
| chloride | 400 | $CoCl_2$ | +18.5 |
| | 400 | $CoCl_2·2H_2O$ | +9.8 |
| | 400 | $CoCl_2·6H_2O$ | −2.9 |
| iodide | aq | $CoI_2$ | +18.8 |
| sulfate | 400 | $CoSO_4$ | +15.0 |
| | 400 | $CoSO_4·6H_2O$ | −1.4 |
| | 400 | $CoSO_4·7H_2O$ | −3.6 |
| Cupric acetate | aq | $Cu(C_2H_3O_2)_2$ | +2.4 |
| formate | aq | $Cu(CHO_2)_2$ | +0.5 |
| nitrate | 200 | $Cu(NO_3)_2$ | +10.3 |
| | 200 | $Cu(NO_3)_2·3H_2O$ | −2.6 |
| | 200 | $Cu(NO_3)_2·6H_2O$ | −10.7 |
| sulfate | 800 | $CuSO_4$ | +15.9 |
| | | $CuSO_4·H_2O$ | +9.3 |
| | | $CuSO_4·3H_2O$ | +3.65 |
| | | $CuSO_4·5H_2O$ | −2.85 |
| Cuprous sulfate | aq | $Cu_2SO_4$ | +11.6 |
| Ferric chloride | 1000 | $FeCl_3$ | +31.7 |
| | 1000 | $FeCl_3·2½H_2O$ | +21.0 |
| | 1000 | $FeCl_3·6H_2O$ | +5.6 |
| nitrate | 800 | $Fe(NO_3)_3·9H_2O$ | −9.1 |
| Ferrous bromide | aq | $FeBr_2$ | +18.0 |
| chloride | 400 | $FeCl_2$ | +17.9 |
| | 400 | $FeCl_2·2H_2O$ | +8.7 |
| | 400 | $FeCl_2·4H_2O$ | +2.7 |
| iodide | aq | $FeI_2$ | +23.3 |
| sulfate | 400 | $FeSO_4$ | +14.7 |
| | 400 | $FeSO_4·H_2O$ | +7.35 |
| | 400 | $FeSO_4·4H_2O$ | +1.4 |
| | 400 | $FeSO_4·7H_2O$ | −4.4 |
| Lead acetate | 400 | $Pb(C_2H_3O_2)_2$ | +1.4 |
| | 400 | $Pb(C_2H_3O_2)_2·3H_2O$ | −5.9 |
| bromide | aq | $PbBr_2$ | −10.1 |
| chloride | aq | $PbCl_2$ | −3.4 |
| formate | aq | $Pb(CHO_2)_2$ | −6.9 |
| nitrate | 400 | $Pb(NO_3)_2$ | −7.61 |
| Lithium bromide | ∞ | $LiBr$ | +11.54 |
| | ∞ | $LiBr·H_2O$ | +5.30 |
| | ∞ | $LiBr·2H_2O$ | +2.05 |
| | ∞ | $LiBr·3H_2O$ | −1.59 |
| chloride | ∞ | $LiCl$ | +8.66 |

*The numbers represent moles of water used to dissolve 1 g formula weight of substance; ∞ means "infinite dilution"; and *aq* means "aqueous solution of unspecified dilution."

**TABLE 2-224 Heats of Solution of Inorganic Compounds in Water** (*Continued*)

| Substance | Dilution* | Formula | Heat, kg-cal/ g-mole |
|---|---|---|---|
| Lithium—(*Cont.*) | | | |
| | ∞ | $LiCl·H_2O$ | +4.45 |
| | ∞ | $LiCl·2H_2O$ | +1.07 |
| | ∞ | $LiCl·3H_2O$ | −1.98 |
| fluoride | ∞ | LiF | −0.74 |
| hydroxide | ∞ | LiOH | +4.74 |
| | ∞ | $LiOH·⅛H_2O$ | +4.39 |
| | ∞ | $LiOH·H_2O$ | +9.6 |
| iodide | ∞ | LiI | +14.92 |
| | ∞ | $LiI·½H_2O$ | +10.08 |
| | ∞ | $LiI·H_2O$ | +6.93 |
| | ∞ | $LiI·2H_2O$ | +3.43 |
| | ∞ | $LiI·3H_2O$ | −0.17 |
| nitrate | ∞ | $LiNO_3$ | +0.466 |
| | ∞ | $LiNO_3·3H_2O$ | −7.87 |
| sulfate | ∞ | $Li_2SO_4$ | +6.71 |
| | ∞ | $Li_2SO_4·H_2O$ | +3.77 |
| Magnesium bromide | ∞ | $MgBr_2$ | +43.7 |
| | ∞ | $MgBr_2·H_2O$ | +35.9 |
| | ∞ | $MgBr_2·6H_2O$ | +19.8 |
| chloride | ∞ | $MgCl_2$ | +36.3 |
| | ∞ | $MgCl_2·2H_2O$ | +20.8 |
| | ∞ | $MgCl_2·4H_2O$ | +10.5 |
| | ∞ | $MgCl_2·6H_2O$ | +3.4 |
| iodide | ∞ | $MgI_2$ | +50.2 |
| nitrate | ∞ | $Mg(NO_3)_2·6H_2O$ | −3.7 |
| phosphate | aq | $Mg_3(PO_4)_2$ | +10.2 |
| sulfate | ∞ | $MgSO_4$ | +21.1 |
| | ∞ | $MgSO_4·H_2O$ | +14.0 |
| | ∞ | $MgSO_4·2H_2O$ | +11.7 |
| | ∞ | $MgSO_4·4H_2O$ | +4.9 |
| | ∞ | $MgSO_4·6H_2O$ | +0.55 |
| | ∞ | $MgSO_4·7H_2O$ | −3.18 |
| sulfide | aq | MgS | +25.8 |
| Manganic nitrate | 400 | $Mn(NO_3)_2$ | +12.9 |
| | 400 | $Mn(NO_3)_2·3H_2O$ | −3.9 |
| | 400 | $Mn(NO_3)_2·6H_2O$ | −6.2 |
| sulfate | aq | $Mn_2(SO_4)_3$ | +22 |
| Manganous acetate | aq | $Mn(C_2H_3O_2)_2$ | +12.2 |
| | aq | $Mn(C_2H_3O_2)_2·4H_2O$ | +1.6 |
| bromide | aq | $MnBr_2$ | +15 |
| | aq | $MnBr_2·H_2O$ | +14.4 |
| | aq | $MnBr_2·4H_2O$ | +16.1 |
| chloride | 400 | $MnCl_2$ | +16.0 |
| | 400 | $MnCl_2·2H_2O$ | +8.2 |
| | 400 | $MnCl_2·4H_2O$ | +1.5 |
| formate | aq | $Mn(CHO_2)_2$ | +4.3 |
| | aq | $Mn(CHO_2)_2·2H_2O$ | −2.9 |
| iodide | aq | $MnI_2$ | +26.2 |
| | aq | $MnI_2·H_2O$ | +24.1 |
| | aq | $MnI_2·2H_2O$ | +22.7 |
| | aq | $MnI_2·4H_2O$ | +19.9 |
| | aq | $MnI_2·6H_2O$ | +21.2 |
| sulfate | 400 | $MnSO_4$ | +13.8 |
| | 400 | $MnSO_4·H_2O$ | +11.9 |
| | 400 | $MnSO_4·7H_2O$ | −1.7 |
| Mercuric acetate | aq | $Hg(C_2H_3O_2)_2$ | −4.0 |
| bromide | aq | $HgBr_2$ | −2.4 |
| chloride | aq | $HgCl_2$ | −3.3 |
| nitrate | aq | $Hg(NO_3)_2·½H_2O$ | −0.7 |
| Mercurous nitrate | aq | $Hg_2(NO_3)_2·2H_2O$ | −11.5 |
| Nickel bromide | aq | $NiBr_2$ | +19.0 |
| | aq | $NiBr_2·3H_2O$ | +0.2 |
| Nickel chloride | 800 | $NiCl_2$ | +19.23 |
| | 800 | $NiCl_2·2H_2O$ | +10.4 |
| | 800 | $NiCl_2·4H_2O$ | +4.2 |
| | 800 | $NiCl_2·6H_2O$ | −1.15 |
| iodide | aq | $NiI_2$ | +19.4 |
| nitrate | 200 | $Ni(NO_3)_2$ | +11.8 |
| | 200 | $Ni(NO_3)_2·6H_2O$ | −7.5 |
| sulfate | 200 | $NiSO_4$ | +15.1 |
| | 200 | $NiSO_4·7H_2O$ | −4.2 |
| Phosphoric acid, ortho- | 400 | $H_3PO_4$ | +2.79 |
| | 400 | $H_3PO_4·½H_2O$ | −0.1 |
| pyro- | aq | $H_4P_2O_7$ | +25.9 |
| | aq | $H_4P_2O_7·1½H_2O$ | +4.65 |
| Potassium acetate | ∞ | $KC_2H_3O_2$ | +3.55 |
| aluminum sulfate | 600 | $KAl(SO_4)_2$ | +48.5 |
| | 600 | $KAl(SO_4)_2·3H_2O$ | +26.6 |
| | | $KAl(SO_4)_2·12H_2O$ | −10.1 |
| bicarbonate | 2000 | $KHCO_3$ | −5.1 |
| bromate | ∞ | $KBrO_3$ | −10.13 |
| bromide | ∞ | KBr | −5.13 |
| carbonate | ∞ | $K_2CO_3$ | +6.58 |
| | | $K_2CO_3·½H_2O$ | +4.25 |
| | | $K_2CO_3·1½H_2O$ | −0.43 |
| chlorate | ∞ | $KClO_3$ | −10.31 |
| chloride | ∞ | KCl | −4.404 |
| chromate | 2185 | $K_2CrO_4$ | −4.9 |
| chrome sulfate | 600 | $KCr(SO_4)_2$ | +55 |
| | | $KCr(SO_4)_2·H_2O$ | +42 |
| | | $KCr(SO_4)_2·2H_2O$ | +33 |
| | | $KCr(SO_4)_2·6H_2O$ | +7 |
| | | $KCr(SO_4)_2·12H_2O$ | −9.5 |
| cyanide | 200 | KCN | −3.0 |
| dichromate | 1600 | $K_2Cr_2O_7$ | −17.8 |
| fluoride | ∞ | KF | +3.96 |
| | ∞ | $KF·2H_2O$ | −1.85 |
| | ∞ | $KF·4H_2O$ | −6.05 |
| hydrosulfide | ∞ | KHS | +0.86 |
| | ∞ | $KHS·¼H_2O$ | +1.21 |
| hydroxide | ∞ | KOH | +12.91 |
| | ∞ | $KOH·¾H_2O$ | +4.27 |
| | ∞ | $KOH·H_2O$ | +3.48 |
| | ∞ | $KOH·7H_2O$ | +0.86 |
| iodate | ∞ | $KIO_3$ | −6.93 |
| iodide | ∞ | KI | −5.23 |
| nitrate | ∞ | $KNO_3$ | −8.633 |
| oxalate | 400 | $K_2C_2O_4$ | −4.6 |
| | | $K_2C_2O_4·H_2O$ | −7.5 |
| perchlorate | ∞ | $KClO_4$ | −12.94 |
| permanganate | 400 | $KMnO_4$ | −10.4 |
| phosphate, dihydrogen | aq | $KH_2PO_4$ | +4.7 |
| pyrosulfite | aq | $K_2S_2O_5$ | −11.0 |
| | aq | $K_2S_2O_5·½H_2O$ | −10.22 |
| sulfate | ∞ | $K_2SO_4$ | −6.32 |
| sulfate, acid | 800 | $KHSO_4$ | −3.10 |
| sulfide | ∞ | $K_2S$ | −11.0 |
| sulfite | aq | $K_2SO_3$ | +1.8 |
| | aq | $K_2SO_3·H_2O$ | +1.37 |
| thiocyanate | ∞ | KCNS | −6.08 |
| thionate, di- | aq | $K_2S_2O_6$ | −13.0 |
| thiosulfate | ∞ | $K_2S_2O_3$ | −4.5 |
| Silver acetate | aq | $AgC_2H_3O_2$ | −5.4 |
| nitrate | 200 | $AgNO_3$ | −4.4 |
| Sodium acetate | ∞ | $NaC_2H_3O_2$ | +4.085 |
| | ∞ | $NaC_2H_3O_2·3H_2O$ | −4.665 |
| arsenate | 500 | $Na_3AsO_4$ | +15.6 |
| | 500 | $Na_3AsO_4·12H_2O$ | −12.61 |
| bicarbonate | 1800 | $NaHCO_3$ | −4.1 |
| borate, tetra- | 900 | $Na_2B_4O_7$ | +10.0 |
| | 900 | $Na_2B_4O_7·10H_2O$ | −16.8 |
| bromide | ∞ | NaBr | −0.58 |
| | ∞ | $NaBr·2H_2O$ | −4.57 |
| carbonate | ∞ | $Na_2CO_3$ | +5.57 |
| | ∞ | $Na_2CO_3·H_2O$ | +2.19 |
| | ∞ | $Na_2CO_3·7H_2O$ | −10.81 |
| | ∞ | $Na_2CO_3·10H_2O$ | −16.22 |
| chlorate | ∞ | $NaClO_3$ | −5.37 |
| chloride | ∞ | NaCl | −1.164 |
| chromate | 800 | $Na_2CrO_4$ | +2.50 |
| | 800 | $Na_2CrO_4·4H_2O$ | −7.52 |
| | 800 | $Na_2CrO_4·10H_2O$ | −16.0 |
| cyanide | 200 | NaCN | −0.37 |
| | 200 | $NaCN·½H_2O$ | −0.92 |

**TABLE 2-224 Heats of Solution of Inorganic Compounds in Water** (*Concluded*)

| Substance | Dilution* | Formula | Heat, kg-cal/ g-mole |
|---|---|---|---|
| Sodium—(*Cont.*) | | | |
| | 200 | $NaCN{\cdot}2H_2O$ | −4.41 |
| fluoride | ∞ | NaF | −0.27 |
| hydrosulfide | ∞ | NaHS | +4.62 |
| | ∞ | $NaHS{\cdot}2H_2O$ | −1.49 |
| Sodium hydroxide | ∞ | NaOH | +10.18 |
| | ∞ | $NaOH{\cdot}½H_2O$ | +8.17 |
| | ∞ | $NaOH{\cdot}⅔H_2O$ | +7.08 |
| | ∞ | $NaOH{\cdot}¾H_2O$ | +6.48 |
| | ∞ | $NaOH{\cdot}H_2O$ | +5.17 |
| iodide | ∞ | NaI | +1.57 |
| | ∞ | $NaI{\cdot}2H_2O$ | −3.89 |
| metaphosphate | 600 | $NaPO_3$ | +3.97 |
| nitrate | ∞ | $NaNO_3$ | −5.05 |
| nitrite | aq | $NaNO_2$ | −3.6 |
| perchlorate | ∞ | $NaClO_4$ | −4.15 |
| phosphate di | 1600 | $Na_2HPO_4$ | +5.21 |
| tri- | 1600 | $Na_3PO_4$ | +13 |
| phosphate di | 1600 | $Na_3PO_4{\cdot}12H_2O$ | −15.3 |
| di- | 1600 | $Na_2HPO_4{\cdot}2H_2O$ | −0.82 |
| | 1600 | $Na_2HPO_4{\cdot}7H_2O$ | −12.04 |
| | 1600 | $Na_2HPO_4{\cdot}12H_2O$ | −23.18 |
| phosphite, mono- | 600 | $NaH_2PO_3$ | +0.90 |
| | 600 | $NaH_2PO_3{\cdot}2½H_2O$ | −5.29 |
| di- | 800 | $Na_2HPO_3$ | +9.30 |
| | 800 | $Na_2HPO_3{\cdot}5H_2O$ | −4.54 |
| pyrophosphate | 1600 | $Na_4P_2O_7$ | +11.9 |
| | 1600 | $Na_4P_2O_7{\cdot}10H_2O$ | −11.7 |
| di- | 1200 | $Na_2H_2P_2O_7$ | −2.2 |
| | 1200 | $Na_2H_2P_2O_7{\cdot}6H_2O$ | −14.0 |
| sulfate | ∞ | $Na_2SO_4$ | +0.28 |
| | ∞ | $Na_2SO_4{\cdot}10H_2O$ | −18.74 |
| sulfate, acid | 800 | $NaHSO_4$ | +1.74 |
| | 800 | $NaHSO_4{\cdot}H_2O$ | +0.15 |
| sulfide | ∞ | $Na_2S$ | +15.2 |
| | ∞ | $Na_2S{\cdot}4½H_2O$ | +0.09 |
| | ∞ | $Na_2S{\cdot}5H_2O$ | −6.54 |
| | ∞ | $Na_2S{\cdot}9H_2O$ | −16.65 |
| sulfite | ∞ | $Na_2SO_3$ | +2.8 |
| | ∞ | $Na_2SO_3{\cdot}7H_2O$ | −11.1 |
| thiocyanate | ∞ | NaCNS | −1.83 |
| Sodium—(*Cont.*) | | | |
| thionate, di- | aq | $Na_2S_2O_6$ | −5.80 |
| | aq | $Na_2S_2O_6{\cdot}2H_2O$ | −11.86 |
| Sodium thiosulfate | aq | $Na_2S_2O_3$ | +2.0 |
| | aq | $Na_2S_2O_3{\cdot}5H_2O$ | −11.30 |
| Stannic bromide | aq | $SnBr_4$ | +15.5 |
| Stannous bromide | aq | $SnBr_2$ | −1.6 |
| iodide | aq | $SnI_2$ | −5.8 |
| Strontium acetate | ∞ | $Sr(C_2H_3O_2)_2$ | +6.2 |
| | ∞ | $Sr(C_2H_3O_2)_2{\cdot}½H_2O$ | +5.9 |
| bromide | ∞ | $SrBr_2$ | +16.4 |
| | ∞ | $SrBr_2{\cdot}H_2O$ | +9.25 |
| | ∞ | $SrBr_2{\cdot}2H_2O$ | +6.5 |
| | ∞ | $SrBr_2{\cdot}4H_2O$ | +0.4 |
| | ∞ | $SrBr_2{\cdot}6H_2O$ | −6.1 |
| chloride | ∞ | $SrCl_2$ | +11.54 |
| | ∞ | $SrCl_2{\cdot}H_2O$ | +6.4 |
| | ∞ | $SrCl_2{\cdot}2H_2O$ | +2.95 |
| | ∞ | $SrCl_2{\cdot}6H_2O$ | −7.1 |
| iodide | ∞ | $SrI_2$ | +20.7 |
| | ∞ | $SrI_2{\cdot}H_2O$ | +12.65 |
| | ∞ | $SrI_2{\cdot}2H_2O$ | +10.4 |
| | ∞ | $SrI_2{\cdot}6H_2O$ | −4.5 |
| nitrate | ∞ | $Sr(NO_3)_2$ | −4.8 |
| | ∞ | $Sr(NO_3)_2{\cdot}4H_2O$ | −12.4 |
| sulfate | ∞ | $SrSO_4$ | +0.5 |
| Sulfuric acid, pyro- | ∞ | $H_2S_2O_7$ | −18.08 |
| Zinc acetate | 400 | $Zn(C_2H_3O_2)_2$ | +9.8 |
| | 400 | $Zn(C_2H_3O_2)_2{\cdot}H_2O$ | +7.0 |
| | 400 | $Zn(C_2H_3O_2)_2{\cdot}2H_2O$ | +3.9 |
| bromide | 400 | $ZnBr_2$ | +15.0 |
| chloride | 400 | $ZnCl_2$ | +15.72 |
| iodide | aq | $ZnI_2$ | +11.6 |
| nitrate | 400 | $Zn(NO_3)_2{\cdot}3H_2O$ | −5 |
| | 400 | $Zn(NO_3)_2{\cdot}6H_2O$ | −6.0 |
| sulfate | 400 | $ZnSO_4$ | +18.5 |
| | 400 | $ZnSO_4{\cdot}H_2O$ | +10.0 |
| | 400 | $ZnSO_4{\cdot}6H_2O$ | −0.8 |
| | 400 | $ZnSO_4{\cdot}7H_2O$ | −4.3 |

NOTE: To convert kilocalories per gram-mole to British thermal units per pound-mole, multiply by $1.799 \times 10^{-3}$.

**TABLE 2-225 Heats of Solution of Organic Compounds in Water (at Infinite Dilution and Approximately Room Temperature)**

Recalculated and rearranged from *International Critical Tables*, vol. 5, pp. 148–150. (g·cal)/(g·mol) = Btu/(lb·mol) × 1.799.

| Solute | Heat of Solution, G-cal/g-mole Solute* | Solute | Heat of Solution, G-cal/g-mole Solute* |
|---|---|---|---|
| Acetic acid (solid), $C_2H_4O_2$ | –2,251 | Oxalic acid, $C_2H_2O_4$ | –2,290 |
| Acetylacetone, $C_5H_8O_2$ | –641 | ($2H_2O$) | –8,485 |
| Acetylurea, $C_3H_6N_2O_2$ | –6,812 | Phenol (solid), $C_6H_6O$ | –2,605 |
| Aconitic acid, $C_6H_6O_6$ | –4,206 | Phthalic acid, $C_8H_6O_4$ | –4,871 |
| Ammonium benzoate, $C_7H_9NO_2$ | –2,700 | Picric acid, $C_6H_3N_3O_7$ | –7,098 |
| picrate | –8,700 | Piperic acid, $C_{12}H_{10}O_4$ | –10,492 |
| succinate (*n*-) | –3,489 | Piperonylic acid, $C_8H_6O_4$ | –9,106 |
| Aniline, hydrochloride, $C_6H_8ClN$ | –2,732 | Potassium benzoate | –1,506 |
| Barium picrate | –4,708 | citrate | 2,820 |
| Benzoic acid, $C_7H_6O_2$ | –6,501 | tartrate (*n*-) (0.5 $H_2O$) | –5,562 |
| Camphoric acid, $C_{10}H_{16}O_4$ | –502 | Pyrogallol, $C_6H_6O_3$ | –3,705 |
| Citric acid, $C_6H_8O_7$ | –5,401 | Pyrotartaric acid | –5,019 |
| Dextrin, $C_{12}H_{20}O_{10}$ | 268 | Quinone | –3,991 |
| Fumaric acid, $C_4H_4O_4$ | –5,903 | Raffinose, $C_{18}H_{32}O_{16}$ ($5H_2O$) | –9,703 |
| Hexamethylenetetramine, $C_6H_{12}N_4$ | 4,780 | Resorcinol, $C_6H_6O_2$ | –3,960 |
| Hydroxybenzamide (*m*-), $C_7H_7NO_2$ | –4,161 | Silver malonate (*n*-) | –9,799 |
| (*m*-), (HCl) | –7,003 | Sodium citrate (tri-) | 5,270 |
| (*o*-), $C_7H_7NO_2$ | –4,340 | picrate | –6,441 |
| (*p*-) | –5,392 | potassium tartrate | –1,817 |
| Hydroxybenzoic acid (*o*-), $C_7H_6O_3$ | –6,350 | ($4H_2O$) | –12,342 |
| (*p*-), $C_7H_6O_3$ | –5,781 | succinate (*n*-) | 2,390 |
| Hydroxybenzyl alcohol (*o*-), $C_7H_8O_2$ | –3,203 | ($6H_2O$) | –10,994 |
| Inulin, $C_{36}H_{62}O_{31}$ | –96 | tartrate (*n*-) | –1,121 |
| Isosuccinic acid, $C_4H_6O_4$ | –3,420 | ($2H_2O$) | –5,882 |
| Itaconic acid, $C_5H_6O_4$ | –5,922 | Strontium picrate | 7,887 |
| Lactose, $C_{12}H_{22}O_{11}·H_2O$ | –3,705 | ($6H_2O$) | –14,412 |
| Lead picrate | –7,098 | Succinic acid, $C_4H_6O_4$ | –6,405 |
| ($2H_2O$) | –13,193 | Succinimide, $C_4H_5NO_2$ | –4,302 |
| Magnesium picrate | 14,699 | Sucrose, $C_{12}H_{22}O_{11}$ | –1,319 |
| ($8H_2O$) | –15,894 | Tartaric acid (*d*-) | –3,451 |
| Maleic acid, $C_4H_4O_4$ | –4,441 | Thiourea, $CH_4N_2S$ | –5,330 |
| Malic acid, $C_4H_6O_5$ | –3,150 | Urea, $CH_4N_2O$ | –3,609 |
| Malonic acid, $C_3H_4O_4$ | –4,493 | acetate | –8,795 |
| Mandelic acid, $C_8H_2O_3$ | –3,090 | formate | –7,194 |
| Mannitol, $C_6H_{14}O_6$ | –5,260 | nitrate | –10,803 |
| Menthol, $C_{10}H_{20}O$ | 0 | oxalate | –17,806 |
| Nicotine dihydrochloride, $C_{10}H_{16}Cl_2N_2$ | 6,561 | Vanillic acid | –5,160 |
| Nitrobenzoic acid (*m*-), $C_7H_5NO_4$ | –5,593 | Vanillin | –5,210 |
| (*o*-), $C_7H_5NO_4$ | –5,306 | Zinc picrate | –11,496 |
| (*p*-), $C_7H_5NO_4$ | –8,891 | ($8H_2O$) | –15,894 |
| Nitrophenol (*m*-), $C_6H_5NO_3$ | –5,210 | | |
| (*o*-), $C_6H_5NO_3$ | –6,310 | | |
| (*p*-), $C_6H_5NO_3$ | –4,493 | | |

*+ denotes heat evolved, and – denotes heat absorbed. All values are positive unless otherwise noted. The data in the *International Critical Tables* were calculated by E. Anderson.