Handbook of the Thermodynamics of Organic Compounds

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SECTION ON
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Elsevie
New York

Foreword

This book brings together data from Czechoslovakia on vapor pressures, data from England on critical properties, and data from America on physical properties of organic and organometallic compounds to provide a basic reference book for engineers and scientists involved with research and design in the chemical and petroleum industries.

We would like to acknowledge Jaroslav Dykyj, Milan Repas, and Josef Svoboda of Czechoslovakia for providing the material on Antoine constants and Douglas Ambrose of the University of London for providing the material on critical properties. Stanislaw Malanowski pointed out and made available the sources of data from Eastern Europe. Richard Stephenson translated and correlated the data in tabular form.

We would like to thank Dr. Matej Andras of the Slovenska Literarna Agentura for granting permission to use the data from Czechoslovakia and Dr. Marjan Bace of Elsevier Science Publishing Co., Inc., who encouraged preparation of this manuscript and handled the publishing arrangements. Particular thanks go to Mary Stephenson for typing the entire camera-ready copy.

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Introduction

All scientific and engineering calculations are dependent on the availability of thermodynamic and physical property data for the materials or systems in question. This dependency is particularly true in engineering design, which relies almost exclusively on computers for accurate data to produce meaningful final designs.

Because industry cannot afford the time nor money to make experimental measurements of quantities needed for design calculations most designers are limited to standard reference books. For this reason, we have compiled basic design information for a large number of organic and organometallic compounds. Much of this information is not readily available elsewhere.

We have arbitrarily divided into two general classes: properties of organic compounds, which includes all compounds made up of carbon, hydrogen, oxygen, nitrogen, sulfur, phosphorus, and the halogens; properties of organometallic compounds, which includes all compounds containing any other chemical element such as silicon, boron, and aluminum.

For each compound listed in the table we give, where available, the following basic data:

1. The name of the compound, including important synonyms.

2. The *Chemical Abstracts* entry number, which identifies the particular compound.

3. Toxicity and hazard warnings.

4. The melting point (*T*m) at one atmosphere pressure, given in kelvins. In some cases we give the freezing point (*T*f), which is usually substantially lower than the melting point.

5. The boiling point (*T*b) at one atmosphere pressure, given in kelvins.

6. The liquid molar volume (*V*m) calculated from the density. It is given in cubic meters per kilomole (m^3/kmol) at a particular temperature given in kelvins.

7. The critical temperature (*T*c) is the temperature above which a gas cannot be liquified. It is given in kelvins.

8. The critical pressure (*P*c) is the minimum pressure required for liquefaction at the critical temperature. It is given in kilopascals (kPa).

9. The critical volume (*V*c) is the volume occupied by one kilomole of the substance at the critical temperature and pressure. It is given in cubic meters per kilomole (m^3/kmol).

The Antoine constants, A, B, and C, are the constants for the Antoine equation

$$\log_{10} P = A - \frac{B}{C + T}$$

or

$$T = \frac{B}{A - \log_{10} P} - C$$

where P is the saturated vapor pressure in kilopascals (kPa) and T is the temperature in kelvins. In most cases the Antoine constants are for the liquid (liq), but in some cases the constants are for the solid (sol). The listed deviation (dev) gives the estimated average difference in degrees Kelvin between the experimental values of temperature and values calculated using the given values of A, B, and C. The range is the temperature range in kelvins over which the given values of A, B, and C are valid.

SOURCES OF DATA

The best and most comprehensive source of physical property data for organics is the *Dictionary of Organic Compounds* edited by J. Buckingham.[2] His recently published *Dictionary of Organometallic Compounds*[3] is the best source for the organometallics. The *CRC Handbook of Data on Organic Compounds*[9] is a useful source, although it is little different from the *CRC Handbook of Chemistry and Physics*. Much of the data comes from Beilstein. The *Merck Index*[7] is particularly good for medicinal chemicals. *Kirk-Othmer*[6] is useful for industrial chemicals, and the *Aldrich Catalog*[1] is a good source for shipping and handling

requirements. The DIPPR[4] project is extremely comprehensive, but it includes only some two hundred chemicals of greatest industrial interest. Sax[8] is by far the best source for toxicity and handling precautions.

Vapor pressure data are taken from the extremely comprehensive study by Dykyj, Repas, and Svoboda[5] published in Czechoslovakia in two volumes. This important survey of some five thousand organic compounds is practically unknown outside of eastern Europe. It is an extremely important source for vapor pressure data, which are of great practical interest to the chemical and petroleum industries.

Following the data on organic and organometallic compounds is a listing of vapor-liquid critical constants of fluids. The fluids are listed by formula.

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Contents

$CBrClF_2$ MW 165.36

Bromochlorodifluoromethane, CA 353-59-3: Used as refrigerant and fire extinguisher. Tm = 112.15; Tb = 269.15; Vm = 0.0894 at 298.15; Tc = 426.88; Antoine I (liq) A = 5.95024, B = 930.716, C = -33.26, dev = 0.1, range = 194 to 287; Antoine II (liq) A = 6.1309, B = 1020.262, C = -21.885, dev = 0.1, range = 268 to 324; Antoine III (liq) A = 6.34598, B = 1157.096, C = -1.885, dev = 0.1, range = 321 to 403; Antoine IV (liq) A = 7.12694, B = 1829.935, C = 96.199, dev = 0.1, range = 403 to 427.

$CBrCl_3$ MW 198.27

Bromotrichloromethane, CA 75-62-7: Highly toxic, causes liver damage; soluble ethanol, ether. Tm = 294.15; Tb = 377.85; Vm = 0.0985 at 293.15; Antoine (liq) A = 5.99115, B = 1294.08, C = -53.15, dev = 0.1 to 1.0, range = 294 to 443.

CBrFO MW 126.91

Carbonic bromide fluoride, CA 753-56-0: Tm = 153.15; Tb = 255.65 to 263.15; Antoine (liq) A = 6.7434, B = 1196.7, C = 0, dev = 5.0, range = 197 to 256.

$CBrF_3$ MW 148.91

Bromotrifluoromethane, CA 75-63-8: Toxic; irritant; fire-extinguishing agent, refrigerant; soluble chloroform. Tm = 105.15; Tb = 215.35; Vm = 0.0942 at 293.15; Tc = 340.15; Pc = 3960; Vc = 0.200; Antoine I (liq) A = 5.91830, B = 738.40, C = -26.64, dev = 0.1, range = 160 to 267; Antoine II (liq) A = 6.41474, B = 983.612, C = 8.63, dev = 0.1, range = 276 to 340.

CBrN MW 105.92

Cyanogen bromide, CA 506-68-3: Highly irritant; toxic; impure material decomposes and may explode; soluble water, ethanol, ether. Tm = 325.15; Tb = 334.15 to 335.15; Antoine (sol) A = 9.71635, B = 2697.49, C = 18.61, dev = 1.0, range = 273 to 318.

$CBrN_3O_6$ MW 229.93

Bromotrinitromethane, CA 560-95-2: Irritant; can explode if heated. Tm = 290.15 to 291.15; Vm = 0.1132 at 293.15; Antoine (liq) A = 7.7901, B = 2496.32, C = 0, dev = 1.0, range = 318 to 335.

CBr_2F_2 MW 209.82

Dibromodifluoromethane, CA 75-61-6: Moderately irritant; fire-extinguishing agent, refrigerant; soluble ethanol, ether, acetone, benzene. Tm = 163.15; Tb = 297.65; Vm = 0.0916 at 293.15; Tc = 471.30; Antoine (liq) A = 6.28693, B = 1185.98, C = -18.91, dev = 0.1, range = 247 to 297.

CBr_3F MW 270.72

Tribromofluoromethane, CA 353-54-8: Irritant; soluble ethanol. Tm = 199.55; Tb = 381.11; Vm = 0.0981 at 293.15; Antoine (liq) A = 6.73669, B = 1793.439, C = -0.298, dev = 1.0, range = 315 to 380.

CBr_4 MW 331.63

Carbon tetrabromide, CA 558-13-4: Toxic; soluble ethanol, ether, chloroform; insoluble water. Tm = 363.25; Tb = 462.65, decomposes; Vm = 0.112 at 372.65; Antoine I (sol) A = 8.5116, B = 2841.4, C = 0, dev = 1.0 to 5.0, range = 294 to 319; Antoine II (sol) A = 7.6919, B = 2578.9, C = 0, dev = 1.0 to 5.0, range = 320 to 329; Antoine III (liq) A = 5.30743, B = 1097.81, C = -130.113, dev = 1.0, range = 369 to 463.

$CClFO$ MW 82.46

Carbonic chloride fluoride, CA 353-49-1: Toxic. Tm = 125.15; Tb = 228.15; Antoine (liq) A = 7.2298, B = 1187.2, C = 0, dev = 1.0, range = 165 to 211.

$CClF_2NO$ MW 115.47

Difluorocarbamoyl chloride, CA 16847-30-6: Irritant. Tb = 268.15; Antoine (liq) A = 7.03661, B = 1347.345, C = 0, dev = 1.0, range = 189 to 234.

$CClF_3$ MW 104.46

Chlorotrifluoromethane, CA 75-72-9: Narcotic in high concentrations; refrigerant, fire-extinguishing agent. Tm = 92.15; Tb = 191.15; Vm = 0.0805 at 243.15; Tc = 302.05; Pc = 3870; Vc = 0.181; Antoine I (liq) A = 6.03488, B = 692.39, C = -19.81, dev = 0.1, range = 145 to 192; Antoine II (liq) A = 5.99404, B = 681.375, C = -20.784, dev = 0.1, range = 133 to 185; Antoine III (liq) A = 6.01518, B = 694.106, C = -18.568, dev = 0.1, range = 184 to 246; Antoine IV (liq) A = 6.38143, B = 863.583, C = 6.651, dev = 0.1, range = 243 to 271; Antoine V (liq) A = 7.52662, B = 1630.607, C = 112.164, dev = 0.1, range = 268 to 302.

$CClF_3O$ MW 120.46

Trifluoromethyl hypochlorite, CA 22082-78-6: Antoine I (liq) A = 6.538, B = 1025, C = 0, dev = 5.0, range = 142 to 219; Antoine II (liq) A = 7.00026, B = 1159.205, C = 4.684, dev = 1.0 to 5.0, range = 160 to 226.

$CClF_3O_2$ MW 136.46

Peroxyhypochlorous acid, trifluoromethyl ester, CA 32755-26-3: Tm = 141.15; Tb = 251.15; Antoine (liq) A = 6.867, B = 1221, C = 0, dev = 5.0, range = 163 to 296.

$CClF_3O_3S$ MW 184.52

Fluorosulfuric acid, chlorodifluoromethyl ester, CA 6069-31-4: Antoine (liq) A = 5.36772, B = 745.576, C = -86.423, dev = 5.0, range = 228 to 310.

$CClF_3O_4$ MW 168.46

Perchloric acid, trifluoromethyl ester, CA 52003-45-9: Antoine (liq) A = 6.6077, B = 1301, C = 0, dev = 1.0, range not specified.

$CClF_3S$ MW 136.52

Methanesulfenylchloride, trifluoro, CA 421-17-0: Highly toxic. Tb = 272.45; Antoine (liq) A = 5.25548, B = 639.89, C = -75.65, dev = 1.0, range = 247 to 272.

$CClF_4N$ MW 137.46

Difluoro(difluorochloromethyl) amine, CA 13880-71-2: Irritant. Tm = 177.15; Antoine (liq) A = 6.83952, B = 1388.771, C = 0, dev = 1.0, range = 209 to 277.

$CClF_4NO_2S$ MW 201.52

Chloro(trifluoromethyl) sulfamoyl fluoride, CA 19419-95-5: Antoine (liq) A = 6.901, B = 1503, C = 0, dev = 5.0, range = 253 to 288.

$CClF_4NO_{12}S_4$ MW 457.70

Fluorosulfuric acid, bis[(fluorosulfonyl)oxy]amino chloromethylene ester, CA 53684-03-0: Antoine (liq) A = 7.955, B = 2520, C = 0, dev = 1.0 to 5.0, range not specified.

$CClF_7S$ MW 212.51

Tetrafluorochloro(trifluoromethyl) sulfur, CA 25030-42-6: Antoine (liq) A = 6.615, B = 1352, C = 0, dev = 5.0, range not specified.

CClN MW 61.47

Cyanogen chloride, CA 506-77-4: Highly irritant; toxic; lachrymator; similar to HCN in effects; soluble water, ethanol, ether: Tf = 267.15; Tb = 286.95; Vm = 0.0518 at 293.15; Antoine (sol) A = 7.15381, B = 1232.34, C = -43.887, dev = 1.0, range = 196 to 259.

CCl_2FNO MW 131.92

Dichlorocarbamic fluoride, CA 32751-02-3: Irritant; decomposes on standing. Tb = 344.15; Antoine (liq) A = 8.185, B = 2125.7, C = 0, dev = 1.0 to 5.0, range not specified.

CCl_2F_2 MW 120.91

Dichlorodifluoromethane, CA 75-71-8: Nonflammable refrigerant; narcotic in high concentrations; can react violently with aluminum or magnesium; insoluble water; soluble ethanol, ether, acetone. Tm = 118.15; Tb = 243.35; Vm = 0.0922 at 298.15; Tc = 385.15; Pc = 4110; Vc = 0.217; Antoine I (liq) A = 5.94677, B = 839.6, C = -30.311, dev = 0.1, range = 173 to *(continues)*

CCl_2F_2 *(continued)*

244; Antoine II (liq) A = 6.0058, B = 860.828, C = -28.11, dev = 0.1, range = 173 to 240; Antoine III (liq) A = 5.92289, B = 826.707, C = -32.274, dev = 0.1, range = 236 to 285; Antoine IV (liq) A = 6.30541, B = 1035.857, C = -1.496, dev = 0.1, range = 282 to 345; Antoine V (liq) A = 7.51271, B = 2016.711, C = 132.578, dev = 0.1, range = 341 to 385.

CCl_2F_3N MW 153.92

Methyl amine, *N*,*N*-dichloro-1,1,1-trifluoro, CA 13880-73-4: Irritant. Tb = 288.05; Antoine (liq) A = 6.65638, B = 1347.371, C = 0, dev = 1.0 to 5.0, range = 226 to 291.

CCl_2F_3NS MW 185.98

(Trifluoromethyl)imidosulfurous dichloride, CA 10564-47-3: Irritant. Tb = 362.15 to 363.15; Antoine (liq) A = 8.27066, B = 2724.4, C = 72.44, dev = 1.0, range = 283 to 362.

CCl_2F_3PS MW 202.95

Dichloro(trifluoromethylthio) phosphine, CA 18799-78-5: Irritant; toxic. Tb = 371.15; Antoine (liq) A = 6.4699, B = 1655, C = 0, dev = 5.0, range = 293 to 363.

CCl_2O MW 98.92

Phosgene, carbonyl chloride, CA 75-44-5: Irritant; highly toxic, used as military gas in first world war; important chemical raw material and intermediate; slightly soluble water; soluble benzene, acetic acid, chloroform. Tm = 145.31; Tb = 280.63; Vm = 0.0713 at 293.15; Tc = 455.15; Pc = 5680; Vc = 0.190; Antoine I (liq) A = 6.06819, B = 986.45, C = -37.88, dev = 0.1, range = 240 to 281; Antoine II (liq) A = 6.81263, B = 1428.299, C = 16.439, dev = 1.0, range = 280 to 341; Antoine III (liq) A = 6.37426, B = 1144.238, C = -19.373, dev = 1.0, range = 338 to 410; Antoine IV (liq) A = 6.58798, B = 1303.455, C = 4.738, dev = 1.0, range = 406 to 455.

CCl_3F MW 137.37

Trichlorofluoromethane, CA 75-69-4: Nonflammable refrigerant; narcotic at high concentrations; insoluble water; soluble ethanol, ether. Tm = 162.15; Tb = 296.97; Vm = 0.0931 at 298.15; Tc = 471.15; Pc = 4410; Vc = 0.247; Antoine I (liq) A = 5.99210, B = 1032.23, C = -37.85, dev = 0.1, range = 213 to 249; Antoine II (liq) A = 5.99652, B = 1034.048, C = -37.672, dev = 0.1, range = 213 to 301; Antoine III (liq) A = 6.03083, B = 1053.874, C = -34.955, dev = 0.1 to 1.0, range = 295 to 363; Antoine IV (liq) A = 6.36472, B = 1285.088, C = -0.653, dev = 0.1 to 1.0, range = 357 to 429; Antoine V (liq) A = 7.75501, B = 2744.806, C = 196.225, dev = 1.0, range = 424 to 468.

CCl_3F_2N MW 170.37

Difluoro(trichloromethyl) amine, CA 24708-52-9: Irritant. Tm = 252.15; Antoine (liq) A = 7.31983, B = 1745.398, C = 0, dev = 1.0 to 5.0, range = 252 to 325.

CCl_3F_2P MW 187.34

Difluoro(trichloromethyl) phosphine, CA 1112-03-4: Irritant. Tm = 288.95 to 289.55; Tb = 346.25; Antoine I (sol) A = 7.6679, B = 1920, C = 0, dev = 5.0, range = 264 to 283; Antoine II (liq) A = 6.9019, B = 1699, C = 0, dev = 5.0, range = 289 to 313.

CCl_3NO MW 148.38

Trichloronitrosomethane, CA 3711-49-7: Irritant; decomposes at room temperature. Tb = 330.15 to 331.15, decomposes; Vm = 0.1016 at 293.15; Antoine (liq) A = 7.085, B = 1690, C = 0, dev = 5.0, range = 253 to 333.

CCl_3NO_2 MW 164.38

Trichloronitromethane, chloropicrin, CA 76-06-2: Strong irritant; highly toxic; explosive; lachrymator; stable to water; can detonate by shock; fumigation insecticide; insoluble water; soluble benzene, ether, carbon disulfide. Tf = 204.15; Tb = 385.15; Vm = 0.0972 at 273.15; Antoine I (liq) A = 6.15825, B 1369.7, C = -55.15, dev = 0.1, range = 301 to 449; Antoine II (liq) A = 7.40016, B = 2054.3, C = 0, dev = 1.0, range = 273 to 333.

CCl_4 MW 153.82

Carbon tetrachloride, CA 56-23-5: Highly toxic by inhalation and skin contact; reacts violently with powdered aluminum; can decompose to phosgene on strong heating; nonflammable solvent used for dry cleaning, as grain fumigant, and organic raw material; soluble ethanol, ether; insoluble water. Tm = 251.95, highest melting of three solid forms; Tb = 349.87; Vm = 0.09425 at 273.15; Tc = 556.35; Pc = 4600; Vc = 0.276; Antoine I (sol) A = 8.214, B = 2027, C = 0, dev = 1.0 to 5.0, range = 208 to 225; Antoine II (sol) A = 7.946, B = 1975.3, C = 0, dev = 1.0 to 5.0, range = 226 to 248; Antoine III (liq) A = 5.99114, B = 1202.9, C = -48.01, dev = 0.1, range = 262 to 349; Antoine IV (liq) A = 5.97092, B = 1195.903, C = -48.217, dev = 0.1 to 1.0, range = 349 to 416; Antoine V (liq) A = 6.22882, B = 1392.458, C = -19.19, dev = 1.0, range = 412 to 497; Antoine VI (liq) A = 6.36976, B = 1439.651, C = -25.734, dev = 1.0, range = 494 to 555.

CFIO MW 173.91

Carbonyl fluoride iodide: Tm = 183.15; Antoine (liq) A = 6.6133, B = 1366.6, C = 0, dev = 5.0, range = 230 to 292.

CFN MW 45.02

Cyanogen fluoride, CA 1495-50-7: Tm = 201.15; Antoine I (sol) A = 8.9229, B = 1508, C = 0, dev = 1.0, range = 147 to 191; Antoine II (liq) A = 7.1549, B = 1169.2, C = 0, dev = 1.0, range = 201 to 227.

$CFNO_3S$ MW 125.07

Sulfuryl fluoride isocyanate, CA 1495-51-8: Irritant; toxic. Antoine (liq) A = 7.68377, B = 1905.365, C = 0, dev = 1.0, range = 294 to 335.

$CFNO_6S_2$ MW 205.13

Pyrosulfuryl fluoride isocyanate, CA 27931-74-4: Irritant; toxic. Antoine (liq) A = 7.2599, B = 2134, C = 0, dev = 1.0, range = 330 to 405.

CFN_3O_6 MW 169.03

Fluorotrinitromethane, CA 1840-42-2: Irritant; lachrymator; oxidant for liquid rocket propellants. Tm = 244.15; Tb = 356.15 to 357.15; Vm = 0.1063 at 293.15; Antoine (liq) A = 6.9436, B = 1785.71, C = 0, dev = 1.0, range = 274 to 358.

CF_2NO_2P MW 126.99

Difluorophosphoryl isocyanate, CA 1495-54-1: Irritant; toxic. Antoine (liq) A = 7.52, B = 1880, C = 0, dev = 5.0, range from melting point to 341.

CF_2N_2 MW 78.02

Difluorocyanamide, CA 7127-18-6: Tm = 253.55; Antoine (sol) A = 7.095, B = 1075, C = 0, dev = 5.0, range = 179 to 198.

CF_2N_2OS MW 126.08

Cyanoimidosulfuryl fluoride, CA 19073-57-5: Tm = 244.65; Antoine (liq) A = 7.485, B = 1945, C = 0, dev = 5.0, range = 262 to 354.

$CF_2N_2O_4$ MW 142.02

Difluorodinitromethane, CA 1185-11-1: Oxidant for liquid rocket propellants. Tb = 307.15; Vm = 0.0910 at 283.15; Antoine (liq) A = 8.995, B = 2163.9, C = 0, dev = 1.0 to 5.0, range = 283 to 310.

CF_2N_2S MW 110.08

N-Cyano-*S*,*S*-difluorosulfilimine, CA 14453-41-9: Tm = 240.65; Antoine (liq) A = 8.11, B = 2302, C = 0, dev = 5.0, range = 271 to 320.

CF_2O MW 66.01

Carbonyl fluoride, CA 353-50-4: Irritant; highly toxic by inhalation; hygroscopic; easily decomposed by water. Tm = 159.15; Tb = 190.05; Vm = 0.0580 at 159.15; Antoine I (sol) A = 6.65565, B = 717.5, C = -32.95, dev = 5.0, range = 130 to 159; Antoine II (liq) A = 6.06499, B = 591.84, C = -42.77, dev = 1.0, range = 159 to 189.

CF_2O_4S MW 146.07

Fluoroformyl fluorosulfate: Antoine (liq) A = 6.61678, B = 1511.3, C = 8.45, dev = 1.0, range = 250 to 296.

CF_2S MW 82.07

Thiocarbonyl fluoride, CA 420-32-6: Tm = 109.65; Tb = 219.15; Antoine I (liq) A = 6.765, B = 1002, C = 0, dev = 5.0, range = 133 to 211; Antoine II (liq) A = 6.3069, B = 908, C = 0, dev = 1.0 to 5.0, range = 178 to 211.

CF_3I MW 195.91

Iodotrifluoromethane, CA 2314-97-8: Fire-extinguishing agent. Tb = 250.65; Vm = 0.0830 at 241.15; Antoine (liq) A = 6.6914, B = 1174.29, C = 0, dev not specified, range = 188 to 296.

CF_3NO MW 99.01

(Difluoroamino) carbonyl fluoride, CA 2368-32-3: Highly toxic; strong oxidizing agent. Tm = 120.95; Tb = 221.15; Antoine (liq) A = 7.1089, B = 1129, C = 0, dev = 1.0, range = 143 to 217.

Trifluoronitrosomethane, CA 334-99-6: Synthetic rubber intermediate. Tm = 76.55; Tb = 189.15; Antoine (liq) A = 6.799, B = 895.86, C = 0, dev = 1.0 to 5.0, range = 141 to 174.

CF_3NOS MW 131.07

S,S-Difluoro-*N*-(fluoroformyl)-sulfilimine, CA 3855-41-2: Highly toxic. Tm = 178.15; Tb = 327.15; Antoine (liq) A = 8.0655, B = 1950, C = 0, dev = 1.0, range = 220 to 323.

(*N*-Sulfinyl)-trifluoromethylamine, CA 10564-49-5: Tb = 291.15; Antoine (liq) A = 6.858, B = 1413, C = 0, dev = 1.0, range = 239 to 289.

Thionitrous acid, *S*-(trifluoromethyl) ester, CA 24892-54-4: Decomposes rapidly above 243; Tm = below 157.15; Tb = 270.15; Antoine (liq) A = 7.005, B = 1350, C = 0, dev = 5.0, range not specified.

CF_3NO_2 MW 115.01

Trifluoronitromethane, fluoropicrin, CA 335-02-4: Tb = 253.15; Antoine (liq) A = 6.666, B = 1128.3, C = 0, dev = 1.0, range = 238 to 243.

CF_3NO_4 MW 147.01

(Trifluoromethyl) peroxynitrate, CA 50311-48-3: Antoine (liq) A = 6.74837, B = 1297.361, C = 0, dev = 1.0 to 5.0, range = 193 to 247.

$CF_3NO_6S_2$ MW 243.13

N-(Fluoroformyl)-*N*,*O*-bis-(fluorosulfonyl) hydroxylamine, CA 19252-48-3: Antoine (liq) A = 6.7944, B = 1895, C = 0, dev = 1.0, range = 325 to 392.

CF_4 MW 88.00

Carbon tetrafluoride, CA 75-73-0: Narcotic in high concentrations; can react violently with aluminum powder; low temperature *(continues)*

CF_4 *(continued)*

refrigerant; gaseous insulator; slightly soluble water; soluble organic solvents. Tm = 89.55; Tb = 145.09; Vm = 0.0546 at 143.15; Tc = 227.55; Pc = 3740; Vc = 0.140; Antoine I (sol, *beta*) A = 8.9729, B = 876.5, C = 0, dev = 1.0, range = 70 to 76; Antoine II (sol, *alpha*) A = 7.6289, B = 770.0, C = 0, dev = 1.0, range = 76 to 90; Antoine III (liq) A = 5.9617436, B = 511.69474, C = -15.7745, dev = 0.02, range = 90 to 146; Antoine IV (liq) A = 5.96254, B = 513.129, C = -15.474, dev = 0.02 to 0.1, range = 89 to 163; Antoine V (liq) A = 6.23758, B = 599.591, C = -3.252, dev = 0.1, range = 160 to 197; Antoine VI (liq) A = 6.99759, B = 936.128, C = 45.844, dev = 0.1, range = 195 to 227.

CF_4N_2O MW 132.02

Fluoro(trifluoromethyl) diimidoxide, CA 815-10-1: Antoine (liq) A = 5.70258, B = 744.07, C = -64.25, dev = 1.0, range = 233 to 267.

$CF_4N_2O_3S_2$ MW 228.14

Carbonylbis(imidosulfuryl fluoride), CA 25523-80-2: Tm = 249.65; Antoine (liq) A = 7.5069, B = 2159, C = 0, dev = 1.0, range = 316 to 331.

CF_4O MW 104.00

Hypofluorous acid, trifluoromethyl ester, CA 373-91-1: Strong oxidizing agent. Tm = below 58.15; Tb = 178.15; Antoine (liq) A = 6.19992, B = 689.23, C = -13.78, dev = 1.0, range = 153 to 194.

CF_4OS MW 136.06

Trifluoromethane sulfinyl fluoride, CA 812-12-4: Antoine (liq) A = 5.56188, B = 804.05, C = -44.8, dev = 1.0 to 5.0, range = 204 to 271.

CF_4O_2 MW 120.00

Hydroperoxyfluoric acid, trifluoromethyl ester, CA 34511-13-2: Tm = below 77.15; Antoine (liq) A = 6.16405, B = 749.708, C = -23.301, dev = 1.0, range = 156 to 203.

CF_4O_2S MW 152.06

Trifluoromethane sulfonyl fluoride, CA 335-05-7: Tb = 251.45; Antoine (liq) A = 6.861, B = 1221, C = 0, dev = 1.0, range = 226 to 249.

$CF_4O_5S_2$ MW 232.12

Anhydride fluorosulfonic acid and trifluoromethane sulfonic acid, CA 21595-44-8: Antoine (liq) A = 7.043, B = 1721, C = 0, dev = 1.0, range = 308 to 338.

CF_5N MW 121.01

Pentafluoro methylamine, CA 335-01-3: Tm = 141.15; Tb = 195.15; Antoine I (sol) A = 7.075, B = 970, C = 0, dev = 5.0, range = 128 to 141; Antoine II (liq) A = 6.5989, B = 901, C = 0, dev = 1.0, range = 151 to 198.

CF_5NO MW 137.01

Pentafluoro methoxyamine, CA 4217-93-0: Tm = 93.15 to 113.15; Tb = 213.15; Antoine (liq) A = 6.4999, B = 968.6, C = 0, dev = 1.0, range = 167 to 210.

CF_5OPS MW 186.04

Difluorothiophosphoric acid, *S*-(trifluoromethyl) ester, CA 52752-66-6: Antoine (liq) A = 6.0269, B = 1207.4, C = 0, dev = 1.0 to 5.0, range not specified.

CF_5O_3P MW 185.98

Difluoroperoxyphosphoric acid, trifluoromethyl ester, CA 39125-42-3: Tm = 184.55; Antoine (liq) A = 7.8019, B = 1672.8, C = 0, dev = 1.0 to 5.0, range = 241 to 280.

$CF_6N_2S_2$ MW 218.13

Difluoromethane bis(*S*,*S*-difluorosulfilimine), CA 17686-45-2: Tm = 188.15; Antoine (liq) A = 7.206, B = 1880, C = 0, dev = 5.0, range = 230 to 313.

CF_6PS MW 189.04

Difluoro(trifluoromethylthio) phosphine, CA 52752-65-5: Antoine (liq) A = 6.2109, B = 1164.2, C = 0, dev = 1.0 to 5.0, range not specified.

CF_8OS MW 212.06

Pentafluoro(trifluoromethoxy) sulfur, CA 1873-23-0: Tm = 130.15; Antoine (liq) A = 6.16109, B = 949.88, C = -33.622, dev = 1.0, range = 217 to 262.

CF_8S MW 196.06

(Pentafluorothio)methane, trifluoro, CA 373-80-8: Tm = 186.25; Tb = 253.15; Antoine (liq) A = 5.96611, B = 849.09, C = -38.36, dev = 1.0, range = 205 to 262.

CF_9NOS MW 245.06

Tetrafluoro(difluoroamino)(trifluoromethoxy) sulfur: Antoine (liq) A = 6.60149, B = 1294.535, C = -19.011, dev = 1.0, range = 257 to 298.

$CF_{10}O_5S_2$ MW 346.11

Carbonodicarboxato-decafluoro disulfur, CA 60672-59-5: Tm = 227.65; Antoine (liq) A = 7.2147, B = 1988.4, C = 0, dev = 1.0 to 5.0, range not specified.

$CHBrF_2$ MW 130.92

Bromodifluoromethane, CA 1511-62-2: Soluble ethanol. Tb = 258.65; Vm = 0.0844 at 289.15; Antoine (liq) A = 6.870, B = 1255, C = 0, dev = 1.0, range = 194 to 259.

$CHBr_3$ MW 252.73

Tribromomethane, bromoform, CA 75-25-2: Highly toxic vapor; irritant; lachrymator; slightly soluble water; soluble ethanol, ether, acetone, benzene. Tm = 280.85; Tb = 422.65; Vm = 0.0874 at 293.15; Antoine (liq) A = 6.20911, B = 1544.81, C = -54.77, dev = 0.1, range = 320 to 412.

$CHClF_2$ MW 86.47

Chlorodifluoromethane, CA 75-45-6: Refrigerant; can react exothermically with aluminum powder, narcotic in high concentrations; soluble ethanol, acetone, chloroform. Tm = 113.15; Tb = 232.4; Vm = 0.0724 at 298.15; Tc = 369.15; Pc = 4970; Vc = 0.165; Antoine I (liq) A = 6.33292, B = 919.834, C = -19.718, dev = 0.1, range = 170 to 233; Antoine II (liq) A = 6.19138, B = 863.436, C = -26.04, dev = 0.1 to 1.0, range = 230 to 275; Antoine III (liq) A = 6.35713, B = 950.38, C = -13.474, dev = 0.1 to 1.0, range = 275 to 327; Antoine IV (liq) A = 7.13064, B = 1490.048, C = 64.627, dev = 1.0, range = 324 to 366.

$CHCl_2F_2$ MW 102.92

Dichlorofluoromethane, CA 75-43-4: Moderately toxic; refrigerant; bacteriocide; insoluble water; soluble ethanol, ether, chloroform. Tm = 138.15; Tb = 282.07; Vm = 0.0760 at 298.15; Tc = 451.65; Pc = 5170; Vc = 0.197; Antoine I (liq) A = 6.22023, B = 1052.833, C = -32.317, dev = 0.1, range = 225 to 282; Antoine II (liq) A = 6.02210, B = 957.338, C = -43.675, dev = 0.1, range = 279 to 344; Antoine III (liq) A = 6.35759, B = 1156.802, C = -15.644, dev = 0.1, range = 341 to 399; Antoine IV (liq) A = 7.66239, B = 2394.666, C = 155.01, dev = 0.1 to 1.0, range = 397 to 450.

$CHCl_2FO_3S$ MW 182.98

Fluorosulfuric acid, dichloromethyl ester, CA 42016-50-2: Irritant. Tm = 207.15; Antoine (liq) A = 7.125, B = 1890, C = 0, dev not specified, range = 275 to 293.

$CHCl_3$ MW 119.38

Trichloromethane, chloroform, CA 67-66-3: Toxic vapor; eye irritant; suspected carcinogen; can explode with powdered aluminum or magnesium; can explode with acetone if base is present; nonflammable solvent; important chemical intermediate; slowly decomposes in air and light; slightly soluble water; soluble ethanol, ether, benzene. Tm = 209.95; Tb = (continues)