Correlation constants for chemical compounds

PHYSICAL & THERMODYNAMIC PROPERTIES

24

Procedures to speed calculations for:

- Gas thermal conductivity
- Gas viscosity
- Liquid viscosity
- Vapor pressure

*Carl L. Yaws, Lamar University, and others**

☐ Correlation constants for major organic and inorganic chemicals are presented for calculating gas-phase thermal conductivity and viscosity, liquid viscosity, and vapor pressure of saturated liquids at any temperature.

Tabulated for easy accessibility, the constants make possible the rapid calculation of the foregoing physical and thermodynamic properties with a hand calculator or a computer. They are based on extensive documentation and experimental data. Margins of statistical accuracy are noted for each chemical listed.

The constants are valuable for designing or evaluating such chemical process equipment as heat exchangers, fluidized-bed units, reactors, distillation towers, flash tanks, and process piping.

THERMAL CONDUCTIVITY OF GAS

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Gas thermal conductivity data are important in numerous chemical engineering unit operations involving heat transfer. Representative examples include: heat exchangers to bring gas-phase reactants up to reaction temperature; fluidized-bed operations handling gases; gas-phase reactors requiring heating or cooling; and heat exchangers handling gases. In addition, the pure component data may be used to ascertain mixture property values.

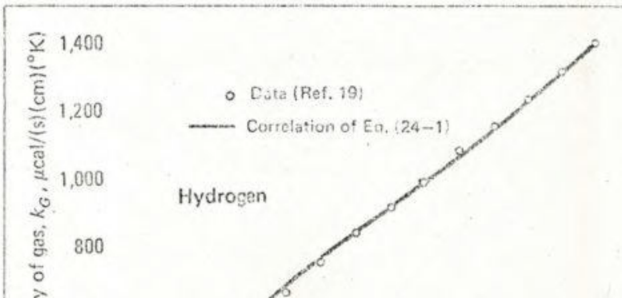
Correlation constants—Table 24—I

Thermal conductivity of the gas was correlated as a function of temperature by the relation:

$$k_G = A + BT + CT^2 + DT^3 \qquad (24\text{—}1)$$

In Eq. (24—1), k_G = thermal conductivity of the gas at low pressure (approximately 1 atm); A, B, C, D = correlation constants for the chemical compound; and T = temperature, K.

The constants were determined by a generalized



Thermal conductivity of gas Fig. 1

*For author biographies, see p. 162.

Correlation constants: thermal conductivity of gas

Table 24–I

$$k_G = A + BT + CT^2 + DT^3$$

Compound	A	$B \times 10^2$	$C \times 10^4$	$D \times 10^8$	k_G at 25°C, μ cal/(s)(cm)(°K)	Range, °C	References
Halogens							
Fluorine, F_2	1.8654	19.79	1.24	−17.77	66.2	−130 to 525	14,18,19,36,37,44,65
Chlorine, Cl_2	3.25	5.8	0.21	−1.25	22.08	−80 to 1,200	14,18,19,36,37,44,65
Bromine, Br_2	−0.16	4.13	−0.03	−0.09	11.86	−80 to 1,200	14,18,19,36,37,44,65
Iodine, I_2	0.63	2.73	−0.03	0.15	8.54	−80 to 1,200	14,18,19,36,37,44,65
Sulfur oxides							
Sulfur dioxide, SO_2	−19.31	15.15	−0.33	0.55	23.07	0 to 1,400	14,79,92
Sulfur trioxide, SO_3	−15.96	16.9	−0.47	3.00	31.05	−100 to 1,000	14
Nitrogen oxides							
Nitrous oxide, N_2O	−18.71	21.26	−0.2142	−0.6371	41.2	−100 to 1,400	10,12,18,19,96,102,125,131
Nitric oxide, NO	11.99	17.18	−0.02	−0.85	62.81	−190 to 1,400	10,18,65,96,97,102,126
Nitrogen dioxide, NO_2	−33.52	26.46	−0.755	1.071	38.9	25 to 1,400	10,12,98,99,101,132
Carbon oxides							
Carbon monoxide, CO	1.21	21.79	−0.8416	1.958	59.3	−160 to 1,400	18,19,65,97
Carbon dioxide, CO_2	−17.23	19.14	0.1308	−2.514	40.3	−90 to 1,400	18,19,96,143
Hydrogen halides							
Hydrogen fluoride, HF	9.21	12.60	0.54	−2.35	50.96	−100 to 1,400	65,177,180
Hydrogen chloride, HCl	−0.26	12.67	−0.25	0.16	35.34	−150 to 1,400	18,19,36,65,84,158,160,173
Hydrogen bromide, HBr	−1.89	9.16	−0.26	0.53	23.25	−150 to 1,400	18,36,40,65
Hydrogen iodide, HI	−5.14	7.28	−0.22	0.43	14.72	−150 to 1,400	18
Nitrogen hydrides							
Ammonia, NH_3	0.91	12.87	2.93	−8.68	63.03	0 to 1,400	12,13,14,18,19,207
Hydrazine, N_2H_4	−53.89	28.50	0.20	−0.19	32.91	0 to 1,400	13,14
Hydrogen oxides							
Water, H_2O	17.53	−2.42	4.3	−21.73	42.8	0 to 800	6,19,238,246,258
Hydrogen peroxide, H_2O_2	−21.07	16.97	0.17	−1.56	30.63	0 to 1,200	13,14
Diatomic gases							
Hydrogen, H_2	19.34	159.74	−9.93	37.29	417.22	−160 to 1,200	2,18,19,44,47,272,293,304,306,307,317,318
Nitrogen, N_2	0.9359	23.44	−1.21	3.591	61.02	−160 to 1,200	2,18,19,44,47,266,267,300,306,317,318,323, 328,329,330
Oxygen, O_2	−0.7816	23.8	−0.8939	2.324	62.8	−160 to 1,200	2,18,19,44,47,300,303,306,317,327,329,330
Inert gases							
Helium, He	88.89	93.04	−1.79	3.09	351.20	−160 to 800	18,19,43,44,47,158,267,306,317,318,323,339, 345,349,350,351,353,364,366,368,373,374, 375,385,392,399,401
Neon, Ne	21.75	36.81	−2.005	6.042	115.3	−160 to 1,200	18,19,43,44,47,158,318,344,353,368,374,375, 390,392,401,407
Argon, Ar	6.48	13.23	−0.52	1.32	41.65	−160 to 1,200	18,19,43,44,47,158,266,293,316,318,328,344, 345,349,353,363,368,373,374,375,385,389, 390,392,401,402,408
Olefins							
Ethylene, C_2H_4	−42.04	28.65	0.7963	−3.262	49.6	−75 to 1,000	18,19,84,246,421,429,431,440,443
Propylene, C_3H_6	−18.11	14.57	2.38	−9.17	44.06	−100 to 1,000	246,422,429,430,435,440,443
1-Butene, C_4H_8	−25.12	13.78	2.43	−10.20	34.87	−100 to 1,000	246,429,433,435,443
Alkanes							
Methane, CH_4	−4.463	20.84	2.815	−8.631	80.4	0 to 1,000	19,47,84,246,443,458,462,464
Ethane, C_2H_6	−75.8	52.57	−4.593	39.74	51.1	0 to 750	19,84,246,443,444,458
Propane, C_3H_8	4.438	−1.122	5.198	−20.08	42	0 to 1,000	19,84,246,443,450
Xylenes							
o-Xylene, $C_6H_4(CH_3)_2$	−13.66	8.53	1.78	−6.26	25.94	0 to 1,000	14,443
m-Xylene, $C_6H_4(CH_3)_2$	31.53	−10.02	3.97	−14.58	33.08	0 to 1,000	14,443,470
p-Xylene, $C_6H_4(CH_3)_2$	−19.53	9.29	1.81	−6.93	22.42	0 to 1,000	14,443
Aromatics							
Benzene, C_6H_6	−20.19	8.64	2.34	−9.69	23.81	0 to 1,000	14,18,19,443,494,515
Naphthalene, $C_{10}H_8$	−22.40	11.79	0.91	−2.54	20.17	0 to 1,000	14,443
Alkyl aromatics							
Toluene, $C_6H_5CH_3$	18.14	−9.57	5.66	−22.22	34.03	0 to 1,000	19,470,471,494
Ethylbenzene, $C_6H_5C_2H_5$	1.44	−1.40	5.11	−21.31	37.04	0 to 1,000	14,443
Cumene, $C_6H_5CH(CH_3)_2$	−13.35	5.38	4.33	−17.92	36.43	0 to 1,000	14,443
Benzene derivatives							
Chlorobenzene, C_6H_5Cl	−15.27	6.29	1.75	−5.53	17.58	0 to 1,000	13,14
Aniline, $C_6H_5NH_2$	−26.39	11.89	1.55	−4.30	21.70	0 to 1,000	13,14
Phenol, C_6H_5OH	−31.87	15.26	1.74	−4.40	27.93	0 to 1,000	13,14
Cycloalkanes							
Cyclopropane, C_3H_6	−20.46	9.74	3.77	−16.28	37.78	0 to 800	14,515,586,590
Cyclobutane, C_4H_8	−23.39	9.15	3.52	−14.81	31.26	0 to 800	14,590
Cyclopentane, C_5H_{10}	−20.35	5.91	3.87	−16.51	27.30	0 to 800	14,443,586,590
Cyclohexane, C_6H_{12}	−20.57	4.45	4.07	−17.31	24.29	0 to 800	14,409,443,484,500,515,586,587,590

Correlation constants: thermal conductivity of gas (continued) — Table 24—I

$$k_G = A + BT + CT^2 + DT^3$$

Compound	A	$B \times 10^2$	$C \times 10^4$	$D \times 10^8$	k_G at 25°C, μ cal/(s)(cm)(°K)	Range, °C	References
Olefin monomers							
Isobutylene, C_4H_8	−6.63	−0.67	6.03	−30.58	36.87	0 to 800	14,443,614,615,616,623,625
Styrene, $C_6H_5CHCH_2$	2.09	−0.46	2.97	−12.11	23.91	0 to 1,000	14,443
Diolefins							
1,3 Butadiene, C_4H_6	−67.92	29.96	1.74	−12.20	33.64	0 to 1,000	586,625,637
Isoprene, C_5H_8	−56.42	26.29	1.31	−7.58	31.60	0 to 1,000	637
Chloroprene, C_4H_5Cl	−27.26	10.89	2.84	−13.15	26.97	0 to 1,000	4,620
Organic oxides							
Ethylene oxide, C_2H_4O	−34.84	12.96	3.63	−18.26	31.23	0 to 1,000	4,10,14,515,590,625,637,648,659
Propylene oxide, C_3H_7O	−19.59	8.75	2.56	−10.91	26.37	0 to 1,000	14
Butylene oxide, C_4H_9O	−21.85	7.75	2.36	−10.66	19.41	0 to 1,000	14
Primary alcohols							
Methanol, CH_3OH	−18.62	9.95	2.90	−12.38	33.55	0 to 1,000	6,9,14,19,515,574,587,637,669,646,674,677,682,695
Ethanol, C_2H_5OH	−18.62	9.95	2.90	−12.38	33.55	0 to 1,000	6,9,14,19,416,574,590,637,646,674,687,682,695
n-Propanol, C_3H_7OH	−18.94	9.52	2.85	−11.99	31.60	0 to 1,000	14,590,637,646,682
n-Butanol, C_4H_9OH	−18.56	8.51	2.88	−11.92	29.26	0 to 1,000	590,637,646,682
Chloromethanes							
Methyl chloride, CH_3Cl	−7.62	3.77	2.82	−12.91	25.27	25 to 1,000	9,19,84,574,590,625,637
Methylene chloride, CH_2Cl_2	2.81	−1.00	2.31	−10.21	17.66	25 to 1,000	625,637
Chloroform, $CHCl_3$	−5.732	6.29	0.5904	−3.352	17.4	25 to 1,000	9,19,574,587,590,637
Carbon tetrachloride, CCl_4	−0.4161	4.067	0.6115	−3.566	16.2	25 to 1,000	9,19,84,574,637,646

least-squares computer program that minimized deviations between data and calculated results. Average deviations in most cases are less than 1-5%.

The correlation constants are presented in Table 24—I. The table also lists room temperature values (k_G at 25°C), which may be used at ambient conditions.

Correlation and data values are compared in Fig. 24—1 for hydrogen, a representative chemical.

Example 24-1—To estimate the thermal conductivity of gaseous hydrogen at 500°C, substitute the correlation constants A, B, C and D from Table 24—I and temperature ($T = 500°C = 773.16$ K) into Eq. (24—1):

$$k_G = 19.34 + 157.94 \times 10^{-2}(773.16) - 9.93 \times 10^{-4}(773.16)^2 + 37.29 \times 10^{-8}(773.16)^3$$

$$k_G = 833 \text{ microcal/(s)(cm)(K)}$$

The calculated and data values compare favorably (833 vs. 835).

VISCOSITY OF GAS

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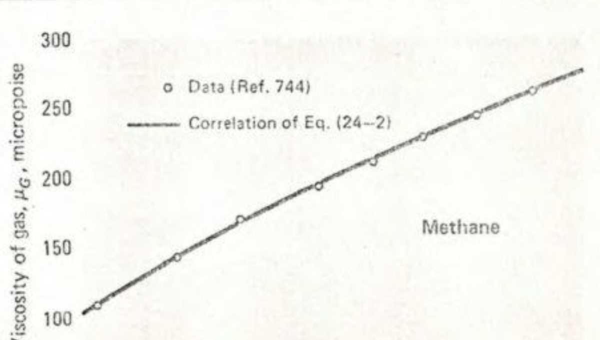
Gas-phase viscosity data for chemicals is important in the design of a variety of unit operations. For example, the viscosity of a gas must be known to determine the size of the pipe in which it is to flow, and the pressure drop. Additionally, viscosity data are needed to design process equipment involving heat, momentum and mass-transfer unit operations. The gas viscosity of mixtures may be determined from data for the individual components contained in the mixture.



Viscosity of gas — Fig. 2

Correlation constants—Table 24—II

The correlation for viscosity of the gas at low pressure is based on a series expansion in temperature:

$$\mu_G = A + BT + CT^2 \qquad (24\text{—}2)$$

In Eq. (24—2), μ_G = viscosity of gas at low pressure, micropoise; A, B, C = correlation constants characteristic for the compound; and T = temperature, °K.

The correlation constants were determined by least-

Correlation constants: viscosity of gas

Table 24–II

$$\mu_G = A + BT + CT^2$$

Compound	A	$B \times 10^2$	$C \times 10^6$	μ_G at 25°C, micropoise	Range, °C	References
Halogens						
Fluorine, F_2	22.09	76.9	−211.6	232.6	−200 to 1,000	19,38,47,48
Chlorine, Cl_2	5.175	45.69	−88.54	133.5	−200 to 1,200	19,24,26,58,61,66,67,68
Bromine, Br_2	2.153	54.50	−122.2	153.8	−200 to 1,200	19,25,57,59
Iodine, I_2	−17.75	54.71	−99.70	136.5	−200 to 1,200	19,26,59,60
Sulfur oxides						
Sulfur dioxide, SO_2	−3.793	46.45	−72.76	128.2	−100 to 1,400	10,13,14,18,19,75,82,89,92
Sulfur trioxide, SO_3	4.207	47.12	−68.34	138.6	−100 to 1,400	13,14
Nitrogen oxides						
Nitrous oxide, N_2O	32.28	44.54	−77.08	158.2	−150 to 1,400	2,9,10,12,18,19,114,122,123
Nitric oxide, NO	56.77	48.14	−84.34	192.8	−150 to 1,400	2,9,10,18,19,114,124
Nitrogen dioxide, NO_2			Equation not applicable			
Carbon oxides						
Carbon monoxide, CO	32.28	47.47	−96.48	165.2	−200 to 1,400	9,12,13,18,137,139
Carbon dioxide, CO_2	25.45	45.49	−86.49	153.4	−100 to 1,400	9,12,18,82,136,156
Hydrogen halides						
Hydrogen fluoride, HF	−19.21	45.98	−79.96	110.8	−120 to 1,400	14,18,187
Hydrogen chloride, HCl	−9.554	54.45	−96.56	144.2	−120 to 1,400	2,4,6,10,12,18,19,158,159,172,173
Hydrogen bromide, HBr	−23.37	74.03	−144.8	184.5	−120 to 1,200	2,6,10,12,18
Hydrogen iodide, HI	−17.65	69.77	−136.5	178.2	−120 to 1,400	2,6,10,12,18,19,159,172
Nitrogen hydrides						
Ammonia, NH_3	−9.372	38.99	−44.05	103	−200 to 1,200	2,12,14,83,173,192,207,223,224,225
Hydrazine, N_2H_4	−17.05	34.01	−47.51	80.13	−200 to 1,400	14,173,225,226,227
Hydrogen oxides						
Water, H_2O	−31.89	41.45	−8.272	90.14	0 to 1,000	2,6,18,237,254,258
Hydrogen peroxide, H_2O_2	5.381	28.98	38.40	95.2	−80 to 1,000	18,254,258
Diatomic gases						
Hydrogen, H_2	21.87	22.2	−37.51	84.7	−160 to 1,200	2,10,18,19,47,264,269,281,286,294,306,307,312,317,336
Nitrogen, N_2	30.43	49.89	−109.3	169.5	−160 to 1,200	2,10,18,19,47,270,274,281,286,291,294,297,300,306,317, 326,329,330
Oxygen, O_2	18.11	66.32	−187.9	199.2	−160 to 1,000	2,10,18,19,47,286,294,300,303,306,317,329,330
Inert gases						
Helium, He	54.16	50.14	−89.47	195.7	−160 to 1,200	18,43,47,158,269,270,274,278,281,291,294,306,317,339, 345,364,367,368,374,375,392,396
Neon, Ne	87.79	78.60	−176.2	306.5	−160 to 1,200	18,43,47,158,269,270,274,291,294,345,361,368,369,374, 375,382,407
Argon, Ar	43.87	63.99	−128	223.3	0 to 1,200	18,43,47,158,270,281,291,293,294,345,348,362,363,365, 367,368,369,374,375,387,392,402,408
Olefins						
Ethylene, C_2H_4	3.586	35.13	−80.55	101.2	−100 to 800	10,18,246,409,413,416,421,427,429,432,440,442
Propylene, C_3H_6	−5.601	31.88	−62.91	83.9	−100 to 1,000	10,246,409,413,416,422,429,432,440,442
1-Butene, C_4H_8	−8.884	29.59	−57.24	74.3	−100 to 1,000	10,246,413,429,433,442
Alkanes						
Methane, CH_4	15.96	34.39	−81.40	111.9	−80 to 1,000	10,47,246,294,427,442,456,464
Ethane, C_2H_6	5.576	30.64	−53.07	92.2	−80 to 1,000	10,246,427,442,444
Propane, C_3H_8	4.912	27.12	−38.06	82.4	−80 to 1,000	10,246,427,442
Xylenes						
o-Xylene, $C_6H_4(CH_3)_2$	1.776	21.74	−20.57	64.8	0 to 1,000	442
m-Xylene, $C_6H_4(CH_3)_2$	−15.27	25.44	−43.43	56.7	0 to 1,000	442
p-Xylene, $C_6H_4(CH_3)_2$	−13.9	25.57	−44.57	58.4	0 to 1,000	442
Aromatics						
Benzene, C_6H_6	−15.76	32.45	−72.32	74.6	0 to 1,000	14,18,242,442,467,484,500
Naphthalene, $C_{10}H_8$	−24.86	27.65	−49.55	53.2	0 to 1,000	14,442
Alkyl aromatics						
Toluene, $C_6H_5CH_3$	−8.421	27.11	−40.18	63.8	0 to 1,000	14,442,467,519,534
Ethylbenzene, $C_6H_5C_2H_5$	−14.17	27.37	−47.32	63.2	0 to 1,000	442
Cumene, $C_6H_5CH(CH_3)_2$	−13.85	25.67	−43.30	58.8	0 to 1,000	442
Benzene derivatives						
Chlorobenzene, C_6H_5Cl	−15.08	27.85	0.4464	68.0	0 to 1,000	14,545
Aniline, $C_6H_5NH_2$	−14.98	29.03	−1.116	68.5	0 to 1,000	14,545
Phenol, C_6H_5OH	−16.41	32.00	0	79.0	0 to 1,000	14,545
Cycloalkanes						
Cyclopropane, C_3H_6	−7.787	34.78	−81.3	88.7	0 to 1,000	14,467,519,544,586,592
Cyclobutane, C_4H_8	−7.558	31.22	−65.69	79.7	0 to 1,000	14,544
Cyclopentane, C_5H_{10}	−7.935	28.88	−52.38	74.3	0 to 1,000	14,519,544,586,602
Cyclohexane, C_6H_{12}	−4.705	26.32	−44.1	69.9	0 to 1,000	14,46,7,500,513,519,544,546,586,604
Olefin monomers						
Isobutylene, C_4H_8	−7.039	31.72	−69.39	81.4	0 to 1,000	10,14,467,519,544,546
Styrene, $C_6H_5CHCH_2$	−5.683	23.68	−32.68	62.0	0 to 1,000	14,544

Correlation constants: viscosity of gas (continued) **Table 24—II**

$$\mu_G = A + BT + CT^2$$

Compound	A	$B \times 10^2$	$C \times 10^6$	μ_G at 25°C, micropoise	Range, °C	References
Diolefins						
1,3 Butadiene, C_4H_6	−10.67	34.32	−80.80	84.5	0 to 1,000	14,546,586,637
Isoprene, C_5H_8	−0.4474	27.56	−49.78	77.3	0 to 1,000	14
Chloroprene, C_4H_5Cl	−29.93	41.14	−67.86	86.7	0 to 800	14
Organic oxides						
Ethylene oxide, C_2H_4O	−7.614	36.27	−66.32	94.6	0 to 1,000	14
Propylene oxide, C_3H_7O	−7.72	33.89	−55.94	88.4	0 to 1,000	14
Butylene oxide, C_4H_9O	−2.54	28.25	−35.24	78.6	0 to 1,000	14
Primary alcohols						
Methanol, CH_3OH	−5.636	34.45	−3.340	96.8	0 to 900	14,416,467,500,545,637,646,669,671,683,703
Ethanol, C_2H_5OH	1.396	28.48	12.41	87.42	0 to 1,000	9,14,416,467,545,637,646,671,683,703
n-Propanol, C_3H_7OH	−20.70	31.44	−14.35	71.8	25 to 1,000	9,14,416,467,545,637,646
n-Butanol, C_4H_9OH	−18.43	28.67	−10.48	66.1	25 to 1000	416,545,637
Chloromethanes						
Methyl chloride, CH_3Cl	0.3847	38.20	−54.97	109.4	0 to 1,000	9,416,467,574,637,646,703,715,716
Methylene chloride, CH_2Cl_2	−4.929	37.72	−53.9	102.8	0 to 1,000	467,637
Chloroform, $CHCl_3$	−6.688	37.26	−50.87	99.9	0 to 1,000	9,467,574,637,703,715,716
Carbon tetrachloride, CCl_4	5.698	32.73	−40.28	99.7	0 to 1,000	416,467,637,646,703,715,716,719,723

squares-regression analysis of the available data. The numerous data points were processed by a generalized least-squares-regression computer program to minimize deviation. Average absolute deviations of correlation and data are less than 1–3% in most cases.

Correlation and data values are compared in Fig. 24—2 for methane, a representative chemical compound. The agreement is quite good.

Example 24-2—To estimate the gas viscosity of methane at 403°C, substitute the correlation constants A, B and C from Table 24—II and temperature ($T = 403°C = 676.16$ K) into Eq. (24—2):

$$\mu_G = 15.96 + 34.39 \times 10^{-2}(676.16) - 81.4 \times 10^{-6}(676.16)^2$$

$$\mu_G = 211.3 \text{ micropoise}$$

The calculated value compares favorably with the data results (211.3 vs. 211).

VISCOSITY OF LIQUID

Joseph W. Miller, Jr., Gordon R. Schorr and Carl L. Yaws

Liquid viscosity is important in the design of a variety of process equipment. For example, it is an important parameter in estimating efficiency of distillation. Determining process piping size and pressure drop requires information on the viscosity of the liquid flowing in the piping. Additionally, liquid viscosity is involved in the design of heat transfer equipment. The viscosity of liquid mixtures may be estimated from results for the individual components in the solution.

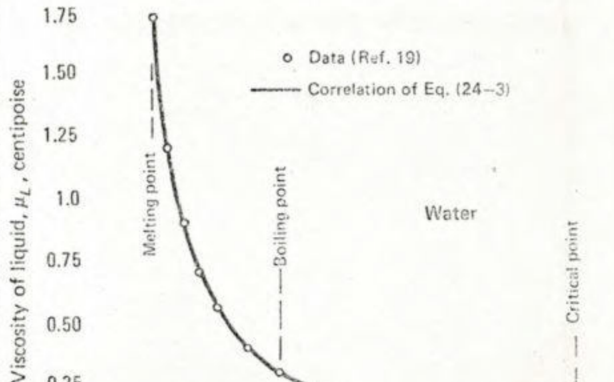
Correlation constants—Table 24—III

The correlation for the viscosity of the saturated liquid as a function of temperature was based on the relation:

$$\log \mu_L = A + B/T + CT + DT^2 \quad (24—3)$$

In Eq. (24—3), μ_L = viscosity of saturated liquid, centipoise; A, B, C, D = correlation constants characteristic for the chemical compound; and T = temperature, °K.

The correlation constants were determined by a least-squares-regression analysis of data. The numerous



Viscosity of liquid **Fig. 3**

Correlation constants: viscosity of liquid

Table 24–III

$$\log \mu_L = A + \frac{B}{T} + CT + DT^2$$

Compound	A	B	$C \times 10^2$	$D \times 10^6$	μ_L at 25°C, centipoise	Range, °C	References
Halogens							
Fluorine, F_2	−1.576	85.63	−0.04073	−2.725	0.73 @ −215	−219 to 188.1	31,47
Chlorine, Cl_2	−0.7681	151.4	−0.08065	0.4075	0.34	−101 to 144.0	2,4,61
Bromine, Br_2	−1.400	387.5	−0.04157	−0.5214	0.95	−7.2 to 315.0	2,3,9
Iodine, I_2	−0.9048	519.0	−0.01983	0.04676	1.76 @ 150	113.6 to 546.0	6,43
Sulfur oxides							
Sulfur dioxide, SO_2	−2.67	406.7	0.6141	−12.54	0.26	−72.7 to 157.6	2,4,6,73,92,93
Sulfur trioxide, SO_3	12.57	−988.9	−4.079	35.02	1.60	16.8 to 218.3	4,85
Nitrogen oxides							
Nitrous oxide, N_2O	0.4733	21.8	−0.4923	−4.274	0.05	−102.3 to 36.5	14,
Nitric oxide, NO	−4.995	238.3	3.669	−134.3	0.35 @ −160.5	−163.8 to −93.10	14
Nitrogen dioxide, NO_2	−8.431	932.6	2.759	−37.54	0.39	−11.2 to 158.0	9,10,94,129
Carbon oxides							
Carbon monoxide, CO	−2.346	105.2	0.4613	−19.64	0.21 @ −200	−205.0 to 140.1	138
Carbon dioxide, CO_2	−1.345	21.22	1.034	−34.05	0.06	−56.5 to 31.1	6,9,13,144
Hydrogen halides							
Hydrogen fluoride, HF	−6.099	816	1.292	−13.29	0.20	−83.5 to 188.0	10,12,169
Hydrogen chloride, HCl	−1.515	194.6	0.3067	−13.76	0.068	−114.2 to 51.5	12,165,168
Hydrogen bromide, HBr	−9.238	866.7	3.432	−51.72	0.20	−86.9 to 90.0	12,168
Hydrogen iodide, HI	−9.373	1,015	3.186	−42.20	0.60	−50.8 to 151.0	12,168
Nitrogen hydrides							
Ammonia, NH_3	−8.591	876.4	2.681	−36.12	0.13	−77.74 to 132.4	2,12,14,188,192,207,213,222,224
Hydrazine, N_2H_4	−8.024	1,299	1.611	−13.3	0.90	2.0 to 380.0	4,14,173,189,208,233
Hydrogen oxides							
Water, H_2O	−10.73	1,828	1.966	−14.66	0.90	0.0 to 374.2	2,4,6,9,13,238,246,257,258
Hydrogen peroxide, H_2O_2	−1.615	503.8	0.03501	−1.168	1.19	−0.43 to 455.0	2,243,249,250,257
Diatomic gases							
Hydrogen, H_2	−4.857	25.13	14.09	−2,773	0.016 @ −256.0	−259.4 to −240.2	47,263,273,278,290,293,305,306,307,312,317, 319,333,335
Nitrogen, N_2	−12.14	376.1	12.00	−470.9	0.18 @ −200.0	−209.9 to −195.8	43,47,270,276,278,279,290,300,306,317,319, 320,332
Oxygen, O_2	−2.072	93.22	0.6031	−27.21	0.47 @ −210	−218.4 to −118.5	47,300,303,306,317,319,320,334
Inert gases							
Helium, He	4.732	−2.990	−586.0	1,417,000	0.0034 @ −270.0	−272.0 to −271.6	43,47,290,306,317,339,345,364,374,375,392,399
	−3.442	1.002	32.22	−35,650		−270.5 to −268.0	
Neon, Ne	−8.378	86.41	23.68	−2,899	0.137 @ −247	−248.7 to −228.7	42,263,271,276,290,300,337,345,365,374,375,402
Argon, Ar	−12.38	459.1	10.55	−351.6	0.252 @ −185	−189.3 to −122.4	43,47,263,271,276,290,300,337,345,365,374,375, 402
Olefins							
Ethylene, C_2H_4	−7.706	468.1	3.725	−76.33	0.031 @ 0.0	−169.2 to 9.9	10,18,246,409,413,416,421,427,429,432,440,442
Propylene, C_3H_6	−27.84	1,096	26.02	−863.5	0.081	−185.3 to −160.0	10,246,409,413,416,422,429,432, 440,442
	−5.009	413.2	1.771	−30.92		−160.0 to 91.9	
1-Butene, C_4H_8	−3.117	272.0	1.836	−67.33	0.17	−185.4 to −140.0	10,246,413,429,433,442
	−4.617	426.3	1.531	−24.29		−140.0 to 146.2	
Alkanes							
Methane, CH_4	−11.67	499.3	8.125	−226.3	0.14 @ −170.0	−182.6 to −82.6	3,47,246,417,464,465,466
Ethane, C_2H_6	−4.444	290.1	1.905	−41.64	0.032	−183.2 to 32.3	3,246,417,444,465
Propane, C_3H_8	−3.372	313.5	1.034	−20.26	0.091	−187.7 to 96.7	3,246,465,466
Xylenes							
o-Xylene, $C_6H_4(CH_3)_2$	−1.447	451.1	−0.07678	0.4675	0.76	−25.2 to 357.8	6,9,14,409,415,416,417,467,476,484
m-Xylene, $C_6H_4(CH_3)_2$	−1.659	446.1	−0.02770	0.1963	0.60	−47.9 to 343.8	6,9,14,409,415,416,417,467,476,484,490
p-Xylene, $C_6H_4(CH_3)_2$	−3.383	686.0	0.3792	−2.925	0.61	13.3 to 344.0	6,9,14,409,415,416,417,467,476,484,490
Aromatics							
Benzene, C_6H_6	2.003	64.66	−1.105	9.648	0.61	5.53 to 288.94	3,4,415,417,484,506
Naphthalene, $C_{10}H_8$	−4.460	1,093	0.4767	−2.548	0.78 @ 100.0	80.55 to 475.02	3,6,484,505,506,511
Alkyl aromatics							
Toluene, $C_6H_5CH_3$	14.73	−217.9	−10.46	198.6	0.55	−95.0 to −40.0	9,14,415,417,517,520,522,524,536,537,542,546
	−2.553	559.1	0.1987	−1.954		−40.0 to 318.8	
Ethylbenzene, $C_6H_5C_2H_5$	11.97	22.58	−9.468	189.7	0.64	−95.0 to −40.8	9,415,417,515,519,522,524,546
	−2.652	587.5	0.2220	−1.977		−40.0 to 344.0	
Cumene, $C_6H_5CH(CH_3)_2$	−55.89	5,001	22.01	−302.2	0.74	−80.0 to −20.0	417,517,521,524,546
	−3.601	738.2	0.4354	−3.400		−20.0 to 360.0	
Benzene derivatives							
Chlorobenzene, C_6H_5Cl	−1.986	519.2	0.05951	−0.5984	0.76	−45.2 to 359.2	3,4,6,14,415,416,467,484,546,554,555,564
Aniline, $C_6H_5NH_2$	155.0	−14,060	−54.44	620.1	3.93	−6.15 to 50.0	4,6,14,409,415,416,467,484,546,557,561
	−2.454	886.6	−0.02522	0.5411		50.0 to 426.0	
Phenol, C_6H_5OH	−8.039	1,889	1.055	−6.718	3.25 @ 50.0	40.75 to 420.0	3,6,14,415,416,467,484,564,570
Cycloalkanes							
Cyclopropane, C_3H_6	−1.335	116.2	0.01108	−0.03836	0.12	−127.42 to 124.9	14
Cyclobutane, C_4H_8	−1.972	292,0	0.142.0	−1.706	0.19	−90.73 to 190.4	14
Cyclopentane, C_5H_{10}	−2.615	485.7	0.3162	−3.762	0.42	−93.88 to 238.5	3,14,415,416,417,467,524,546,580
Cyclohexane, C_6H_{12}	−1.910	599.2	−0.06749	0.5026	0.88	6.55 to 280.3	3,14,253,415,416,417,467,484,524,546,593

Correlation constants: viscosity of liquid (continued) — Table 24—III

$$\log \mu_L = A + \frac{B}{T} + CT + DT^2$$

Compound	A	B	$C \times 10^2$	$D \times 10^6$	μ_L at 25°C, centipoise	Range, °C	References
Olefin monomers							
Isobutylene, C_4H_8	−2.800	353.3	0.5734	−10.59	0.14	−140.7 to 144.7	14,434
Styrene, $C_6H_5CHCH_2$	−1.181	410.9	−0.1378	0.7310	0.71	−30.6 to 369.0	4,14,467,546,611,618,620
Diolefins							
1,3 Butadiene, C_4H_6	−2.637	434.5	0.1937	−2.907	0.14	−108.9 to 152.0	253,546
Isoprene, C_5H_8	−0.9676	276.1	−0.3180	3.329	0.20	−146.0 to 210.2	9,620,637,645
Chloroprene, C_4H_5Cl	−1.556	307.7	0.06009	−0.7997	0.38	−130.0 to 261.7	4,620,632
Organic oxides							
Ethylene oxide, C_2H_4O	−1.678	312.4	0.03232	−0.7838	0.25	−112.5 to 195.8	2,4,10,415,416,637,657,658,659,660,661,663
Propylene oxide, C_3H_7O	−1.180	304.0	−0.1904	2.329	0.30	−112.0 to 209.1	4,637,657,658,659,661
Butylene oxide, C_4H_9O	−1.610	351.3	.0.01705	−0.2415	0.40	−150.0 to 252.6	4,657,658
Primary alcohols							
Methanol, CH_3OH	−99.73	7,317	46.81	−745.3	0.53	−97.6 to −40.0	6,9,14,415,416,467,484,637,646
	−17.09	2,096	4.738	−48.93		−40.0 to 239.4	
Ethanol, C_2H_5OH	−2.697	700.9	0.2682	−4.917	1.04	−105.0 to 243.1	6,9,14,415,416,467,484,637
n-Propanol, C_3H_7OH	−5.333	1,158	0.8722	−9.699	1.94	−72.0 to 263.6	6,9,14,415,416,467,484,637,646,679
n-Butanol, C_4H_9OH	−4.222	1,130	0.4137	−4.328	2.61	−60.0 to 289.8	6,9,14,415,416,467,484,637,646
Chloromethanes							
Methyl chloride, CH_3Cl	−1.311	157.7	0.1394	−2.899	0.24	−97.7 to 143.1	4,646,703,708,717,728
Methylene chloride, CH_2Cl_2	−3.501	514.8	0.7038	−7.[illegible]	0.41	−96.7 to 241.0	4,6,9,415,416,574,708,717,719,721,728
Chloroform, $CHCl_3$	−1.812	397.5	0.1174	−1.784	0.52	−63.2 to 263.4	4,6,9,415,416,467,574,705,708,717,721,724,728
Carbon tetrachloride, CCl_4	−5.658	994.5	1.016	−8.733	0.86	−20.0 to 283.2	4,6,9,415,416,574,646,708,709,713,717,719,721 726,728

data points were processed with a generalized least-squares-regression computer program for minimizing deviation. Average absolute deviations in most cases are about 2–5%.

Correlation and data values are compared in Fig. 24—3 for water, a representative compound.

Example 24-3—To estimate the saturated liquid viscosity of water at 250°C, substitute correlation constants A, B, C and D from Table 24—III and temperature ($T = 250°C = 523.16$ K) into Eq. (24—3):

$$\log \mu_L = -10.73 + 1{,}828/523.16 + 1.966 \times 10^{-2} \times (523.16) - 14.66 \times 10^{-6}(523.16)^2 = -0.9654$$

$$\mu_L = 0.108 \text{ centipoise}$$

The values compare favorably (0.108 vs. 0.109).

VAPOR PRESSURE

P. M. Patel, Gordon R. Schorr, Praful N. Shah and Carl L. Yaws

Vapor-pressure data for pure components are extremely important in phase equilibria. Most dew-point, bubble-point and flash calculations in mass-transfer operations (such as distillation) involve the vapor pressure of the respective pure components. The design of pressure requirements for storage equipment and many process vessels requires knowledge of the vapor pressure of the components being stored or processed.

Correlation constants—Table 24—IV

The vapor pressure of the saturated liquid as a function of temperature was based on the correlation:

$$\log P_v = A + B/T + C \log T + DT + ET^2 \quad (24\text{—}4)$$

In Eq. (24—4), P_v = vapor pressure of saturated liquid, mm of Hg; A, B, C, D, E = correlation constants for the chemical compound; and T = temperature, °K.

The correlation constants are given in Table 24—IV, as are the temperature ranges over which the correlation constants apply. In many cases, the correlation covers the complete saturated-liquid state from the triple point to the critical point.

Also given in the table are values for the acentric factor, ω, which is defined by:

$$\omega = -\log P_r - 1.000 \quad (\text{at } T_r = 0.70) \quad (24\text{—}5)$$

In Eq. (24—5), P_r = reduced pressure, P_v/P_c, and T_r = reduced temperature, T/T_c.

The acentric factor is an important parameter in generalized thermodynamic correlations involving virial coefficients, compressibility factor, enthalpy and fugacity.

A generalized least-squares computer program for minimizing the deviation of calculated and data values was used to process the numerous data points (more than 7,500) screened from publications and books. The average deviation was 0.72% for 62 compounds.

In the processing, other vapor-pressure equations

Correlation constants: vapor pressure

Table 24–IV

$$\log P_v = A + \frac{B}{T} + C \log T + DT + ET^2$$

Compound	A	B	C	$D \times 10^3$	$E \times 10^6$	Acentric factor, ω	Range, °C	No. of data points	Avg. dev., %	References
Halogens										
Fluorine, F_2	21.480	-516.51	-7.1218	14.355	–	0.066	-219.2 to -129.0	175	0.86	47,52,64,646
Chlorine, Cl_2	42.262	-2009.8	-13.963	9.3705	–	0.079	-100.4 to 144.1	235	1.24	5,9,10,52,183,413,646
Bromine, Br_2	32.102	-2454.8	-9.2176	4.2584	–	0.097	-7.0 to 315.0	174	0.92	5,52
Iodine, I_2	51.326	-4191.2	-15.727	5.5603	–	0.123	113.8 to 546.0	54	0.82	52
Sulfur oxides										
Sulfur dioxide, SO_2	46.554	-2456.3	-15.169	9.0026	–	0.259	-67.6 to 157.6	233	0.70	5,9,10,81,413
Sulfur trioxide, SO_3	160.89	-8081.2	-54.240	4.3154	17.432	0.431	-1.0 to 218.3	72	0.55	5,9,413
Nitrogen oxides										
Nitrous oxide, N_2O	54.061	-1894.7	-19.406	16.572	–	0.157	-88.5 to 36.5	142	0.62	5,9,10,103,118
Nitric oxide, NO	258.32	-4361.0	-115.06	167.15	–	0.585	-156.8 to -2.9	17	0.69	5,413
Nitrogen dioxide, NO_2	33.024	-2276.7	-10.143	8.9510	–	0.852	-11.3 to 158.4	108	0.26	5,10
Carbon oxides										
Carbon monoxide, CO	32.863	-606.91	-12.969	27.551	–	0.044	-200.7 to -140.0	95	0.37	5,9,10,415,646
Carbon dioxide, CO_2	47.544	-1792.2	-16.559	13.833	–	0.223	-56.0 to 31.2	163	0.12	5,9,10,103,413,415,646
Hydrogen halides										
Hydrogen flouride, HF	66.244	-2588.0	-25.140	28.493	-9.9602	0.375	-74.7 to 168.0	51	0.44	5,413
Hydrogen chloride, HCl	136.05	-3047.3	-58.416	95.496	-58.507	0.133	-150.8 to 51.5	66	0.47	5,9,413
Hydrogen bromide, HBr	-351.11	5375.2	161.83	-259.04	157.16	0.080	-83.0 to 90.0	42	0.97	5,168
Hydrogen iodide, HI	33.943	-1777.9	-10.620	6.9457	–	0.036	-59.5 to 151.0	52	[illegible]	[illegible]
Nitrogen hydrides										
Ammonia, NH_3	38.440	-2066.2	-12.105	7.7768	–	0.253	-65.0 to 132.4	190	0.20	5,9,10,12,413,646
Hydrazine, N_2H_4	60.878	-3880.3	-20.575	15.585	-5.0525	0.314	15.0 to 380.0	58	1.50	189,218
Hydrogen oxides										
Water, H_2O	16.373	-2818.6	-1.6908	-5.7546	4.0073	0.344	0.0 to 374.2	117	0.09	413,646
Hydrogen peroxide, H_2O_2	44.791	-4022.7	-13.076	4.5627	–	0.339	-0.01 to 455.0	45	2.44	248,253,257,260
Diatomic gases										
Hydrogen, H_2	5.2366	-46.280	-0.44809	25.290	–	0	-259.4 to -240.2	88	0.17	5,333,646
Nitrogen, N_2	21.623	-455.57	-7.5107	17.214	–	0.033	-210.0 to -146.8	287	0.16	5,10,277,300,331,332,413,646
Oxygen, O_2	5.6486	-411.30	1.8118	-25.042	62.612	020	-219.1 to -118.4	278	0.36	5,9,10,268,303,334,413,548, 646
Inert gases										
Helium, He	2.3826	-2.8323	4.1992	-506.18	38084.1	0	-272.3 to -268.0	67	0.69	306,646
Neon, Ne	1.4691	-70.075	3.0607	-14.361	–	0	-248.2 to -228.7	78	1.25	5,379,646
Argon, Ar	24.018	-542.78	-8.4430	16.824	–	0	-189.4 to -122.3	179	0.18	5,10,341,377,404,646,737
Olefins										
Ethylene, C_2H_4	30.895	-1196.8	-10.153	9.9351	–	0.084	-169.0 to 10.1	262	0.80	9,10,413,415,440,548,646
Propylene, C_3H_6	36.877	-1725.5	-12.057	8.9948	–	0.146	-150.0 to 92.1	208	0.58	413,415,440,548,646
1-Butene, C_4H_8	41.610	-2158.8	-13.580	8.6536	–	0.194	-130.0 to 146.3	72	0.68	413,415,548,646
Alkanes										
Methane, CH_4	22.573	-656.24	-7.3942	11.896	–	0.012	-182.2 to -81.9	250	0.45	9,10,413,415,464,548,646, 735,738,739,742
Ethane, C_2H_6	16.316	-1074.8	-3.1434	4.5534	10.373	0.099	-179.5 to 32.3	128	0.42	9,10,413,415,446,548
Propane, C_3H_8	36.007	-1737.2	-11.666	8.5187	–	0.152	-128.9 to 96.8	105	0.46	413,415,548,646
Xylenes										
o-Xylene, $C_6H_4(CH_3)_2$	56.025	-3955.6	-17.831	7.3259	–	0.312	-20.0 to 358.4	159	0.27	413,415,477,548,646
m-Xylene, $C_6H_4(CH_3)_2$	58.530	-3990.2	-18.835	7.9678	–	0.328	-30.0 to 246.0	105	0.47	413,415,548,646
p-Xylene, $C_6H_4(CH_3)_2$	57.096	-3923.6	-18.309	7.7401	–	0.322	20.0 to 345.0	137	0.16	413,415,477,548,646
Aromatics										
Benzene, C_6H_6	51.204	-3245.7	-16.403	7.540	–	0.208	7.6 to 289.4	205	0.65	9,413,415,497,548,646
Naphthalene, $C_{10}H_8$	192.16	-8336.3	-72.834	56.768	-17.319	0.295	82.9 to 475.0	157	0.94	413,415,548,646
Alkyl aromatics										
Toluene, $C_6H_5CH_3$	115.21	-4918.1	-43.467	38.548	-13.496	0.266	-60.0 to 320.6	203	0.63	413,415,548,645
Ethylbenzene, $C_6H_5C_2H_5$	60.335	-4012.8	-19.569	8.4620	–	0.312	-30.0 to 246.0	138	0.49	413,415,548,646
Cumene, $C_6H_5CH(CH_3)_2$	136.71	-6044.1	-51.360	42.022	-13.746	0.31	-20.0 to 360.0	103	0.26	413,415,548,646
Benzene derivatives										
Chlorobenzene, C_6H_5Cl	-54.872	-975.28	27.850	-37.491	16.625	0.250	-35.1 to 359.2	135	0.78	9,413,415,548,646
Aniline, $C_6H_5NH_2$	18.893	-3104.0	-3.4714	0.02743	–	0.373	77.4 to 426.0	79	0.77	413,415,548,646
Phenol, C_6H_5OH	672.71	-22197.3	-266.67	226.43	-73.731	0.446	67.8 to 420.0	93	1.09	413,415,548
Cycloalkanes										
Cyclopropane, C_3H_6	38.450	-1865.2	-12.578	8.9375	–	0.125	-90.0 to 125.2	50	2.00	415,588,595
Cyclobutane, C_4H_8	211.96	-5392.8	-89.626	123.13	-64.646	0.141	-92.0 to 190.4	28	0.67	10,413,548
Cyclopentane, C_5H_{10}	45.484	-2726.5	-14.599	7.6700	–	0.197	-60.0 to 238.5	63	0.35	413,548,646
Cyclohexane, C_6H_{12}	64.753	-3619.2	-21.753	10.742	–	0.214	-25.4 to 280.3	132	0.82	413,415,548,646
Olefin monomers										
Isobutylene, C_4H_8	37.475	-2038.7	-11.944	7.6217	–	0.198	-140.0 to 144.9	111	0.65	415,548,601,609,613,620,646
Styrene, $C_6H_5CHCH_2$	768.68	-20562.6	-318.53	340.22	-136.67	0.185	-26.9 to 369	81	3.01	413,415,548,611,612,622

Correlation constants: vapor pressure (continued) **Table 24—IV**

$$\log P_v = A + \frac{B}{T} + C \log T + DT + ET^2$$

Compound	A	B	C	$D \times 10^3$	$E \times 10^6$	Acentric factor, ω	Range, °C	No. of data points	Avg. dev., %	References
Diolefins										
1,3 Butadiene, C_4H_6	41.401	−2181.2	−13.451	8.4524	–	0.198	−108.9 to 152.0	204	0.60	10,413,548,630,639,646
Isoprene, C_5H_8	37.675	−2427.2	−11.470	5.3274	–	0.155	78.1 to 210.2	48	0.79	548,620,646
Chloroprene, C_4H_5Cl	11.416	−1785.1	−1.1467	−0.83410	–	0.119	6.4 to 261.7	13	1.03	548,620
Organic oxides										
Ethylene oxide, C_2H_4O	40.723	−2372.4	−12.865	7.3243	–	0.203	73.8 to 196.0	61	0.40	4,13,413,548
Propylene oxide, C_3H_7O	42.063	−2559.5	−13.309	7.3076	–	0.270	−57.8 to 209.1	.22	0.64	413,647,653
Butylene oxide, C_4H_9O	5.0952	−1361.9	0.23768	0.69569	–	0.257	−9.0 to 252.6	3	0.00	4
Primary alcohols										
Methanol, CH_3OH	−42.629	−1186.2,	23.279	−35.082	17.578	0.568	−67.4 to 240.0	203	0.99	9,413,415,529,548,646,696
Ethanol, C_2H_5OH	−10.967	−2212.6	10.298	−21.061	10.748	0.636	−45.0 to 243.0	139	0.96	9,413,529,548,646
n-Propanol, C_3H_7OH	−338.31	5127.5	148.80	−175.79	74.666	0.622	0.0 to 263.7	175	1.18	9,413,415,529,540,646,666, 675
n-Butanol, C_4H_9OH	−458.03	7760.4	199.14	−229.44	95.289	0.581	−1.2 to 289.8	119	1.19	415,529,646,666,675
Chloromethanes										
Methyl chloride, CH_3Cl	42.827	−2100.9	−14.140	9.5055	–	0.160	−99.5 to 143.1	143	0.92	9,10,413,415,548,645,712
Methylene chloride, CH_2Cl_2	65.845	−2732.3	−25.385	35.167	−19.359	0.149	−40.0 to 241.0	49	0.76	548,729
Chloroform, $CHCl_3$	26.828	−2292.6	−7.1860	3.1365	–	0.213	−42.0 to 263.0	68	0.53	413,415,548
Carbon tetrachloride, CCl_4	50.612	−3135.7	−16.313	7.8036	–	0.193	−69.7 to 283.2	261	0.62	5,9,413,415,529,548,646,731

were evaluated. Eq. (24—4) was selected because its results best agreed with experimental data.

Calculated and data values are compared in Fig. 24—4 for oxygen, a representative compound.

Example 24-4—To calculate the vapor pressure of toluene at 0°C, substitute the correlation constants A, B, C, D and E from Table 24—IV and temperature ($T = 0°C = 273.16$ K) into Eq. (24—4):

$$\log P_v = 115.21 - 4918.1/273.16 - 43.467 \log 273.16 + 38.548 \times 10^{-3}(273.16) - 13.496 \times 10^{-6}(273.16)^2$$
$$= 0.827$$
$$P_v = 6.71 \text{ mm Hg}$$

The calculated and data values compare favorably (6.71 vs. 6.75).

Example 24-5—To estimate the vapor pressure of methyl chloride at the high temperature of 140°C, substitute the correlation constants A, B, C and D from Table 24—IV (note that $E = 0$) and temperature ($T = 140°C = 413.16$ K) into Eq. (24—4):

$$\log P_v = 42.827 - 2100.9/413.16 - 14.14 \log 413.16 + 9.5055 \times 10^{-3}(413.16)$$
$$= 4.677$$
$$P_v = 47{,}500 \text{ mm Hg}$$

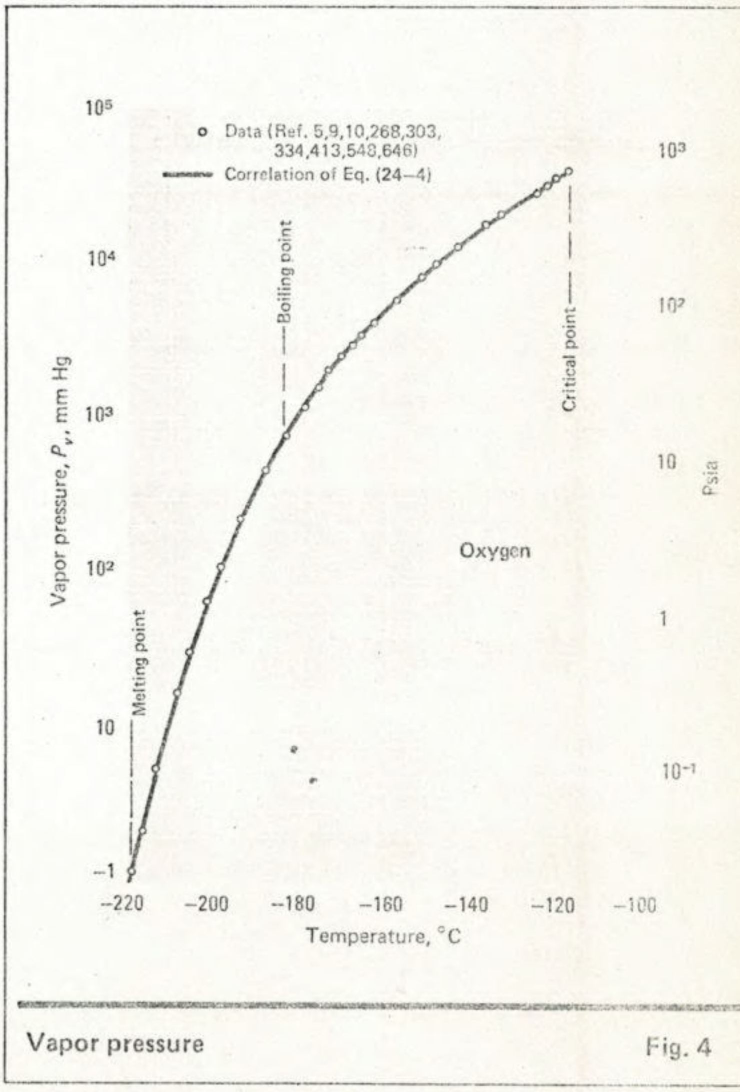
The calculated and experimental values compare favorably (47,500 vs. 47,700).

References

744. Dawe, R. A., others, *Trans. Faraday Soc.*, Vol. 66, No. 1955, 1970.

Other references appear in the previous parts of this series.

(*Continued on p. 162*)



Vapor pressure **Fig. 4**

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This installment ends the series

Part 24 concludes this series on physical, thermodynamic and transport property data of industrially important chemical compounds. Parts 1 through 21 have presented property data graphically, saving the busy engineer from having to make detailed, tedious calculations. Parts 22 and 23, as does Part 24, have provided extensive tables of constants for calculating properties with a computer or hand calculator by means of standardized correlations.

Titles, issue dates and page numbers of all the parts of the series are here tabulated for your convenience:

By way of closing, Dr. Yaws would like to ask that when you judge this series you heed the words of English lexicographer and author Samuel Johnson, who in 1755 wrote about his dictionary (one of the first compiled): "In this work, when it shall be found that much is omitted, let it not be forgotten that much likewise is performed . . ."

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