

# DIMETHYL ETHER

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(Synonym: Methyl Ether)

[Formula:  $(\text{CH}_3)_2\text{O}$ ]

## DESCRIPTION

Dimethyl ether is a flammable, colorless gas with a slight ethereal odor at room temperature and atmospheric pressure. It is shipped as a liquefied gas under its own vapor pressure of  $530.9 \text{ kN/m}^2$  [5.24 atm; 77.0 lbf/in<sup>2</sup> absolute (psia)] at 70 °F.

Dimethyl ether in the vapor phase absorbs at 1122 and 940  $\text{cm}^{-1}$ , corresponding with the asymmetrical and symmetrical stretching vibration of the C-O-C bond, respectively (1).

See Figures 1 and 2 for infrared spectra of gaseous dimethyl ether.



**MATHESON GAS PRODUCTS**

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*Matheson unabridged gas data book 1974-*

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Molecular Weight .....	46.069
One Mole of $(\text{CH}_3)_2\text{O}$ .....	0.046 069 kg
Boiling Point @ 101 325 N/m <sup>2</sup> (1 atm)(2) .....	248.31 K (-12.71 °F)
Freezing Point (2) .....	131.66 K (-222.68 °F)
Critical Temperature (2) .....	400.05 K (260.42 °F)
Critical Pressure (2) .....	5 268.9 kN/m <sup>2</sup> (52.0 atm)
Critical Volume (2) .....	170.0 cm <sup>3</sup> /mol (3.683 dm <sup>3</sup> /kg)
Critical Density (2) .....	0.271 kg/dm <sup>3</sup>
Critical Compressibility Factor (2) .....	0.269
Latent Heat of Fusion (3)	
@ 131.66 K .....	107.27 kJ/kg (25.62 kcal/kg)
Flammable Limits In Air (4) .....	3.4-18.0% (by volume)
Autoignition Temperature (5) .....	623 K (662 °F)
Refractive Index, Liquid @ Saturation Pressure, $n_D$ (2)	
@ 293.15 K .....	1.301 8
@ 298.15 K .....	1.298 4

Density, Gas @ 101 325 N/m<sup>2</sup> (1 atm), d<sub>v</sub> (calculated)

<u>Temperature, K</u>	<u>d<sub>v</sub>, kg/m<sup>3</sup></u>
273.15	2.094 5
293.15	1.951 3
298.15	1.918 55 (3)
313.15	1.825 8
333.15	1.716 3
353.15	1.617 1
373.15	1.531 9

Conversions: °C=K-273.15; °F=9/5(K-273.15)+32; multiply kg/m<sup>3</sup> values by 0.062 428 to obtain lb/ft<sup>3</sup> values.

Specific Gravity, Gas @ 101 325 N/m<sup>2</sup> (1 atm)(Air=1)(calculated)

@ 273.15-373.15 K ..... 1.621

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Density, Liquid @ Saturation Pressure,  $d_L$  (6)

<u>Temperature, K</u>	<u><math>d_L</math>, kg/dm<sup>3</sup></u>
248.31	0.724 0
273.35	0.690 3
293.15	0.668 9 (2)
298.15	0.661 2 (2)
303.00	0.645 8
329.20	0.601 2
353.30	0.552 2
369.67	0.504 2
383.65	0.455 0
394.27	0.395 0

Conversions:  $^{\circ}\text{C} = \text{K} - 273.15$ ;  $^{\circ}\text{F} = 9/5(\text{K} - 273.15) + 32$ ; multiply kg/dm<sup>3</sup> values by 62.428 to obtain lb/ft<sup>3</sup> values.

Vapor Pressure (2)

Vapor pressure data below 101 325 N/m<sup>2</sup> (1 atm) are shown below. The values have been calculated by the following Antoine vapor pressure equation:

$$\log_{10} p = A - \frac{B}{C+t} \quad \text{or} \quad t = \frac{B}{A - \log_{10} p} - C$$

in which  $p = \text{mmHg}$  and  $t = ^\circ\text{C}$ , and the constant A, B, and C have the values of 7.316 46, 1 025.56, and 256.05, respectively.

<u>Temperature, K</u>	<u>Vapor Pressure</u>	
	<u>kN/m<sup>2</sup></u>	<u>mmHg</u>
179.45	1.333	10
187.55	2.666	20
196.55	5.333	40
203.28	7.999	60
206.55	10.659	80
210.01	13.324	100
221.59	26.659	200
229.13	39.993	300
234.64	53.327	400
239.21	66.652	500
243.08	79.986	600
246.47	93.320	700
248.31	101.325	760

Conversion:  $^{\circ}\text{C} = \text{K} - 273.15$ .

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Vapor pressure data above 101.325 kN/m<sup>2</sup> (1 atm) are listed below (6).

<u>Temperature, K</u>	<u>Vapor Pressure</u>	
	<u>kN/m<sup>2</sup></u>	<u>atm</u>
273.15	255.339	2.52
282.40	362.744	3.58
289.95	464.069	4.58
296.90	571.473	5.64
306.70	758.924	7.49
319.28	1 044.661	10.31
329.17	1 328.371	13.11
337.83	1 616.134	15.95
353.25	2 243.336	22.14
363.40	2 715.510	26.80
373.05	3 256.586	32.14
383.72	3 933.437	38.82
389.97	4 398.518	43.41
395.35	4 830.163	47.67
400.05 (C.T.)	5 268.900	52.00 (C.P.)

Conversions: °C=K-273.15; °F=5/9(K-273.15)+32; divide kN/m<sup>2</sup> values by 6.894 757 to obtain lbf/in<sup>2</sup> absolute (psia) values.

See Figure 3 for vapor pressure curve.

Latent Heat of Vaporization,  $\Delta H_v$ 

[calculated by the Watson correlation  $\Delta H_{v2} = \Delta H_{v1} [(1 - Tr_2)/(1 - Tr_1)]^{0.38}$  as described by Reid and Sherwood (7)]

<u>Temperature, K</u>	<u><math>\Delta H_v</math>, kJ/kg</u>
203.15	516.146
223.15	494.660
243.15	475.508
248.31	467.100 (3)
253.15	461.029
273.15	436.037
293.15	411.935
313.15	377.510
333.15	342.384

Conversions:  $^{\circ}\text{C} = \text{K} - 273.15$ ; divide kJ/kg values by 4.184 to obtain kcal/kg values.

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Viscosity, Gas @ 101 325 N/m<sup>2</sup> (1 atm),  $\mu_v$  (8)

<u>Temperature, K</u>	<u><math>\mu_v</math>, cP (1 cP=10<sup>-3</sup> N•s/m<sup>2</sup>)</u>
216.24	0.006 58
231.99	0.007 03
249.76	0.007 55
264.48	0.007 97
273.02	0.008 25
284.86	0.008 62
291.26	0.008 83
296.05	0.008 99

Conversion: °C=K-273.15.



Thermal Conductivity, Gas @ 101 325 N/m<sup>2</sup> (1 atm),

[calculated by the Bromley technique as described by Reid and Sherwood (9)]

<u>Temperature, K</u>	<u><math>\kappa \times 10^6</math>, J·cm/(s·cm<sup>2</sup>·K)</u>
273.15	138.1
298.15	155.2

Conversions: °C=K-273.15; divide  $\kappa \times 10^6$  J·cm/(s·cm<sup>2</sup>·K) values by 4.184 to obtain  $\kappa \times 10^6$  cal·cm/(s·cm<sup>2</sup>·K) values.

Solubility In Water (10)

@ 291.15 K (18.0 °C) and 101 325 N/m<sup>2</sup> (1 atm) ..... 3 700 cm<sup>3</sup>/100 cm<sup>3</sup>H<sub>2</sub>O

Surface Tension, Vapor,  $\gamma$  (11)

<u>Temperature, K</u>	<u><math>\gamma \times 10^7</math>, N/m</u>
233.15	21
253.15	18
263.15	16

Conversions: °C=K-273.15; multiply  $\gamma \times 10^7$  N/m values by 1.000 to obtain dyn/cm values.

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### Thermodynamic Data

The following data are reported for  $(\text{CH}_3)_2\text{O}$  for the ideal gas state at 298.15 K (25.00 °C)(12).

Enthalpy of Formation, $\Delta H_f^\circ$ .....	-184.054 kJ/mol (-43.99 kcal/mol)
Gibbs Energy of Formation, $\Delta G_f^\circ$ .....	-112.675 kJ/mol (-26.93 kcal/mol)
Enthalpy Difference, $H_{298}^\circ - H_0^\circ$ .....	14.083 kJ/mol (3.366 kcal/mol)
Entropy, $S^\circ$ .....	266.270 J/(mol·K) (63.64 cal/(mol·K))
Heat Capacity, $C_p^\circ$ .....	64.392 J/(mol·K) [15.39 cal/(mol·K)]

The following thermodynamic data are reported for liquid  $(\text{CH}_3)_2\text{O}$  at 298.15 K (25.00 °C)(2).

Enthalpy of Formation .....	-203.342 kJ/mol (-48.6 kcal/mol)
Gibbs Energy of Formation .....	-108.784 kJ/mol (-26.0 kcal/mol)
Entropy .....	188.280 J/(mol·K) [45.0 cal/(mol·K)]
Heat Capacity .....	110.039 J/(mol·K) [26.3 cal/(mol·K)]



Heat Capacity, Liquid,  $C_s$  (3)

<u>Temperature, K</u>	<u><math>C_s</math>, J/(mol·K)</u>
137.17	98.130
148.74	98.323
162.91	98.381
172.94	98.574
186.17	99.094
196.29	99.287
205.58	99.711
217.95	100.135
228.72	100.925
234.32	101.060
245.47	103.142

Conversions:  $^{\circ}\text{C} = \text{K} - 273.15$ ; divide J/(mol·K) values by 4.184 to obtain cal/(mol·K) values.

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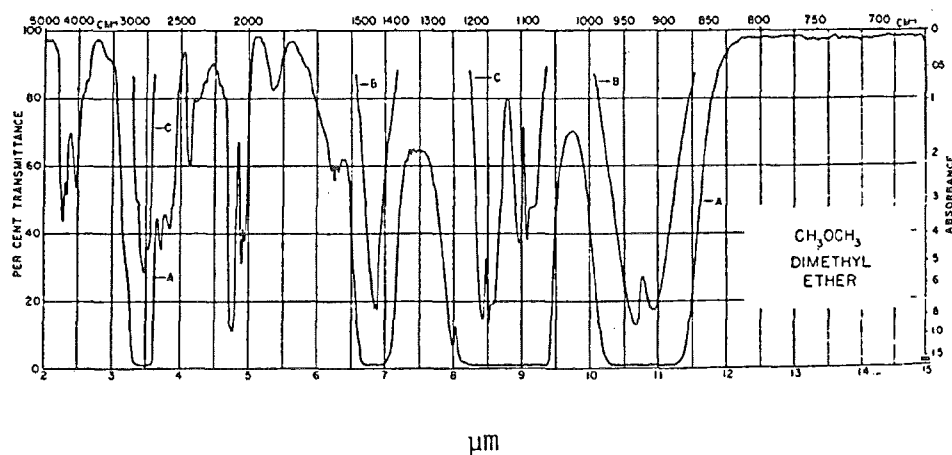


Figure 1. Infrared spectrum of dimethyl ether, using 10-cm cell and sodium chloride optics. Curves A, B, and C were obtained at pressures of 93 859  $\text{N/m}^2$  (704 mmHg), 10 666  $\text{N/m}^2$  (80 mmHg), and 2 400  $\text{N/m}^2$  (18 mmHg), respectively (13.)



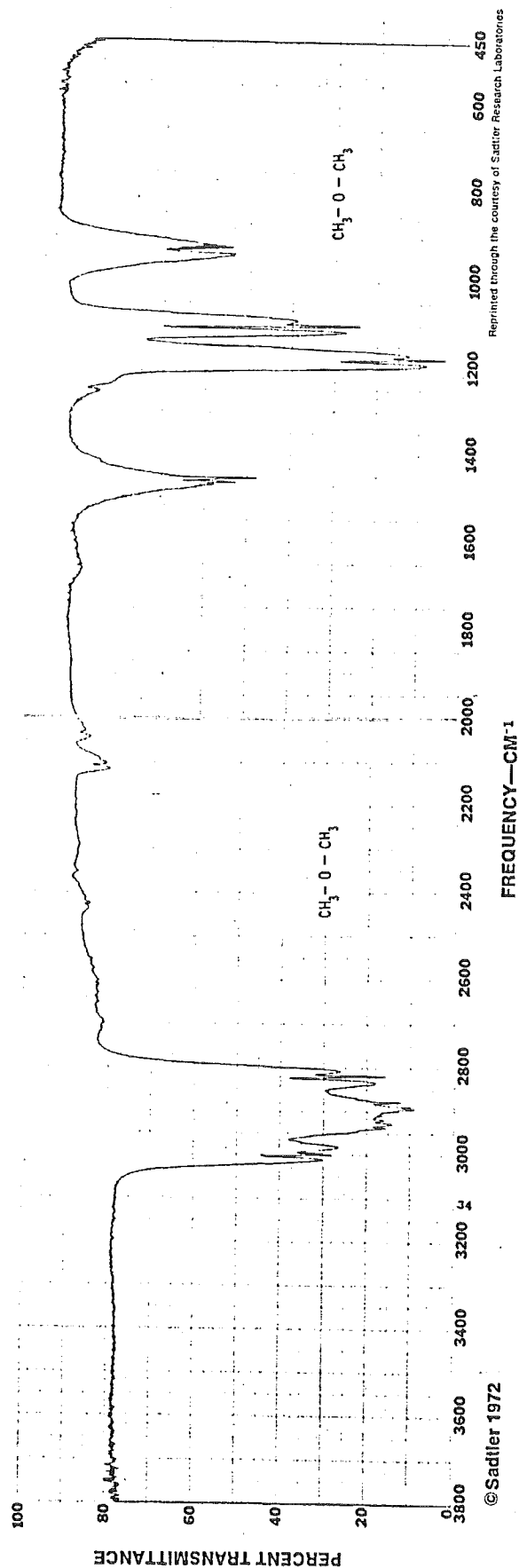


Figure 2. Infrared spectrum of gaseous dimethyl ether over the frequency range 3 800-450 cm<sup>-1</sup>; 10-cm path length cell, with KBr windows; cell pressure: 4 000 N/m<sup>2</sup> (30 mmHg)(14).

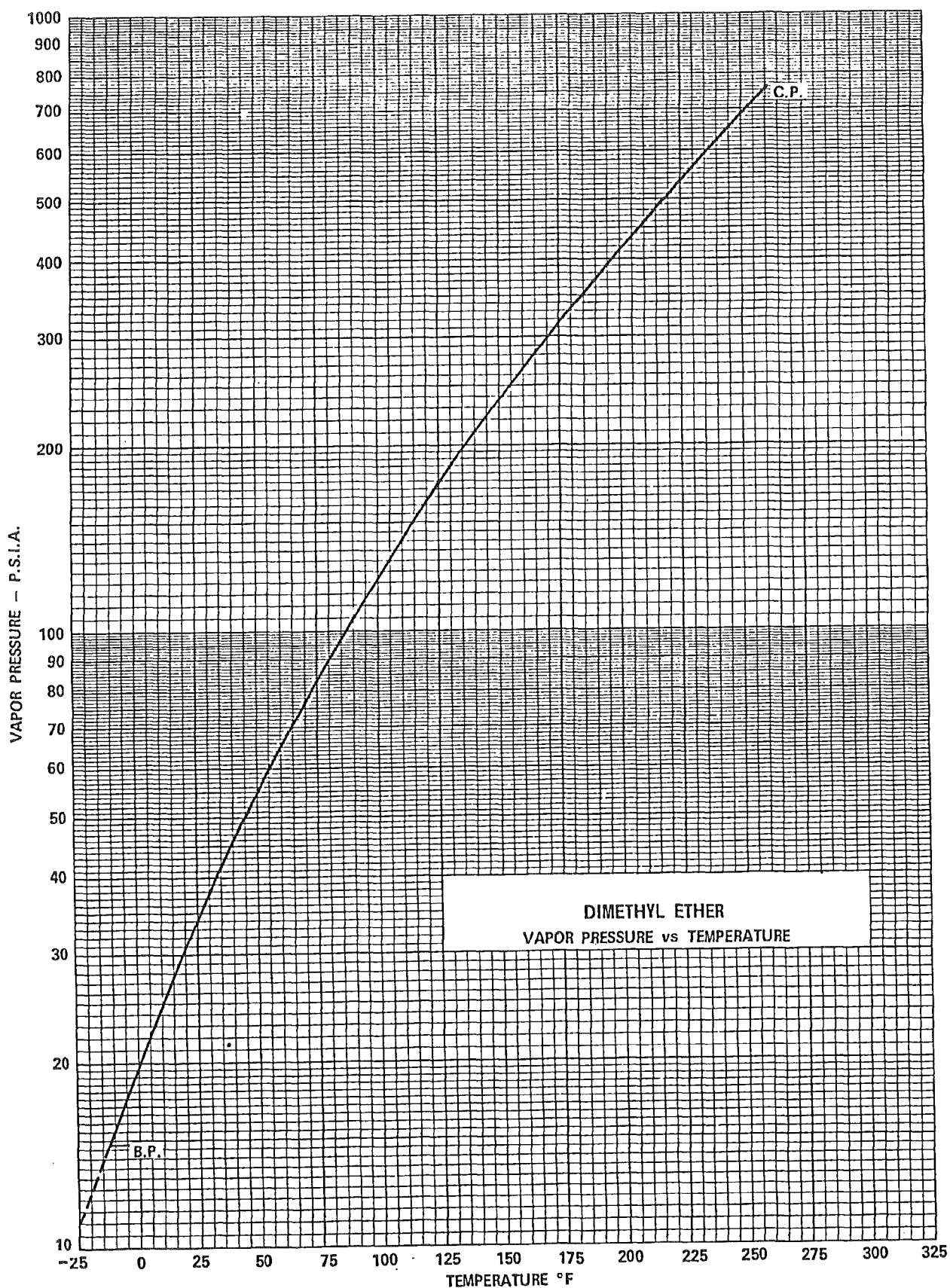


Figure 3. Conversions:  $^{\circ}\text{C} = 5/9(^{\circ}\text{F} - 32)$ ;  $\text{K} = 5/9(^{\circ}\text{F} - 32) + 273.15$ ; multiply psia values by 6.894 757 to obtain  $\text{kN/m}^2$  values.

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