

# DIMETHYL ETHER

(Synonyms: Methyl Ether; Methyl Oxide)

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

## PHYSICAL CONSTANTS

Molecular Weight	46.07
Vapor Pressure @ 68°F. (Cylinder Pressure)	62.3 p.s.i.g. (4.4 kg./cm. <sup>2</sup> gauge)
Specific Volume @ 70°F., 1 atm.	8.4 cu. ft./lb. (524.4 ml./g.)
Boiling Point @ 1 atm.	-12.68°F. (-24.82°C.)
Freezing Point @ 1 atm.	-222.7°F. (-141.5°C.)
Density, Liquid @ b.p.	0.724 g./ml.
Density, Gas @ 25°C.	1.1985 g./l.
Critical Temperature	263.8°F. (128.8°C.)
Critical Pressure	771.75 p.s.i.a. (52.5 atm.) (54.3 kg./cm. <sup>2</sup> absolute)
Critical Density	0.2714 g./ml.
Latent Heat of Vaporization @ b.p.	111.64 cal./g.
Latent Heat of Fusion @ m.p.	25.62 cal./g.
Specific Heat, Gas @ 25°C., 1 atm., $C_p$	0.3408 cal./g.(°C.)
Specific Heat Ratio, Gas @ 6-30°C., 1 atm., $C_p/C_v$	1.11
Flammable Limits in Air	3.4-18.0% (by volume)
Autoignition Temperature	662°F. (350°C.)
Surface Tension @ -40°C.	21.0 dynes/cm.
Solubility in Water @ 18°C., 1 atm.	7% (by weight)
Viscosity, Gas @ 20°C., 1 atm.	0.00855 centipoise
Entropy, Gas @ 25°C., 1 atm.	63.72 cal./mole(°C.) [1.38 cal./g.(°C.)]

**DESCRIPTION** — Dimethyl ether is a flammable, colorless gas with a slight ethereal odor. It is shipped as a liquefied gas under its own vapor pressure of about 60 p.s.i.g. at 70°F. It is soluble in water (7% by weight) but far more soluble in ethyl alcohol (at 18°C., 3700 cc. dimethyl ether dissolves in 100 g. of ethanol).

**SPECIFICATIONS** — Dimethyl ether as supplied by Matheson Gas Products has the following specifications:

Component	Weight Percent
Dimethyl ether	99.0 min.
Methanol	0.5 max.
Methyl formate	0.25 max.
Carbon dioxide	0.25 max.

The average purity is 99.5-99.8%.

**USES** — Dimethyl ether finds commercial use as a refrigerant. It has also been used as a solvent, as an extraction agent, as a propellant in aerosols, and as a fuel for welding, cutting, and brazing.

Dimethyl ether readily forms complexes with inorganic compounds, e.g., boron trifluoride. It is an excellent methyl-

ating agent, e.g., for conversion of aniline into dimethylaniline in the dye industry.

**TOXICITY** — Dimethyl ether produces anesthesia and over-exposure will cause toxic effects. It has been reported that the minimal narcotic concentration for mice was 12% by volume as compared with 3.4% by volume for diethyl ether. It is, therefore, about one-fourth as potent as diethyl ether as a narcotic agent. It has been found that dimethyl ether produced anesthesia in cats in concentrations of 65%; in concentrations of 85%, dimethyl ether caused profound anesthesia with gradual cessation of respiration. The effects of dimethyl ether in humans has been studied and it has been reported that concentrations of 5 and 7.5% caused feeling of mild intoxication but no objective symptoms beyond a slight lack of attention after 12 minutes inhalation of the stronger mixture. The inhalation of 8.2% caused some incoordination and blurring of vision after 21.5 minutes, and after 30 minutes analgesia of the face and rushing of blood through the head. Dimethyl ether in concentrations of 10% caused various narcotic symptoms after 10-20 minutes, and sickness after 64 minutes. In a concentration of 14.4%, dimethyl ether produced unconsciousness after 36 minutes, and with 20% dimethyl ether, unconsciousness was produced in 17 minutes.

# DIMETHYL ETHER

**PRECAUTIONS IN HANDLING AND STORAGE** — The hazards due to the handling of dimethyl ether stem mainly from its extreme flammability. Store and use dimethyl ether cylinders in well-ventilated areas away from heat and all sources of ignition such as flames and sparks. Never use flames to detect flammable gas leaks. Do not use dimethyl ether around sparking motors or other non-explosion-proof equipment. Do not store reserve stocks of dimethyl ether cylinders with cylinders containing oxygen, or other highly oxidizing or flammable materials. Ground all equipment and cylinders before use.

In addition, the general rules listed in Appendix I should be observed.

**LEAK DETECTION** — Lines and equipment to contain dimethyl ether should be pretested for leaks with nitrogen, using soapy water to detect leaks. Matheson Leak Detector, Model 8023, may also be used to detect leaks of dimethyl ether.

**DISPOSAL OF LEAKING CYLINDERS** — For disposal procedure see Appendix II-A.

**MATERIALS OF CONSTRUCTION** — Since dimethyl ether is noncorrosive, any common or commercially available material may be used. However, piping systems or vessels to contain dimethyl ether should be adequately designed to withstand the pressures to be encountered.

**CYLINDER AND VALVE DESCRIPTION** — Cylinders of dimethyl ether are of the low pressure type having a rated service pressure of 150 p.s.i.g. or more. Cylinders of dimethyl ether are equipped with valves having Compressed Gas Association valve outlet No. 510 with a thread size of 0.885 inch

diameter-14 threads per inch, left-hand internal threads, accepting a bullet-shaped nipple. (See Figure 1 for an illustration of the valve and its mating connection).

Lecture bottles have a special 5/16"-32 threads per inch, female valve outlet and a 9/16"-18 threads per inch, male dual valve outlet (see Figure 2).

**SAFETY DEVICES** — Cylinders of dimethyl ether have spring-loaded safety relief devices. These devices will function when the cylinder is overheated and release gas until the pressure returns to a safe level.

## RECOMMENDED CONTROLS

### Automatic Pressure Regulators

Single stage regulator No. 1P-510 is recommended for dimethyl ether service. The regulator has a brass body with brass internal parts plus a fabric-reinforced neoprene rubber diaphragm and neoprene seat. It has a delivery pressure range of 4-35 p.s.i.g. It contains a delivery pressure gauge and a needle valve for accurate flow control. The tank gauge is omitted because, in the case of dimethyl ether, the pressure is no indication of cylinder content; the vapor pressure will remain constant as long as any liquid remains in the cylinder. Cylinder contents should be determined by weighing.

For low pressure regulation, Matheson Gas Products supplies a regulator which has an oversize pancake body of die cast aluminum and Buna N diaphragm. Three pressure ranges are available as follows:

Model No.	Delivery Pressure Range
70B-510	2-15" water column
70-510	0.5-5.0 p.s.i.g.
70A-510	5-10 p.s.i.g.

This regulator is designed primarily for liquefied petroleum gases where it is particularly suited for fuel gas burner operation, since its steady low pressure delivery permits a stable flame to be obtained.

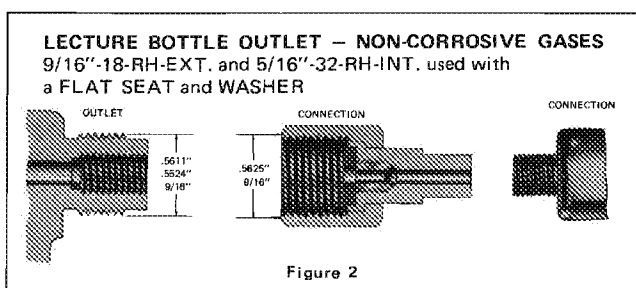
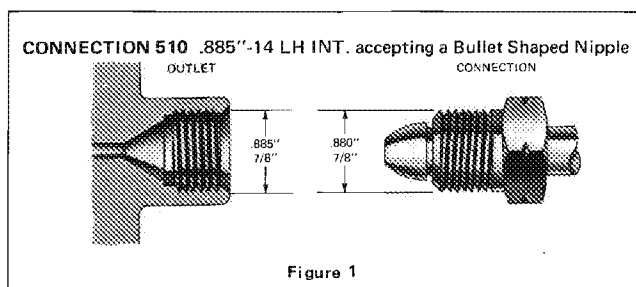
### Manual Valves

Matheson manual needle No. 50-510, a brass bar stock valve, is available for direct connection to the cylinder valve outlet. This valve may be equipped with a variety of outlets, such as a serrated hose end, 1/4" compression fitting, or 1/4" NPT male or female pipe. This valve is used mainly for intermittent flow control but this requires close supervision. It should not be used as a pressure control since dangerous pressures may develop if a system or line becomes plugged. A No. 31B needle valve is recommended for use with lecture bottles.

### Flowmeters

Flowmeters of the rotameter type such as Matheson 600 series flowmeters are recommended where accurate flow rates must be known.

Electronic mass flowmeters, such as Matheson series No. 8110 and No. 8116, should be used where accurate readings



are required. Calibration is unaffected by temperature and pressure changes, and flow rates may be recorded from the instrument's electrical output.

**SHIPPING REGULATIONS** — Dimethyl ether is classified by the D.O.T. as a flammable, compressed gas and is shipped under the required "Red Gas Label".

**COMMERCIAL PREPARATION** — Dimethyl ether is prepared by the dehydration of methanol with sulfuric acid or by dehydration over alumina at high pressures and temperatures.

**CHEMICAL PROPERTIES** — Dimethyl ether is not attacked by boiling alkalis. Halogenation gives a series of halogen sub-

stituted ethers. Dimethyl ether is cleaved by hydriodic acid at temperatures of 100°C. At low temperatures, dimethyl ether forms a series of addition compounds with the halogens and halogen hydrides. It forms an addition compound with boron trifluoride. Dimethyl ether reacts with oleum to give dimethyl sulfate. It can be oxidized catalytically to formaldehyde.

Dimethyl ether reacts with carbon monoxide to give acetic anhydride and (or) methyl acetate. It reacts with acetic acid to give methyl acetate. It reacts with phthalic anhydride to give dimethyl phthalate. It methylates phenol to give anisole. Dimethyl ether reacts with hydrogen cyanide to form acetonitrile.

## PHYSICAL DATA

### Vapor Pressure

#### VAPOR PRESSURE OF DIMETHYL ETHER BELOW ATMOSPHERIC PRESSURE<sup>1</sup>

Temperature °C.	Pressure, mm. Hg
-101.53	4.97
- 95.45	8.46
- 94.95	8.82
- 89.75	13.80
- 78.23	35.13
- 70.67	60.91
- 65.26	87.80
- 60.04	122.37
- 55.15	164.34
- 49.91	221.71
- 45.11	287.53
- 40.03	373.61
- 35.11	475.55
- 31.19	571.59
- 27.68	670.27
- 24.92	756.42

#### VAPOR PRESSURE OF DIMETHYL ETHER ABOVE ATMOSPHERIC PRESSURE<sup>2</sup>

Temperature °C.	Pressure, atmospheres
0.00	2.52
9.25	3.58
16.80	4.58
23.75	5.64
25.40	6.05
33.55	7.49
46.13	10.31
48.50	10.91
49.75	11.22
56.02	13.11
64.68	15.95
80.10	22.14
90.25	26.80
99.20	31.75
99.90	32.14
110.57	38.82
112.80	40.43
113.75	41.24
116.82	43.41
117.80	44.06
122.20	47.67
125.90	51.00
126.90	52.00

See Figure 3 for vapor pressure curve.

## REFERENCES

<sup>1</sup>Kennedy, R., Sagenkahn, M., and Aston, J., J. Amer. Chem. Soc. 63, 2267 (1941).

<sup>2</sup>Cardoso, E., and Bruno, A., J. Chim. Phys. 20, 347 (1923).

