

HP DME

Aerosol Propellant

Technical Information

Introduction

HP DME (dimethyl ether) is a medium to high pressure propellant and an excellent solvent that is very soluble in water. This bulletin presents technical information on its physical properties, chemical stability, solubility, material compatibility, and toxicity. It also discusses the flammability properties of HP DME and those of mixtures of HP DME and propellants and solvents commonly used in the aerosol industry. Reviews of the properties and uses of dimethyl ether have been published (References 1-8).

Physical Properties

Table 1 lists selected physical properties of HP DME. Figures 1 and 2 show the saturated vapor pressures of HP DME over the temperature ranges 0°F to 160°F (-17.8°C to 71.1°C) and 70°F to 130°F (21.1°C to 54.4°C), respectively. The latter temperature range is of particular interest to the aerosol industry. Similarly, Figures 3 and 4 show respectively liquid densities of HP DME over the same two temperature ranges (References 9 and 10).

Flammability

HP DME is a flammable propellant. Its lower explosive limit (LEL) in air is approximately 60 percent larger than that of propane, i.e., comparing HP DME and propane, about 60 percent more HP DME than propane can be vaporized in air before the lower explosive limit is reached. Similarly, the LEL of HP DME is approximately 85 percent larger than that of isobutane. Furthermore, the heat of combustion of HP DME is about 35 percent less than the heat of combustion of hydrocarbon propellants. Nonetheless, pure HP DME is extremely flammable and only trained personnel using proper equipment should handle it.

Table 1. Physical Properties of HP DME

Formula	CH ₃ OCH ₃
Molecular Weight	46.07
Boiling Point, °F	-12.7
Vapor Pressure, psig	
70°F	63
130°F	174
Liquid Density, g/cc	
70°F	0.66
130°F	0.60
Solubility (wt % at 70°F/autogeneous pressure)	
HP DME in Water	35
Water in HP DME	6
Kauri-Butanol Value	60
Solubility Parameter	7.3
Flammability Limits in Air, Vol %	3.4 - 18.0

The flammability of HP DME can be suppressed by HP 134a. Blends of HP DME with nonflammable HP 134a propellant remain nonflammable up to about 3.5 weight percent concentration of the ether.

Mixtures of HP DME and halogenated solvents such as methylene chloride and 1,1,1-trichloroethane show significantly reduced or zero flame extension and flashback relative to the pure propellant.

Water is also effective in reducing the flame extension of HP DME propellant. To illustrate, a blend of 80 percent HP DME, 14 percent water, and 6 percent ethanol exhibits zero flame extension.

Stability

HP DME is a chemically stable compound that reacts or decomposes only under rather severe conditions. In aqueous solutions, the propellant is hydrolytically stable over a wide pH range.

HP DME does not form peroxides under conditions normally encountered in the aerosol industry. HP DME in the pure state or in formulations formed no detectable peroxide in six months storage tests at 104°F (40°C). Aerosol packages filled with HP DME in the pure state or with HP DME and compressed air up to 75 psig (5.2 bar) formed no detectable peroxide. Large quantities of dimethyl ether in the presence of chlorinated solvents and chlorofluorocarbons produced no detectable amounts of bischloromethyl ether.

Solubility

HP DME is unique among aerosol propellants in that it has high solubility in both polar and nonpolar solvents. It has a Kauri-butanol value of 60 and is completely miscible with most organic solvents, such as hydrocarbons, halogenated alcohols, ketones, glycols, ethers, amides, esters, aldehydes, and amines. HP DME is also a very good solvent for many types of polymers, e.g., hair spray and paint resins.

The combination of water and ethanol is of special interest as solvent for HP DME. HP DME has 35 weight percent solubility in water and is the only liquefied gas aerosol propellant that allows formulation of single phase products with large amounts of water. In addition, only 6 weight percent of ethanol produces completely miscible 3-component systems with all proportions of HP DME and water.

Vapor Pressures of Mixtures

A high concentration of HP DME is required in water-ethanol solutions to give vapor pressures useful for aerosol products. For example 28 percent HP DME in pure water and 59 percent HP DME A in pure ethanol are required to produce an internal pressure of 50 psig (3.4 bar) in aerosol containers. This is in contrast to less water soluble propellants.

An aerosol propellant obtained by blending HP DME offers product formulation advantages. HP DME is an excellent solvent but pressure increases slowly as its concentration increases in a formulation. Selected combinations of two propellants and solvents provide interesting formulating possibilities. By varying proportions of two propellants, the formulator can optimize pressure, solvency, and total

propellant content to achieve a range of product performance characteristics.

Material Compatibility

At low to moderate concentrations of HP DME, aerosol formulations can be packaged in most currently used lined or unlined tinplate or aluminum cans. However, only unlined containers are recommended when HP DME is present at more than 25 weight percent to avoid attack of the container lining. Storage tests should be performed on individual formulations to verify compatibility with the container.

In aqueous compositions, particularly non-foaming products, corrosion inhibitors are recommended for tinplate containers. Demineralized water that contains less than 15 ppm chloride ion should be used and air should be removed from the headspace with vacuum and/or purging with an inert gas.

Valve cup and stem gaskets should also be chosen carefully. For mounting cups, polyethylene sleeve gaskets and laminated polypropylene gaskets generally perform very well. Stem gaskets of neoprene or butyl rubber are recommended. As with containers, storage tests should be performed and valve suppliers should be consulted with regard to specific formulations, particularly those with high HP DME concentrations.

Toxicity

HP DME has low acute and chronic toxicity. Although an ACGIH TLV® has not been established for dimethyl ether, a value of 1,000 ppm seems appropriate based on its low toxicity. The main physiological action is that of "weak anesthesia" at high inhaled levels. Weak cardiac sensitization has been observed in animals exposed to HP DME at about 200,000 ppm, a circumstance that would likely occur only in gross misuse situations or accidental release of the propellant.

A two-year inhalation study and carcinogenicity bioassay at exposure levels of up to 20,000 ppm showed no compound-related effects in the test animals examined for gross signs, body weight, hematology, urine analysis, blood chemistry, and gross and histopathologic examination of tissues at any exposure level, Figure 1. HP DME Vapor Pressure. HP DME showed no signs of carcinogenicity in the study and in separate reproductive studies, HP DME has shown no evidence of mutagenicity or teratogenicity. Based on all these studies, the products have been approved by Chemours for general aerosol use, including personal products.

References

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5. Daly, Jr., J. J., "A New Era In Aerosol Propellants," *Drug and Cosmetic Industry*, Volume 134, Number 2, p. 40 (1984).
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Figure 1. HP DME Vapor Pressure

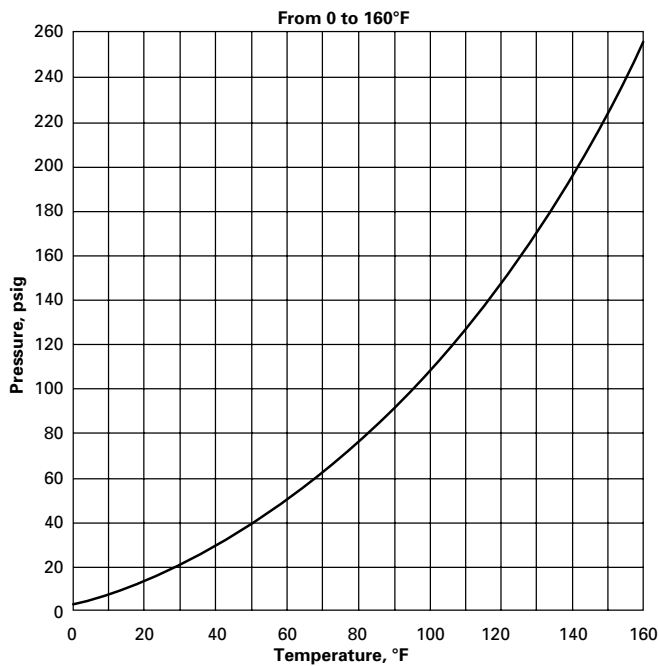


Figure 2. HP DME Vapor Pressure

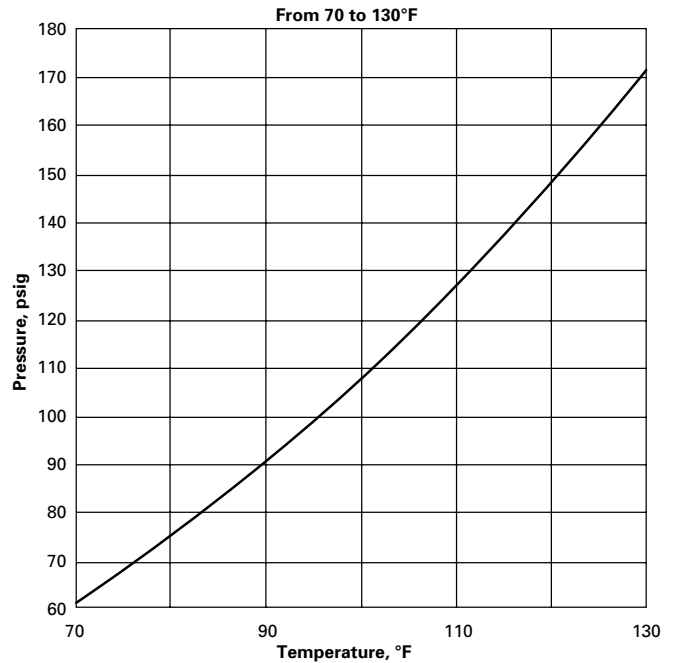


Figure 3. HP DME Liquid Density

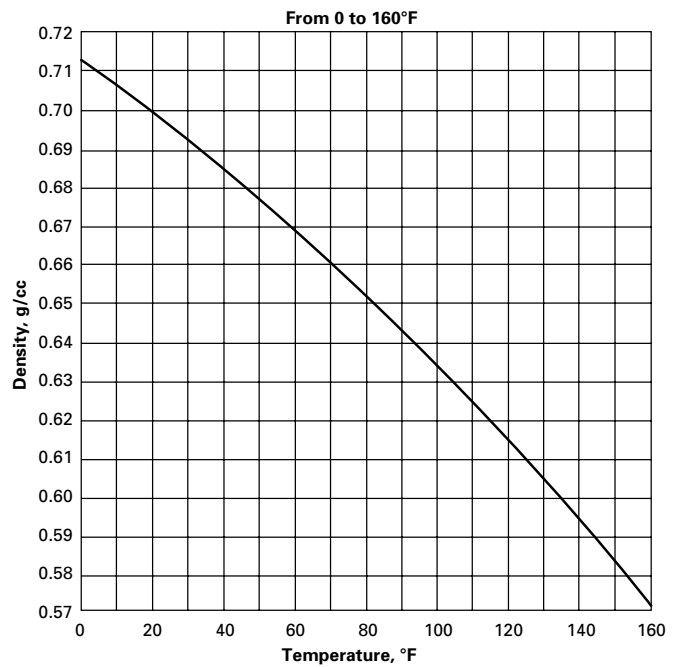
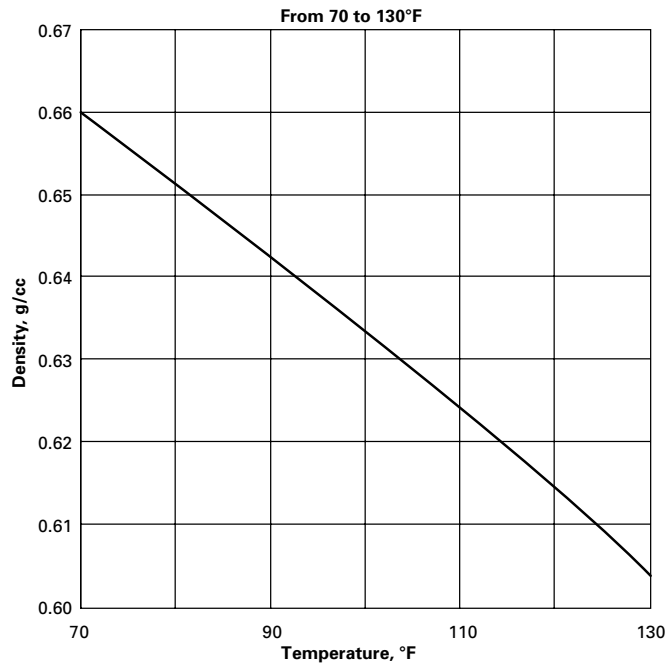


Figure 4. HP DME Liquid Density

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Replaces: H-00250-2

C-10918 (7/16)