

Safety Data Sheet

Dimethyl sulfate

Division of Safety
National Institutes
of Health



WARNING!

THIS COMPOUND IS ABSORBED THROUGH THE SKIN AND RESPIRATORY AND INTESTINAL TRACTS. IT MAY IRRITATE TISSUES AND IS TOXIC, CARCINOGENIC, AND MUTAGENIC. IT IS MODERATELY FLAMMABLE. AVOID FORMATION AND BREATHING OF AEROSOLS OR VAPORS.

LABORATORY OPERATIONS SHOULD BE CONDUCTED IN A FUME HOOD, GLOVE BOX, OR VENTILATED CABINET.

AVOID SKIN CONTACT: IF EXPOSED, WASH WITH 5% SODIUM BICARBONATE SOLUTION OR SOAP AND WATER.

FOR EYE EXPOSURE, IRRIGATE IMMEDIATELY WITH LARGE AMOUNTS OF WATER. FOR INGESTION, DRINK PLENTY OF WATER, SODIUM BICARBONATE SOLUTION, OR MILK. INDUCE VOMITING. FOR INHALATION, REMOVE VICTIM PROMPTLY TO CLEAN AIR. INITIATE RESCUE BREATHING PROCEDURES IF NECESSARY. REFER TO PHYSICIAN.

IN CASE OF LABORATORY SPILL, WEAR PROTECTIVE CLOTHING DURING CLEANUP. AVOID SKIN AND EYE CONTACT OR BREATHING OF AEROSOLS OR VAPORS. WASH DOWN AREA WITH SOAP AND WATER. DISPOSE OF WASTE SOLUTIONS AND MATERIALS APPROPRIATELY.

A. Background

Dimethyl sulfate (DMS) is a moderately flammable, colorless, somewhat oily liquid with little or no odor. It is a strong irritant to skin, eyes, and lungs, moderately toxic, carcinogenic, and mutagenic in animals as would be expected of a strong alkylating agent. Its principal use is as a methylating agent in the laboratory and in the manufacture of many organic chemicals.

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Prepared by the Environmental
Control and Research Program

The threshold limit value for DMS is 0.1 ppm (0.5 mg/m³) as a time-weighted 8-hour average (ACGIH, 1987).

Chemical and Physical Data

1. Chemical Abstract No.: 77-78-1

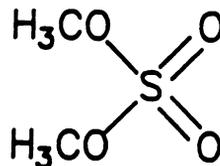
2. Synonyms:

Methyl sulfate

Sulfuric acid, dimethyl ester (9CI)

3. Molecular formula:
C₂H₆O₄S

structure:



weight:
126.13

Density: Liquid, 1.3283 g/cm³ at 20°C; vapor, (air = 1) 4.35.

Absorption spectroscopy: UV: $\lambda = 265$.

Volatility: Vapor pressure is 0.54 mm Hg at 20°C. (For a complete temperature-vapor pressure plot see Rossmann and Grill [1952].)

Solubility: 2.8 g/100 ml of water at 18°C. Miscible with or highly soluble in ethanol, benzene, and other organic solvents. Sparingly soluble in carbon disulfide and aliphatic hydrocarbons.

Description: Colorless, somewhat oily liquid with little or no odor.

Boiling point: 189°C.

Melting point: -26.9°C after extensive purification.

Stability: Stable at ambient temperatures in undiluted form and in nonreacting solvents. Hydrolyzed in water, dilute acid, and alkali to methanol and methyl hydrogen sulfate; this hydrolysis is complete in 24 hours at room temperature. The resultant methyl hydrogen sulfate is extremely stable (Robertson and Sugamori, 1966; Lee et al., 1980).

Chemical reactivity: Strong methylating agent for hydroxy, amino, and sulfide compounds. Reacts with oxidizing materials. Forms explosive mixtures with aqueous ammonia solutions (Savić, 1971).

Flash point: 116°C (open cup); 83°C (closed cup).

Autoignition temperature: No data.

14. Explosive limits in air: No data.

Fire, Explosion, and Reactivity Hazard Data

1. Use water, foam, carbon dioxide, or dry chemical fire extinguishers. Fire-fighting personnel should wear protective clothing and air-supplied respirators with full-face masks or industrial masks with a canister especially approved for DMS vapors (MCA, 1966).
2. DMS is a moderate fire hazard when exposed to heat or flame.
3. Hazardous decomposition products at high temperatures include methanol, sulfuric acid, and sulfur oxides.
4. Other conditions contributing to instability are strong oxidizers and concentrated ammonia solutions.
5. Do not expose to spark or open flames. Store under conditions designed to permit the safe storage of flammable solvents without exposure to moisture.

Operational Procedures

The NIH Guidelines for the Laboratory Use of Chemical Carcinogens describe operational practices to be followed when potentially carcinogenic chemicals are used in NIH laboratories. The Guidelines should be consulted to identify the proper use conditions required and specific controls to be implemented during normal and complex operations or manipulations involving dimethyl sulfate.

1. Chemical inactivation: Validated methods have been reported (Lunn and Sansone, 1985).
2. Decontamination: Turn off equipment that could be affected by dimethyl sulfate or the materials used for cleanup. If more than 100 ml has been spilled or if there is any uncertainty regarding the procedures to be followed for decontamination, call the NIH Fire Department (dial 116) for assistance. If a spill occurs outside a laboratory ventilated cabinet, the area should be evacuated. Workers who enter the area for cleanup should wear positive-pressure airline hose mask or a self-contained breathing apparatus; canister-type gas masks are not safe. Absorb spills of DMS on paper towels or vermiculite. Wash surfaces with water. Wash glassware (in a hood) with 10% sodium hydroxide followed by large quantities of water. Personnel performing these operations should wear rubber gloves. Animal cages should be washed with dilute ammonia solution followed by water.
3. Disposal: It may be possible to decontaminate waste streams containing DMS before disposal. For details, see Lunn and

Sansone (1985). No waste streams containing dimethyl sulfate shall be disposed of in sinks or general refuse. Surplus dimethyl sulfate or chemical waste streams contaminated with dimethyl sulfate shall be handled as hazardous chemical waste and disposed of in accordance with the NIH chemical waste disposal system. Nonchemical waste (e.g., animal carcasses and bedding) containing dimethyl sulfate shall be handled and packaged for incineration in accordance with the NIH medical-pathological waste disposal system. Potentially infectious waste (e.g., tissue cultures) containing dimethyl sulfate shall be packaged for incineration, as above. Burnable waste (e.g., absorbent bench top liners) minimally contaminated with dimethyl sulfate shall be handled as potentially infectious waste and packaged for incineration, as above. Absorbent materials (e.g. associated with spill cleanup) grossly contaminated shall be handled in accordance with the chemical waste disposal system. Radioactive waste containing dimethyl sulfate shall be handled in accordance with the NIH radioactive waste disposal system.

4. Storage: Store in small quantities, preferably in sealed glass containers. Do not store in metal containers. Avoid exposure to atmospheric moisture.

Monitoring and Measurement Procedures Including Direct Field Measurements and Sampling for Subsequent Laboratory Analysis

1. Sampling: DMS in air samples may be adsorbed on Porapak P (Lunsford and Fey, 1979), silica gel (Keller, 1974; Gilland and Bright, 1980), or quartz fiber filters (Lee et al., 1980). Solvents used for desorption of these adsorbates were ether, acetone, and methylene chloride, respectively.
2. Analysis: Most colorimetric procedures are based on the class reaction of alkylating agents with γ -(4-nitrobenzyl)pyridine (Epstein et al., 1955) and are therefore not specific for DMS. A specific application to DMS has been described (Druckrey et al., 1970). Another colorimetric procedure, designed for air analysis, has been developed (Keller, 1974) but requires a 500-liter air sample for analysis at the 0.01 ppm level. More recently, gas chromatography of DMS desorbed from filters has become preferable because of greater specificity and lower sampling requirement. A NIOSH proposed method utilizes an electrolytic conductivity detector (Lunsford and Fey, 1979) with a linear range of 1.1-39 μg per sample; others prefer flame ionization or (more sensitive) flame photometric detectors (Lee et al., 1980; Gilland and Bright, 1980). The latter authors quote a minimum detectable level of 0.04 ppm in a 20-liter air sample. A still more sensitive method, utilizing gas chromatography-mass spectrometry, requires only 1 liter of air to determine DMS in the 0.01 ppm range (Ellgehausen, 1974).

Biological Effects (Animal and Human)

1. Absorption: DMS is absorbed and produces toxic effects by inhalation, by ingestion, and through the skin. It is a potent eye irritant but it is not known whether systemic effects are produced via this route. Transplacental absorption is suspected.
2. Distribution: No specific data. Following absorption, DMS is probably quickly hydrolyzed and/or metabolized so that little or no intact material remains for distribution. For instance, 3 minutes after intravenous injection in rats, DMS is no longer detectable in blood.
3. Metabolism and excretion: There are two main pathways of DMS metabolism. The first is the methylating action of the intact molecule directed chiefly to tissue RNA and DNA; the main site of methylation is the 7-position of guanine, with lesser insertions at the 1- and 3-positions of adenine and the 3-position of cytidine. The second pathway is that of hydrolysis to methyl hydrogen sulfate and eventually to inorganic sulfate and methanol. These acid hydrolysis products are responsible for the irritant actions of DMS. The main urinary excretion product is inorganic sulfate ion; small amounts of the above-mentioned purines and of methanol have been detected in urine of animals following inhalation of DMS.
4. Toxic effects: The acute LD50s in the rat are 440, 100, and 40 mg/kg by the oral, subcutaneous, and intravenous routes, respectively; the LT50 (time to death for 50% of exposed animals) upon inhalation exposure to 75 ppm DMS is 17-26 minutes in mice, rats, and guinea pigs.

Toxic symptoms in humans can be ascribed mainly to the highly corrosive properties of the hydrolysis products of DMS. It should be noted that on first exposure, DMS has a mildly anesthetic effect in the mucosa of the eye and upper respiratory tract, so that even severe intoxication is usually noted only several hours after a nearly symptom-free latent period. There is at first a temporary loss of smell and taste and hoarseness accompanied by irritation of the respiratory passages. The respiratory tract shows damage to the upper mucosa and alveolar epithelium, which may be followed by dyspnea, pulmonary edema, and death. Effects on the eye consist sequentially of lacrimation, irritation of the conjunctiva, swelling of the eyelids, photophobia, blepharospasm, swelling, and, in the case of exposure to liquid DMS, extensive damage to the cornea. Exposed skin may show severe reddening, blistering, edema, and necrosis.

5. Carcinogenic effects: Subcutaneous DMS in rats (single dose, 50 mg/kg) results in local sarcomas, often with lung metastasis;

repeated dosage in mice, rats, and hamsters causes carcinomas of nose, lung, and thorax. Inhaled DMS produced mainly cerebral and cerebellar tumors in rats. Intravenous DMS in pregnant rats also yielded tumors of the nervous system in the offspring. Evidence for human carcinogenicity is mainly inferential (Druckrey et al., 1966). DMS has been identified by an IARC Working Group as being probably carcinogenic for humans (Subgroup 2B) (Althouse et al., 1980).

6. Mutagenic and teratogenic effects: As may be expected of an alkylating compound, DMS is mutagenic in the Ames test, Drosophila, E. coli, and mammalian cell cultures. There is no evidence regarding teratogenicity.

Emergency Treatment

1. Skin and eye exposure: For skin exposure, remove contaminated clothing and wash skin immediately with 5% sodium bicarbonate solution followed by large amounts of water. If reddening or blisters develop, apply a paste of sodium bicarbonate or compresses with 5% sodium bicarbonate. For eye exposure, irrigate immediately with copious quantities of running water for at least 15 minutes.
2. Ingestion: Drink plenty of milk, sodium bicarbonate solution, or water. Induce vomiting.
3. Inhalation: Remove victim promptly to clean air. Administer rescue breathing if necessary.
4. Refer to physician.

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