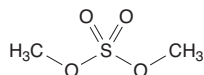


Dimethyl Sulfate

CAS No. 77-78-1

Reasonably anticipated to be a human carcinogen

First listed in the *Second Annual Report on Carcinogens* (1981)



Carcinogenicity

Dimethyl sulfate is *reasonably anticipated to be a human carcinogen* based on sufficient evidence of carcinogenicity from studies in experimental animals.

Cancer Studies in Experimental Animals

Dimethyl sulfate caused tumors in rats at several different tissue sites and by several different routes of exposure. Inhalation exposure to dimethyl sulfate caused cancer of the nasal cavity (squamous-cell carcinoma) and other local tumors. Exposure by subcutaneous injection caused cancer at the injection site (sarcoma). Dimethyl sulfate administered to pregnant rats by intravenous injection caused tumors of the nervous system in the offspring (IARC 1974).

Cancer Studies in Humans

The data available from epidemiological studies are inadequate to evaluate the relationship between human cancer and exposure specifically to dimethyl sulfate. At the time dimethyl sulfate was listed in the *Second Annual Report on Carcinogens*, four cases of bronchial cancer (carcinoma) had been reported in men occupationally exposed to dimethyl sulfate. Since that time, two additional cases of cancer in workers exposed to dimethyl sulfate have been identified. In one case, a man who had been exposed to dimethyl sulfate for six years developed primary cancer of the eye (choroidal melanoma). In the second case, a man who had been exposed for seven years to “small amounts” of dimethyl sulfate but also to larger amounts of the known human carcinogens bis(chloromethyl) ether and chloromethyl methyl ether developed lung cancer (pulmonary carcinoma) (IARC 1982).

Properties

Dimethyl sulfate is the dimethyl ester of sulfuric acid, which exists at room temperature as a colorless, oily liquid with a faint onion-like odor. It is soluble in water, ether, dioxane, acetone, benzene, and other aromatic hydrocarbons, miscible with ethanol, and sparingly soluble in carbon disulfide. It is stable under normal temperatures and pressures, but hydrolyzes rapidly in water at or above 18°C (HSDB 2009). Physical and chemical properties of dimethyl sulfate are listed in the following table.

Property	Information
Molecular weight	126.1 ^a
Density	1.33 g/mL at 20°C ^a
Melting point	-27°C ^a
Boiling point	188°C with decomposition ^a
Log K_{ow}	0.16 ^b
Water solubility	28 g/L at 18°C ^a
Vapor pressure	0.677 mm Hg at 25°C ^a
Vapor density relative to air	4.35 ^a

Sources: ^aHSDB 2009, ^bChemIDplus 2009.

Use

Dimethyl sulfate is used primarily as a methylating agent to convert compounds such as phenols, amines, and thiols to the corresponding methyl derivatives (IARC 1999). It is also used as a methylating or sulfating agent in the manufacture of methyl esters, ethers, and amines in dyes, drugs, perfumes, pesticides, phenol derivatives, fabric softeners, polyurethane-based adhesives, and other organic chemicals. Dimethyl sulfate is also used as a solvent for the separation of mineral oils, for the analysis of auto fluids, and with boron to stabilize liquid sulfur trioxide (HSDB 2009). It was formerly used as a chemical weapon.

Production

Dimethyl sulfate has been produced commercially since at least the 1920s (IARC 1974, 1999). One production method is continuous reaction of dimethyl ether with sulfur trioxide (IARC 1974). In 2009, dimethyl sulfate was available from 44 suppliers, including 16 U.S. suppliers (ChemSources 2009). In 2015, combined U.S. production and imports of dimethyl sulfate were reported to be in the range of 10 million to 50 million pounds (EPA 2016).

Exposure

The routes of potential exposure to dimethyl sulfate are inhalation, dermal contact, and ingestion (HSDB 2009). Dimethyl sulfate enters air and water largely through various waste streams resulting from its production and use. According to EPA's Toxics Release Inventory, environmental releases of dimethyl sulfate from 1988 to 2002 ranged from a high of 14,300 lb in 1989 to a low of 5,800 lb in 1993. Releases increased in 2003, primarily because a large quantity was released to air as fugitive emissions, mostly from a single facility. Since 2005, annual releases have totaled about 3,000 lb or less. In 2007, 2,626 lb of dimethyl sulfate was released to the environment from 11 facilities, primarily as air emissions (TRI 2009). Dimethyl sulfate released to air is likely to remain in the vapor phase and be degraded by reacting with the water in the atmosphere, with a half-life of over 30 min, or by reacting with photochemically produced hydroxyl radicals, with a half-life of over 32 days. Dimethyl sulfate is expected to hydrolyze in moist soils or surface water, with a half-life in water of 1.2 hours. The rapid hydrolysis rate in surface water prevents significant volatilization, adsorption to suspended solids or sediments, or biodegradation and bioconcentration. Dimethyl sulfate has been detected in remote rural air at a concentration of 58 ppt (299 ng/m³) and in urban air at concentrations almost a million times greater (several milligrams per cubic meter) (HSDB 2009).

The National Occupational Exposure Survey (conducted from 1981 to 1983) estimated that 10,500 workers, including 2,500 women, potentially were exposed to dimethyl sulfate (NIOSH 1990).

Regulations

Department of Transportation (DOT)

Dimethyl sulfate is considered a hazardous material, and special requirements have been set for marking, labeling, and transporting this material.

Environmental Protection Agency (EPA)

Clean Air Act

National Emission Standards for Hazardous Air Pollutants: Listed as a hazardous air pollutant.

New Source Performance Standards: Manufacture is subject to certain provisions for the control of volatile organic compound emissions.

Comprehensive Environmental Response, Compensation, and Liability Act

Reportable quantity (RQ) = 100 lb.

Emergency Planning and Community Right-To-Know Act

Toxics Release Inventory: Listed substance subject to reporting requirements.

Reportable quantity (RQ) = 100 lb.

Threshold planning quantity (TPQ) = 500 lb.

Resource Conservation and Recovery Act

Listed Hazardous Waste: Waste codes for which the listing is based wholly or partly on the presence of dimethyl sulfate = U103, K131.

Listed as a hazardous constituent of waste.

Occupational Safety and Health Administration (OSHA, Dept. of Labor)

While this section accurately identifies OSHA's legally enforceable PELs for this substance in 2018, specific PELs may not reflect the more current studies and may not adequately protect workers.

Permissible exposure limit (PEL) = 1 ppm (5 mg/m³).

Potential for dermal absorption.

Guidelines

American Conference of Governmental Industrial Hygienists (ACGIH)

Threshold limit value – time-weighted average (TLV-TWA) = 0.1 ppm.

Potential for dermal absorption.

National Institute for Occupational Safety and Health (NIOSH, CDC, HHS)

Recommended exposure limit (REL) (time-weighted-average workday) = 0.1 ppm (0.5 mg/m³).

Immediately dangerous to life and health (IDLH) limit = 7 ppm.

Potential for dermal absorption.

Listed as a potential occupational carcinogen.

References

ChemIDplus. 2009. *ChemIDplus Advanced*. National Library of Medicine. <http://chem.sis.nlm.nih.gov/chemidplus/chemidheavy.jsp> and select Registry Number and search on CAS number. Last accessed: 5/09.

ChemSources. 2009. *Chem Sources - Chemical Search*. Chemical Sources International. <http://www.chemsources.com/chemonline.html> and search on dimethyl sulfate. Last accessed: 5/09.

EPA. 2016. *Chemical Data Reporting Summary: Dimethyl ester sulfuric acid*. U.S. Environmental Protection Agency. <https://chemview.epa.gov/chemview> and search on CAS number or substance name and select Manufacturing, Processing, Use, and Release Data Maintained by EPA and select Chemical Data Reporting Details.

HSDB. 2009. *Hazardous Substances Data Bank*. National Library of Medicine. <http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB> and search on CAS number. Last accessed: 5/09.

IARC. 1974. Dimethyl sulphate. In *Some Aromatic Amines, Hydrazine and Related Substances, N-Nitroso Compounds and Miscellaneous Alkylating Agents*. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Humans, vol. 4. Lyon, France: International Agency for Research on Cancer. pp. 271-276.

IARC. 1982. Dimethyl sulphate. In *Chemicals, Industrial Processes and Industries Associated with Cancer in Humans*. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Humans, suppl. 4. Lyon, France: International Agency for Research on Cancer. pp. 119-120.

IARC. 1999. Dimethyl sulfate. In *Re-evaluation of Some Organic Chemicals, Hydrazine, and Hydrogen Peroxide*. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Humans, vol. 71. Lyon, France: International Agency for Research on Cancer. pp. 575-588.

NIOSH. 1990. *National Occupational Exposure Survey (1981-83)*. National Institute for Occupational Safety and Health. Last updated: 1990. <http://www.cdc.gov/noes/noes1/26880sic.html>.

TRI. 2009. *TRI Explorer Chemical Report*. U.S. Environmental Protection Agency. <http://www.epa.gov/triexplorer> and select Dimethyl Sulfate. Last accessed: 7/09.