

Occupational Health Guideline for Dimethylsulfate

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: $(\text{CH}_3)_2\text{SO}_4$
- Synonyms: Methyl sulfate
- Appearance and odor: Colorless, oily liquid with a faint onion odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for dimethylsulfate is 1 part of dimethylsulfate per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 5 milligrams of dimethylsulfate per cubic meter of air (mg/m^3). The American Conference of Governmental Industrial Hygienists has recommended for dimethylsulfate a Threshold Limit Value of 0.1 ppm.

HEALTH HAZARD INFORMATION

- Routes of exposure
Dimethylsulfate can affect the body if it is inhaled, comes in contact with the eyes or skin, or is swallowed. It may readily enter the body through the skin.
- Effects of overexposure
Dimethylsulfate vapor is an extremely severe irritant of the eyes, respiratory tract, and skin. While exposure often produces no immediate effects other than slight eye and nose irritation, after a period of up to 10 hours or more, headache and giddiness with intense pain on exposure to light may occur. This is usually followed by inflammation of the throat and voice box, difficulty in speaking, difficulty in swallowing, cough, tightness of

the chest, shortness of breath, a blue coloration of the skin, vomiting, diarrhea, and painful urination. Other effects are delirium, fever, yellow jaundice, and bloody urine. Liver and kidney damage may occur. If the liquid is swallowed, in addition to causing burns of the throat and stomach, the above effects may occur. Contact of the liquid with the eyes and skin will cause severe burns. Animal experiments have shown that this chemical may cause cancer in animals and their offspring.

• Reporting signs and symptoms

A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to dimethylsulfate.

• Recommended medical surveillance

The following medical procedures should be made available to each employee who is exposed to dimethylsulfate at potentially hazardous levels:

1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the eyes, respiratory tract, liver, kidneys, and central nervous system should be stressed. The skin should be examined for evidence of chronic disorders.

—Urinalysis: Since kidney damage has been observed in humans exposed to dimethylsulfate, a urinalysis should be obtained to include at a minimum specific gravity, albumin, glucose, and a microscopic on centrifuged sediment.

—Liver function tests: Since liver damage has been observed in humans exposed to dimethylsulfate, a profile of liver function should be obtained by using a medically acceptable array of biochemical tests.

—14" x 17" chest roentgenogram: Dimethylsulfate causes lung damage in animals. Surveillance of the lungs is indicated.

—FVC and FEV (1 sec): Dimethylsulfate is a respiratory irritant. Persons with impaired pulmonary function may be at increased risk from exposure. Periodic surveillance is indicated.

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Center for Disease Control
National Institute for Occupational Safety and Health

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis, except that an x-ray is considered necessary only when indicated by the results of pulmonary function testing, or by signs and symptoms of respiratory disease.

• **Summary of toxicology**

Dimethylsulfate vapor is an extremely severe irritant of the eyes, mucous membranes, and skin; it is carcinogenic in rats. It has a strong vesicant action and rapidly hydrolyzes in the presence of water to produce sulfuric acid and methanol. It caused malignant tumors in rats in various organs by inhalation, subcutaneous injection, and following prenatal exposure. A single intravenous dose of 20 mg/kg given to 8 pregnant rats on day 15 of gestation induced malignant tumors, including 3 tumors of the nervous system, in 7 of 59 offspring which were observed for over 1 year. The LC50 in rats was 75 ppm for 18 minutes; autopsy findings were marked pulmonary edema, pulmonary emphysema, peribronchitis, and focal necrosis of the liver. Several human deaths have occurred from occupational exposure. While exposure of humans often produces no immediate effects other than occasional slight eye and nose irritation, after a latent period of up to 10 hours or more, there is onset of headache and giddiness with intense conjunctival irritation, photophobia, and periorbital edema; this is usually followed by inflammation of the pharyngo-laryngeal mucosa, dysphonia, aphonia, dysphagia, productive cough, oppression in the chest, dyspnea and cyanosis; vomiting and diarrhea may intervene. Dysuria may occur for 3 to 4 days; there may be persistence of laryngeal edema for up to 2 weeks and of photophobia for several months. Other effects are delirium, fever, icterus, albuminuria, and hematuria. Contact of the liquid with the eyes or skin will cause very severe burns due to its powerful vesicant action. In one incident of moderate skin contact with the liquid, generalized intoxication occurred even though there was prompt treatment of the skin; the vapor was inhaled for no more than a few minutes.

CHEMICAL AND PHYSICAL PROPERTIES

• **Physical data**

1. Molecular weight: 126.1
2. Boiling point (760 mm Hg): 188.8 C (372 F)
3. Specific gravity (water = 1): 1.3
4. Vapor density (air = 1 at boiling point of dimethylsulfate): 4.35
5. Melting point: -31.8 C (-25 F)
6. Vapor pressure at 20 C (68 F): 0.5 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 2.8 (reacts slowly)
8. Evaporation rate (butyl acetate = 1): Data not available

• **Reactivity**

1. Conditions contributing to instability: Contact with water may allow formation of flammable concentrations of methyl alcohol.

2. Incompatibilities: Contact with strong oxidizers or with strong ammonia solutions may cause fires and explosions.

3. Hazardous decomposition products: Toxic gases and vapors (such as sulfuric acid mist, methyl alcohol, and carbon monoxide) may be released in a fire involving dimethylsulfate.

4. Special precautions: Dimethylsulfate will attack some forms of plastics, rubber, and coatings.

• **Flammability**

1. Flash point: 83.3 C (182 F) (closed cup)
2. Autoignition temperature: 187.8 C (370 F)
3. Flammable limits in air, % by volume: Data not available
4. Extinguishant: Dry chemical, foam, carbon dioxide

• **Warning properties**

1. Odor Threshold: Patty states that "dimethylsulfate is a colorless, oily liquid, which is nearly odorless or which may have a faint onion-like odor."

2. Irritation Levels: Grant states that "injury of the eye by vapor of dimethylsulfate is a much more common industrial accident than injury by a splash of liquid, which is more easily prevented by goggles. Numerous instances of burns and poisoning from the vapor have been described. Also, in animal eyes the effects of the vapor have several times been studied and reproduced. Characteristically, during exposure to vapor of dimethylsulfate the patient or experimental animal is not aware of irritation or unpleasant sensation but begins to develop discomfort several hours later.

Moeschlin in his book on poisonings particularly has placed great emphasis on the latent period that is characteristic of the action of dimethylsulfate vapors on the eyes, giving description of specific cases in which there were latent periods as long as six hours before severe inflammation of the eyes and respiratory tract developed. Browning in her book on toxicology has reviewed several of the reports in the literature of eye involvement from vapor exposure.

Typical industrial exposure occurs when workmen pour dimethylsulfate from one container to another, with no irritation of eyes or nose, or no unpleasant odor to warn of danger. After several hours the eyes begin to feel irritated and have a sandy sensation. Photophobia and lacrimation develop; the lids become edematous and the conjunctiva hyperemic. The skin of the face and other exposed parts is reddened. The symptoms increase in intensity for several hours, and then superficial clouding and irregularity of the corneal epithelium may be seen. Associated with the ocular symptoms are temporary loss of smell and taste, with hoarseness and irritation of the respiratory passages which may become severe, and in the worst cases may develop into fatal pneumonia.

The course of the eye injuries in the mildest cases may be spontaneous return to normal in a few days, or, in severe cases, gray necrosis of the epithelium, edema and infiltration of the corneal stroma, and permanent

partial opacification may result.”

No quantitative information is available concerning the levels of dimethylsulfate which produce eye irritation. The effects on the eyes are delayed.

3. Evaluation of Warning Properties: Since dimethylsulfate is “almost odorless,” and since the irritant effects produced by this compound are delayed, dimethylsulfate is treated as a material with poor warning properties.

MONITORING AND MEASUREMENT PROCEDURES

• General

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

• Method

An analytical method for dimethylsulfate is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 5, 1979, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00349-1).

RESPIRATORS

• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

• In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

• Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent any possibility of skin contact with liquid dimethylsulfate.

• Clothing contaminated with dimethylsulfate should be placed in closed containers for storage until it can be

discarded or until provision is made for the removal of dimethylsulfate from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the dimethylsulfate, the person performing the operation should be informed of dimethylsulfate's hazardous properties.

• Where there is any possibility of exposure of an employee's body to liquid dimethylsulfate, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

• Non-impervious clothing which becomes contaminated with dimethylsulfate should be removed immediately and not reworn until the dimethylsulfate is removed from the clothing.

• Employees should be provided with and required to use splash-proof safety goggles where there is any possibility of liquid dimethylsulfate contacting the eyes.

• Where there is any possibility that employees' eyes may be exposed to liquid dimethylsulfate, an eye-wash fountain should be provided within the immediate work area for emergency use.

SANITATION

• Skin that becomes contaminated with dimethylsulfate should be immediately washed or showered with soap or mild detergent and water to remove any dimethylsulfate.

• Employees who handle liquid dimethylsulfate should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to dimethylsulfate may occur and control methods which may be effective in each case:

Operation	Controls
Use as a methylating agent in organic chemical industry for manufacture of esters, ethers, and amines	Enclosed system/segregation; general dilution ventilation; personal protective equipment
Use in manufacture of dyes, dyestuffs, coloring agents, and perfumes; use in pharmaceutical industry as a solvent for separation/preparation of mineral oils	Enclosed system/segregation; general dilution ventilation; personal protective equipment
Use during analysis of automobile fluids	Enclosed system/segregation; general dilution ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• Eye Exposure

If liquid dimethylsulfate or strong concentrations of dimethylsulfate vapors get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

• Skin Exposure

If liquid dimethylsulfate or strong concentrations of dimethylsulfate vapors get on the skin, immediately flush the contaminated skin with large amounts of water. If liquid dimethylsulfate or strong concentrations of dimethylsulfate vapors penetrate through the clothing, remove the clothing immediately and flush the skin with large amounts of water. Get medical attention immediately.

• Breathing

If a person breathes in large amounts of dimethylsulfate, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• Swallowing

If dimethylsulfate has been swallowed and the person is conscious, give him large quantities of water immediately to dilute the dimethylsulfate. Do not attempt to make the exposed person vomit. Get medical attention immediately.

• Rescue

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL, LEAK, AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

• If dimethylsulfate is spilled or leaked, the following steps should be taken:

1. Ventilate area of spill or leak.

3. For small quantities, absorb on paper towels. Evaporate in a safe place (such as a fume hood). Allow sufficient time for evaporating vapors to completely clear the hood ductwork. Burn the paper in a suitable location away from combustible materials. Large quan-

ties can be collected and atomized in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.

• Waste disposal methods:

Dimethylsulfate may be disposed of:

1. By absorbing it in vermiculite, dry sand, earth or a similar material and disposing in a secured sanitary landfill.

2. By atomizing in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.

REFERENCES

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* SPECIAL NOTE

The International Agency for Research on Cancer (IARC) has evaluated the data on this chemical and has concluded that it causes cancer. See *IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man*, Volume 4, 1974.

RESPIRATORY PROTECTION FOR DIMETHYLSULFATE

Condition	Minimum Respiratory Protection* Required Above 1 ppm
Vapor Concentration	
10 ppm or less	Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
Greater than 10 ppm** or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	Any gas mask with a full facepiece providing protection against dimethylsulfate. Any escape self-contained breathing apparatus with a full facepiece.

*Only NIOSH-approved or MSHA-approved equipment should be used.

**Use of supplied-air suits may be necessary to prevent skin contact while providing respiratory protection from airborne concentrations of dimethylsulfate; however, this equipment should be selected, used, and maintained under the immediate supervision of trained personnel. Where supplied-air suits are used above a concentration of 10 ppm, an auxiliary self-contained breathing apparatus operated in positive pressure mode should also be worn.

