Methyl methane-sulfonate

Safety
Data
Sheet

Division of Occupational Health and Safety
National Institutes of Health

WARNING!

This compound is absorbed through the intestinal tract. It is toxic, carcinogenic, mutagenic, and teratogenic. It is an irritant and is corrosive in the presence of moisture. 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 soap and water.

For eye exposure, irrigate immediately with large amounts of water. For ingestion, drink plenty of water or milk. Induce vomiting. For inhalation, remove victim promptly to clean air. Administer rescue breathing if necessary. Refer to physician.

In case of laboratory spill, wear protective clothing during cleanup. Avoid skin contact or breathing of aerosols or vapors. Use aqueous alkali to dissolve compound. Wash down area with dilute alkali followed by soap and water. Dispose of waste solutions and materials appropriately.

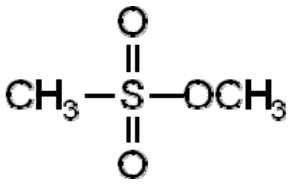
A. Background

Methyl methanesulfonate (MMS) is a colorless liquid that is strongly irritating on inhalation or ingestion. It forms highly corrosive compounds in the presence of water. MMS is toxic in animals and humans and is carcinogenic, mutagenic, and teratogenic in rodents. Its main uses are as a solvent catalyst in polymerization, alkylation, and esterification reactions and in cancer chemotherapy research.

B. Chemical and Physical Data

1. Chemical Abstract No.: 66-27-3
2. Synonyms: MMS; Methyl methanesulfonate; Methyl mesylate; as-Dimethyl sulphite; Methanesulfonic acid, methyl ester (9Cl).
3. Molecular formula, weight and structure:

$C_2H_6O_3S$; 110.14



4. Density: 1.2943g/cm^3.
5. Absorption spectroscopy: No data.
6. Volatility: No data.
7. Solubility: Soluble in water (1 part in 5 at 25ºC); slightly soluble in nonpolar solvents.
8. Description, appearance: Colorless liquid.
9. Boiling point: 203ºC.

   Melting point: No data.
10. Stability: Stable in the absence of moisture; hydrolyzed in water to the strongly corrosive methanesulfonic acid.
11. Chemical reactivity: MMS readily alkylates nucleophiles such as hydroxyl, amino, and sulfhydryl groups in model and biological materials (*e.g.*, proteins). Hydrolyzed by excess aqueous alkali to noncorrosive and nontoxic products.
12. Flash point: No data.
13. Autoignition temperature: No data.
14. Explosive limits in air: No data.

C. Fire, Explosion, and Reactivity Hazard Data

1. MMS does not require special fire-fighting procedures or equipment and does not present unusual fire and explosion hazards.
2. A condition contributing to instability is the presence of moisture, which results in hydrolysis to free acid, which is highly corrosive to metals unless neutralized with alkali.
3. No other incompatibilities are known to exist.
4. MMS does not require nonspark equipment.

D. 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 MMS.

1. Chemical inactivation: No validated method reported.
2. Decontamination: Turn off equipment that could be affected by MMS or the materials used for cleanup. If more than 10 ml has been spilled or if there is any uncertainty regarding the procedures to be followed for decontamination, call the NIH Fire Department (dial 911) for assistance. Wash surfaces with copious quantities of water. Glassware should be rinsed (in a hood) with water, followed by soap and water. Animal cages should be washed with water.
3. Disposal: No waste streams containing MMS shall be disposed of in sinks or general refuse. Surplus MMS or chemical waste streams contaminated with MMS 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 MMS 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 MMS shall be packaged for incineration, as above.

Burnable waste (*e.g.*, absorbent bench top liners) minimally contaminated with MMS 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 MMS shall be handled in accordance with the NIH radioactive waste disposal system.

4. Storage: Store in sealed glass ampoules or screw-capped bottles or vials with Teflon cap liners. Avoid exposure to moisture. Refrigeration is recommended.

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

1. Sampling: No data.
2. Separation and analysis: No specific methods have been reported. General methods for detection and estimation have been described, including colorimetric procedures using 4-picoline and o-dinitro-benzene as reagents (Sawicki and Sawicki, 1969) and the reaction with 4-(4-nitrobenzyl)pyridine (Preussman *et al.*, 1969).

F. Biological Effects (Animal and Human)

1. Absorption: Rapidly absorbed by the digestive tract in the mouse after intraperitoneal injection. Effects in humans after ingestion also imply absorption from the gastrointestinal tract.
2. Distribution: After intraperitoneal injection in the mouse, there is rapid distribution with a pattern as follows (decreasing concentration after 24 hours): liver, kidney, lung, spleen, heart, epididymis, brain, testis, and skeletal muscle (Cumming and Walton, 1970).
3. Metabolism and excretion: Intraveneous ^{14}C-labeled MMS is retained in the blood of rats for about 90 minutes. The major products of excretion in the urine are metabolites resulting from initial methylation of cysteine (IARC, 1974). A significant amount of radioactivity due to intraperitoneally administered MMS is exhaled as CO_2 in mice, less in rabbits.
4. Toxic effects: The acute LD50s in rats are 125 and 175 mg/kg via the subcutaneous and intravenous routes, respectively. Target organs in rodents are liver (depletion of hepatic glycogen), ovaries, testes, and bone marrow. In humans, ingestion of MMS results in nausea, vomiting, a decline in visual acuity, and blood abnormalities (Bateman *et al.*, 1966).
5. Carcinogenic effects: MMS produces pulmonary adenomas and thymus lymphomas in mice (oral) and various spinal cord tumors in rats (intraperitoneal). Subcutaneous MMS results in a variety of tumors at the injection site (Swann and Magee, 1969). Transplacental transport produces a significant number of neurogenic tumors in the offspring of rats dosed intravenously with MMS during gestiation (Kleihues *et al.*, 1972).
6. Mutagenic and teratogenic effects: MMS is positive in the Ames test and produces other mutagenic responses in animal cells in vivo and in vitro. Teratogenic effects have been noted in mice and rats.

G. Emergency Treatment

1. Skin and eye exposure: For skin exposure, remove contaminated clothing and wash skin with soap and water. For eye exposure, irrigate immediately with copious quantities of running water for at least 15 minutes.
2. Ingestion: Drink plenty of water or milk. Induce vomiting.
3. Inhalation: Remove victim promptly to clean air. Administer rescue breathing if necessary.

4. Refer to physician. Observe for pulmonary irritation. Obtain ophthalmological consultation for eye exposure.

H. References

Bateman, J.R., R.L. Peters, J.G. Hazen, and J.L. Steinfield. 1966. Methyl methane sulfonate. Phase I. Clinical Study. Cancer Chemother Rep 50:675-682.

Cumming, R.B., and M.F. Walton. 1970. Fate and metabolism of some mutagenic alkylating agents in the mouse. Ethyl methane-sulphonate and methyl methanesulphonate at sublethal dose in hybrid males. Mutat Res 10:365-377.

IARC, International Agency for Research on Cancer. 1974. Pages 253-260 in IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man. Some Anti-thyroid and Related Substances, Nitrofurans and Industrial Chemicals, Vol. 7. World Health Organization, Geneva, Switzerland.

Kleihues, P., C. Mende, and W. Reucher. 1972. Tumors of the peripheral and central nervous system Induced in BD-rats by prenatal application of methyl methanesulfonated. Eur J Cancer 8:641-645.

Preussman, R., H. Schneider, and F. Epple. 1969. Investigations for the determination of alkylating agents. II. The determination of alkylating agents with a modification of the color reaction with 4-(4-nitrobenzyl)pyridine (NBP). Arzneim Forsch 19:1059-1073.

Sawicki, E., and C.R. Sawicki. 1969. Analysis of alkylating agents: Application to air pollution. Ann NY Acad Sci 163:895-920.

Swann, P.F., and P.N. Magee. 1969. Induction of rat kidney tumors by ethyl methanesulphonate and nervous tissue tumors by methyl methanesulphonate and ethyl methanesulphonate. Nature 223:947-949.