

2-Mercaptoethanol

Safety Data Sheet

Division of Occupational Health and Safety
National Institutes of Health



WARNING!

This compound is acutely toxic. It is readily absorbed through the skin and respiratory and intestinal tracts. It may irritate the skin and eyes. 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 cold water. Avoid washing with solvents. Avoid rubbing of skin or increasing its temperature.

2-ME is flammable. Keep away from sparks and open flames. In case of fire, use carbon dioxide or dry chemical extinguisher.

For eye exposure, irrigate immediately with large amounts of water. For ingestion, induce vomiting. Drink milk or water. Refer for gastric lavage. 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 water to dissolve compound. Use absorbent paper to mop up spill. Wash down area with soap and water. Dispose of waste solutions and materials appropriately.

A. Background

2-Mercaptoethanol (2-ME) is a colorless mobile liquid with a faint characteristic odor. It is miscible with water, ethanol, ether, and benzene. It is absorbed by ingestion, inhalation and through the skin, and acts as powerful eye and skin irritant. Its toxicity by oral, dermal, and intravenous administration is high. Industrial uses of 2-ME have not been described, but it is a useful tool in the biochemical laboratory in protein and peptide sequencing studies since disulfide bonds can be cleaved with the least amount of side reactions by means of this reagent. Another use is as a stabilizer during isolation and purification of enzyme systems which require free sulfhydryl groups for activity.

There is no federal standard for exposure to 2-ME, although it has been proposed that production, use and exposure information be recorded (EPA, 1980). A Russian publication suggests that the maximum permissible concentration in the air should be 1 mg/m^3 (Pugaeva *et al.*, 1971).

B. Chemical and Physical Data

1. Chemical Abstract No.: 60-24-2

2. Synonyms: -mercaptoethanol; 2-hydroxy-1-ethanethiol; 2-hydroxyethyl mercaptan; monothioethylene glycol; thioglycol; 1-ethanol-2-thiol.
3. Chemical structure and molecular weight:
 $\text{HS-CH}_2\text{-CH}_2\text{-OH}$; $\text{C}_2\text{H}_6\text{OS}$; 78.13
4. Density: $d^{20} = 1.1143$; vapor density = 2.69.
5. Absorption spectroscopy: 2-ME has a stable ultraviolet absorption maximum in alkaline solution at 235 nm (DeDeken *et al.*, 1956). Infrared and proton NMR spectra have been published (Simons, 1978a, 1978b). (Spectra # 1661).
6. Volatility: The vapor pressure at 20°C is 1 mm Hg (sax, 1984).
7. Solubility: 2-ME is freely miscible with water, ethanol, ether and benzene.
8. Description: Water-white mobile liquid with a faint characteristic odor. The pK_a of the sulfhydryl group is 9.6.
9. Boiling point: 157-158°C at 742 mm Hg (with decomposition), 63°C at 18 mm Hg, 44.5°C at 4 mm Hg; Melting point: no data.
10. Stability: Very little information. 2-ME appears to be quite stable in pure form or in aqueous solution in the absence of atmospheric oxygen, at room temperature and neutral and low pH. It is oxidized to the corresponding disulfide in aerated solution and this reaction is catalyzed by metal (*e.g.*, copper) ions (Stevens *et al.*, 1983). When heated to decomposition, 2-ME emits toxic vapors of sulfur oxides.
11. Chemical reactivity: Both the sulfhydryl and hydroxyl groups are subject to the usual substitution reactions. At 140°C in the presence of an acid catalyst, 2-ME is cyclized to ethylene episulfide. It reacts with oxidants to form disulfide and further oxidation products.
12. Flash point: 74°C (Cleveland open cup) (Sax, 1984).
13. Autoignition temperature: No data.
14. Explosive limits in air: No data.

C. Fire, Explosion, and Reactivity Hazard Data^A

1. Use alcohol foam, carbon dioxide, or dry chemicals as fire extinguishants. While the fire hazards due to heat or flame are small, exposure by inhalation, eye or skin contact should be avoided. Therefore, fire-fighting personnel should wear air-supplied respirators with full face masks.
2. 2-ME is incompatible with strongly oxidizing materials (depending on the extent of oxidation, the products could be either less or more hazardous than 2-ME itself.)
3. Hazardous decomposition products under conditions of fire are highly toxic sulfur oxides.
4. Do not expose to open flames. Non-spark tools and equipment are not required.

D. Operational Procedures

The NIH Guidelines for Laboratory Use of Chemical Carcinogens describe operational practices to be followed when potentially carcinogenic chemicals are used in NIH laboratories. The NIH 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 2-ME.

^A Information based mainly on Sax (1984).

It should be emphasized that this data sheet and the NIH Guidelines are intended as starting points for the implementation of good laboratory practices when using this compound. The practices and procedures described in the following sections pertain to the National Institutes of Health and may not be universally applicable to other institutions. Administrators and/or researchers at other institutions should modify the following items as needed to reflect their individual management system and current occupational and environmental regulations.

1. Chemical inactivation: No validated method reported.
2. Decontamination: Turn off equipment that could be affected by 2-ME or the materials used for cleanup. If there is any uncertainty regarding the procedures to be followed for decontamination, call the NIH Fire Department (dial 911) for assistance. Use absorbent paper to mop up spill. After the residue has evaporated, 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 2-ME shall be disposed of in sinks or general refuse. Surplus 2-ME shall be disposed of in sinks or general refuse. Surplus 2-ME or chemical waste streams contaminated with 2-ME 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 2-ME 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 2-ME shall be packaged for incineration, as above. Burnable waste (*e.g.*, absorbent bench top liners) minimally contaminated with 2-ME 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 2-ME shall be handled in accordance with the NIH radioactive waste disposal system.
4. Storage: Store in sealed ampoules or in bottles with caps with polyethylene cone liners inside a sealed secondary container in an explosion-safe refrigerator. Avoid exposure to light, moisture and atmospheric oxygen. Store working quantities of 2-ME and its solutions in the dark and under an inert atmosphere in an explosion-safe refrigerator in the work area.

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

1. Sampling: No data. Collection of samples for subsequent analysis in silica tubes, with desorption by methanol, has been mentioned as possibly applicable to field analysis but no data are presented (Choudhary, 1980).
2. Analysis: Colorimetric methods are not specific for 2-ME but are generally applicable to aliphatic sulfhydryl compounds. Several are based on the reaction of thiols with "Ellman reagent" (5,5'-dithiobis[2-nitrobenzoic acid]) which produces a color read at 420 nm (Ellman, 1959) and have been applied to the determination of sulfhydryl groups in blood, urine, tissue samples, and purified proteins. A similar method, using as color reagent 2,6-dibromobenzoquinone-4-chloroimide is even less specific but more sensitive (Stenersen, 1967). Greater specificity can be achieved by use of chromatography, either GLC in the nanogram range (Choudhary, 1980) or more usually by HPLC which is particularly useful for the separation of reduced and oxidized 2-ME (Ingebretsen and Farstad, 1981; Carnevale and Healy, 1982). The most sensitive method to date (though applicable to other sulfhydryl compounds and applied to the determination of SH groups in blood) is the reaction with monobromobimane to form a fluorescent derivative measurable in the pictogram range (Newton *et al.*, 1981). Of interest also is a spectrophotometric procedure for the simultaneous determination of reduced and oxidized forms of thiols, based on differences in reaction speed with a palladium reagent (Dupre and Aureli, 1980).

F. Biological Effects (Animal and Man)

1. Absorption: 2-ME is absorbed by inhalation, ingestion, parenteral injection, and through the skin. It produces necrotizing effects on contact with the eye but there is no indication whether systemic effects are produced via this route.
2. Distribution: No data.
3. Metabolism and excretion: Only one pertinent reference has been found and this has been seen in abstract form only (Federici *et al.*, 1976). According to these authors, ³⁵S-labeled 2-ME on intraperitoneal injection is rapidly metabolized into five or more metabolites which are excreted rapidly in the urine (99% within 2 days); the major metabolite is inorganic sulfate, with a small amount of isethanoic acid (HOCH₂CH₂SO₃H). In purified tissue preparations, the oxidation by NAD (Lambe and Williams, 1965) and the S-methylation by S-adenosyl methionine (Bremer and Greenberg, 1961) has been demonstrated.
4. Toxic effects^B: Intraperitoneal and oral LD50 in the mouse and rat is in the range of 200-350 mg/kg, and the same percutaneous toxicity in the guinea pig is in the same range. No deaths were produced by exposure of rats to an air stream saturated with 2-ME in 4 hours (Smyth and Carpenter, 1944). Acute effects of parenteral 2-ME (~ 1.5 LD50) in rats produced tremors, convulsions, respiratory failure, and death within 1-2 hours, with no histopathological changes. At doses near the LD50 there were minimal changes in liver and kidney and marked depression, possibly due to formation of toxic metabolites. Skin effects in the rabbit (Draize test) were moderate erythema and edema within 24 hours which had disappeared after 72 hours in unabrased skin, lasting longer on abraded skin. Intracutaneous diluted 2-ME produced marked inflammation and necrosis (White *et al.*, 1973). Eye effects of undiluted or diluted 2-ME consisted of corneal irritation and necrosis with prolonged healing periods (Carpenter and Smyth, 1946). No symptoms of intoxication in man have been described.
5. Carcinogenic effects: None has been reported; on the contrary, prolonged administration of 2-ME in the diet of rats over a 2.5 year period postponed the onset and decreased the incidence of tumors, indicative of a potential decrease in free radical accumulation due to the reductive effect of 2-ME (Heidrick *et al.*, 1984).
6. Mutagenic and teratogenic effects: none have been reported.

G. Emergency Treatment

1. Skin and eye exposure: For skin exposure, remove contaminated clothing and wash skin with soap and water. Skin should not be rinsed with organic solvents. Since 2-ME is readily absorbed through the skin, avoiding rubbing of skin or increasing its temperature. For eye exposure, irrigate immediately with copious quantities of running water for at least 15 minutes. Obtain ophthalmological evaluation.
2. Ingestion: Drink plenty of water or milk. Induce vomiting. Refer for gastric lavage.
3. Inhalation: Remove victim promptly to clean air. Administer rescue breathing if necessary.
4. Refer to physician.

^B 2-ME has been mentioned as a possible reaction product in the sterilization of sulfur-containing rubber medical devices with ethylene oxide.

H. References

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Carnevale, I. and K. Healey. 1982. Determination of thiols by titrimetric and chromatographic procedures based on reactions with aromatic thiosulfonates. *Anal Chim Acta* 140: 143-151.

Carpenter, C.P. and H.F. Smyth Jr. 1946. Chemical burns of the rabbit cornea. *Am J Ophthalmol* 29:1363-1372.

Choudhary, G. 1980. Gas-liquid chromatography of 2-mercapto-ethanol. *J Chromatog* 200:211-215.

DeDeken, R.H., J. Broeckhuysen, J. Bechet, and A. Mortier. 1956. Etude spectrophotometrique de la dissociation de la fonction sulfhydrile et structure moleculaire de la cysteine. [Spectro-photometric study of the dissociation of the sulfhydrul group, and molecular configuration of cysteine.] *Biochim Biophys Acta* 19:45-52.

Dupre, S. and M. Aureli. 1980. Simulatneous spectrophotometric determination of oxidized and reduced forms of thiols in solution. *Anal biochem* 105:97-100.

Ellman, G.L. 1959. Tissue sulfhydryl groups. *Arch Biochem Biophys* 82:70-77.

EPA.

Description: Water-white, mobile fluid with disagreeable odor

Other Names: Monothioethyleneglycol; thioglycol; 2-hydroxyethyl-mercaptan

Uses: Solvent for dye stuffs, intermediate for producing dye stuffs, pharmaceuticals, rubber chemicals, flotation agents, insecticides, plasticizers, textile assistants and other compounds, water soluble reducing agent, biochemical reagent.

Hazardous Properties:

1. Fire Hazard
 - a. Combustible when exposed to heat or flame, otherwise moderate
2. Health Hazard
 - a. Moderately toxic by ingestion
 - b. Moderately toxic by inhalation
 - c. Moderate skin irritant

Precautions:

1. Fire Protection
 - a. Avoid contact or exposure of 2-mercapto ethanol to open flames or heat
2. Personal Protection
 - a. Avoid inhalation of vapors

- b. Skin contact with liquid should be avoided
- c. Do not eat, drink or smoke where chemical is being used to avoid accidental ingestion of liquid
- d. Use protective clothing and gloves when working with chemical
- e. Always use this chemical in a fume hood

Storage

- 1. Store chemical in an approved storage area or in a refrigerator specifically designed for the storage of flammable liquids
- 2. Keep chemical away from potential fire hazards

Technical Data

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| 1. | Chemical formula | H-S-CH ₂ -CH ₂ -OH |
| 2. | Molecular weight | 78.13 |
| 3. | Vapor pressure | 1.0 mm @ 20°C |
| 4. | Vapor density (air = 1) | 2.69 |
| 5. | Boiling point | 151.1°C |
| 6. | Melting point | Below -100°C |
| 7. | Flash point | 170°C |
| 8. | Ignition | ----- |
| 9. | Explosive limits | ----- |
| 10. | Specific gravity (water =1) | 1.1168 |
| 11. | Solubility | water, alcohol, ethanol and benzene |
| 12. | Threshold Limit Value (TLV) has not been established for this chemical | |

Emergency Procedures:

- 1. Fire
 - a. Use dry chemical foam or carbon dioxide to extinguish fire
 - b. Use water spray to keep fire exposed containers cool
 - c. If leak or spill has not ignited, use water spray to dispense vapors
 - d. Flush away spills and dilute spills to non-flammable mixtures with water spray
- 2. First Aid
 - a. Skin contact – wash area immediately with copious amounts of water
 - b. Eye contact – wash eyes immediately with copious amounts of water
 - c. Ingestion – insufficient information available at this time
 - d. Call physician

The information contained in this bulleting is based on a literature search and may not be complete.

Environmental and Industrial Hygiene Section
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Division of Research Services

References:

1. The Condensed Chemical Dictionary, 8th Edition, Revised by Gessner G. Hawley, Van Nostrand Reinhold Company, N.Y., New York.
2. Dangerous Properties of Industrial Materials by N. Irving Sax, 1957, Reinhold Company, N.Y., New York.
3. Handbook of Chemistry and Physics by Robert C. Weast, 52nd Edition, 1971-1972, The Chemical Rubber Company, Cleveland, Ohio.