MERCAPTOETHANOL

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I. IDENTIFICATION[1-3]

Chemical Name: 2-Mercaptoethanol
Synonyms: 2-ME;1-hydroxy-2-mercaptoethane; 2-thioethanol; thioethyelenglycol; thioglycol; 2-hydroxyethyl mercaptan
CAS Number: 60–24–2
Molecular Formula: C2H6OS
Structural Formula: $HSCH_2CH_2OH$

II. CHEMICAL AND PHYSICAL PROPERTIES[1-3]

Physical State: Colorless liquid
Odor Description and Threshold: Strongly disagreeable, 0.12 to 0.64 ppm (0.383 to 2.04 mg/m^3)
Molecular Weight: 78.13
Conversion Factors: 1 ppm = 3.19 mg/m^3;
1 mg/m^3 = 0.314 ppm at 25°C
Boiling Point: 157°C (315°F)
Melting Point: < -100°C (-148°F)
Vapor Pressure: 62 mm Hg (8 kPa) at 20°C
Saturated Vapor Concentration: 81600 ppm (8.2%) at 20°C
Flammability Limits: LEL: 2.3%, UEL: 18%
Flash Point (open cup): 74°C (165°F)
Autoignition Temperature: No data available.
Specific Gravity: 1.12 (water = 1)
Solubility: Miscible with water; soluble in alcohol, ether, benzene.
Stability and Reactivity: Incompatible with oxidizing agents, strong acids, reacts with alkali metals.
Log K_{ow}: -0.20 (estimated)

III. USES AND VOLUMES

Used as a solvent for dyestuffs; intermediate in manufacture of pharmaceuticals, rubber chemicals, dyestuffs, flotation agents, insecticides, plasticizers; water soluble reducing agent; biochemical reagent.[1]

IV. TOXICOLOGY DATA

A. Acute Toxicity and Irritancy

1. Oral Toxicity

LD_{50} = 224 mg/kg (albino rat, male, strain not specified)[4]
LD_{50} = 241 mg/kg (Charles River rat, male and female)[5]
LD_{50} = 300 mg/kg (Wistar rat, male)[6]
LD_{50} = 330 mg/kg (albino rat, male, strain not specified)[7]
LD_{50} = 190 mg/kg (mouse, sex and strain not specified)[4]
LD_{50} = 348 mg/kg (Swiss-Webster mouse, male)[8]

2. Eye Irritation

Severe eye irritation (Draize score of 60.1, 14 days after exposure) was observed in male and female New Zealand White rabbits exposed to 0.1 ml of undiluted 2-mercaptoethanol in an unpublished study following the CPSC-FHSA unwashed technique.[5] When tested using the FHSA washout protocol, the Draize score was 33.6 at 24 hours after exposure, indicating moderate irritation.[5] In another unpublished Draize study with New Zealand White rabbits, exposure to 0.1 ml of undiluted 2-mercaptoethanol produced severe irritation, with mean scores of 39.0 at 1 hr post-exposure, 68.0 at 24 hr post-exposure and 68.2 at 14 days.[5] Exposure to 0.005 ml of undiluted mercaptoethanol or to solutions of 40% or more (in propylene glycol) produced severe eye irritation in another rabbit study.[9] Undiluted mercaptoethanol and 20% solutions (in saline)

were also tested for eye irritation in male New Zealand White rabbits.[8] Undiluted mercaptoethanol produced severe redness and chemosis, along with corneal scarring and opacity after four months. Slight irritation was produced by 20% solutions in saline.

3. *Skin Absorption*

LD_{50} = 0.15 ml/kg (~168 mg/kg, rabbit, sex and strain not specified, 24 hours occluded)[7]

LD_{50} = 0.3 ml/kg (~330 mg/kg, guinea pig, sex and strain not specified, 4 days occluded, 10-day observation period)[6]

LD_{50} = 251 mg/kg (New Zealand White rabbit, both sexes, 24 hours occluded, 14-day observation period)[5]

LD_{50} = 241 mg/kg (New Zealand White rabbit, both sexes, 24 hours occluded, 14-day observation period)[5]

4. *Skin Irritation*

In an unpublished Draize skin irritation study with New Zealand White rabbits, 0.5 ml of undiluted 2-mercaptoethanol was applied under an occlusive patch to one abraded and one non-abraded site on each of six animals. Five of the six test animals died within 6–48 hours of exposure. The irritation score was based on the one surviving animal. The primary skin irritation index was determined to be 8.0 (extremely irritating).[5] In another unpublished dermal irritation test (US DOT protocol), a primary skin irritation index of 3.4 (moderate irritant) was determined following exposure of four male and three female New Zealand White rabbits to 0.5 ml of 2-mercaptoethanol.[5] Primary irritation was also reported in a published study in which 2-mercaptoethanol was applied undiluted, or as a 1:5 or 1:10 dilution (in saline) to abraded and unabraded sites on the backs of six rabbits.[8] Undiluted mercaptoethanol produced moderate irritation on both the intact and abraded sites. The irritant reactions persisted on the abraded sites beyond the 72-hr observation period, while on intact skin irritant reactions were reduced by 72 hours following exposure. Dilutions of 1:5 or 1:10 mercaptoethanol in saline produced moderate transitory irritation on abraded skin and a very slight reaction on intact skin. Skin irritation was also evaluated in an unpublished rabbit belly vesicant test.[7] Undiluted mercaptoethanol produced slight erythema.

5. *Skin Sensitization*

No data available.

6. *Inhalation Toxicity*

LC_{50} = 4138 ppm (13200 mg/m^3, mouse, exposure duration, sex, strain not specified)[4]

$LC_0 \geq$ 125 ppm (8 hr, 0/6 rats died, sex and strain not specified)[7]

LC_{100} = 250 ppm (8 hr, 6/6 rats died, sex and strain not specified)[7]

$LC_0 \geq$ 2.4 ppm (7.7 mg/m^3, 1 hr, 0/6 male Sprague Dawley rats died)[5]

7. *Other*

LD_{50} i.p. = 322 mg/kg (Swiss-Webster mouse, male)[8]

LD_{50} i.p. = 200–300 mg/kg (CF-1 mouse, male)[10]

B. Subacute Toxicity

Three groups of 15 male Swiss-Webster mice were administered 5 i.p. doses per week of 0 (saline), 80.5 or 161 mg/kg for 4 weeks. All test mice in both treatment groups died within the 4-week period, while only 1/15 controls died. Seven mice in the high dose group and two in the low dose group died after the first eight days of treatment. The exposed mice exhibited progressive weakness and depression with curtailed activity, decreased response to pain and body weight loss. Histopathologic studies revealed foci of hepatic necrosis in mercaptoethanol-treated mice. There were no significant differences in the organ to body weight ratios of treated versus control mice.[8]

C. Subchronic Toxicity

Two groups of 20 male albino rats each were exposed via inhalation to 6 or 10 mg/m^3 mercaptoethanol for six months. Twenty unexposed rats served as the control group. The duration of the daily exposures was not discussed. Rats exposed to 10 mg/m^3 exhibited neuromuscular depression, lymphopenia, neutrophilia, and decreased oxygen consumption, starting from the third month of exposure. Changes in body weight, arterial blood pressure, liver function, and protein metabolism were observed after five months of high-level exposure. Less pronounced changes in oxygen consumption, neutrophil and lymphocytes counts, and no pathological changes in organs were observed in rats exposed at 6 mg/m^3 for six months. The authors speculated that 6 mg/m^3 may be close to the no observable adverse effect level, lowest observable adverse effect level (NOAEL/LOAEL) for inhala-

tion exposure to mercaptoethanol. Interpretation of this study is hindered by the limited information concerning the study design, exposure conditions, and significance of the observed effects.[4]

D. Chronic Toxicity/Carcinogenicity

No data available.

E. Reproductive/Developmental Toxicity

Pregnant rats (10–13/group) received i.p. doses of 35 mg/kg twice daily from gestation day 9–11 or 9–14. Dams were sacrificed on gestation days 12 or 15 and the fetuses were examined and weighed. The number of control rats was not specified. Intraperitoneal exposure to mercaptoethanol increased early resorptions and decreased fetal weight. Exposed dams examined histologically revealed necrosis of the uterine mucosa and inhibition of mitosis. No information was presented regarding such maternal toxicity parameters as food consumption, clinical signs, or body weight/weight gain. Although 2/460 pups showed signs of malformation, no control, or historical control background incidence was provided.[11]

F. Genotoxicity/Mutagenicity

Mercaptoethanol has been shown to be negative in Ames assays with *S. typhimurium* strains TA1535, TA1527, TA1538, TA98, and TA100, with or without metabolic activation. It was also negative in the mouse lymphoma forward mutation assay and in a sister chromatid exchange (SCE) assay with Chinese Hamster Ovary (CHO) cells.[5]

In another SCE assay with V79 CHO cells, mercaptoethanol induced SCEs leading to an incidence twice that of the control. It also induced some chromosome damage.[12] Mercaptoethanol was also shown to induce polyploidy in human lymphocyte cultures at a maximally tolerated concentration of 1.3 mM.[13]

Mercaptoethanol was tested in *S. cerevisiae* using a mitotic chromosomal malsegregation assay, and was negative at all concentrations up to those that were toxic to the cells.[14]

G. Metabolism/Pharmacokinetics

Mercaptoethanol is metabolized in the rat by alcohol dehydrogenase to mercaptoacetic acid and *in vitro* by cysteamine oxygenase to isethenic acid and isethionic acid.[15-17]

V. HUMAN USE AND EXPERIENCE

One case of an accidental spill of mercaptoethanol has been recorded by the U.S. Centers for Disease Control. No adverse effects to exposed persons was reported.[18]

The odor threshold for mercaptoethanol has been reported to be between 0.383 and 2.04 mg/m^3 (0.12 to 0.64 ppm).[2] An exposure limit of 1 mg/m^3 (0.3 ppm) was proposed by Pugaeva et al.[4]

VI. RATIONALE

2-Mercaptoethanol is a liquid with a highly offensive odor. It can be absorbed through the skin in toxic amounts. The NOAEL/LOAEL in the only repeated-exposure rat inhalation toxicity study was 2 ppm (6 mg/m^3) following 6 months of exposure. In an acute inhalation study in rats, the 8-hr LC_{100} was 250 ppm while the LC_0 was 125 ppm. The odor threshold for mercaptoethanol has been reported to be between 0.383 and 2.04 mg/m^3 (0.12 to 0.64 ppm).[2] An OEL Guide of 0.2 ppm is expected to provide an adequate margin of safety for the protection of health, and to minimize complaints due to odor.

VII. RECOMMENDED OEL

8-hr time-weighted average (TWA): 0.2 ppm (0.6 mg/m^3)

VIII. REFERENCES

1. **HSDB:** Catalog ID Number 001854. Mercaptoethanol, 2-, 2000.
2. **Cheminfo:** Record 469, 2-Mercaptoethanol. Canadian Centre for Occupational Health and Safety, searched August, 2000, last revised 1998.
3. **RTECS:** Record KL5600000, Ethanol, 2-mercapto-, last revision 07/2000, searched January 2001.
4. **Pugaeva, V.P., et al.:** Hygienic Standardization of b-Hydroxyethylmercaptan in the Air of Industrial Establishments. *Gig. Tr. Prof. Zabol. 15(2)*:56–58 (1971) (In Russian).
5. **Philips Petroleum Company:** "Toxicity Study Summary of 2-Mercaptoethanol." June 17, 1985. [Unpublished data.] Philips Petroleum Company, 4th and Keeler Ave., Bartlesville, OK 74004.
6. **Smyth, H.F. and C.P. Carpenter:** The Place of the Range Finding Test in the Industrial Toxicology Laboratory. *J. Ind. Hyg. Toxicol. 26*:269–273 (1944).
7. **Dow Chemical Company, Union Carbide Corporation:** "Animal Toxicity Data for Mercaptoethanol (Product File 5791)." May 2, 1956. [Unpublished data.] Dow Chemical Company, Union Carbide Corporation, Midland, MI 48667.
8. **White, K., J.V Bruckner, and W.L. Guess:** Toxicological Studies of 2-Mercaptoethanol. *J. Pharm. Sci. 62(2)*:237–241 (1973).
9. **Carpenter, C.P and H.F. Smyth:** Chemical Burns of the Rabbit Cornea. *Am. J. Opthalmol. 26*:1363–1372 (1946).

10. **USAF Aerospace Medical Division, Radiation Laboratory:** *A Survey of Compounds for Radiation* by Doull, J., V. Plzak, and S.J. Brois (Report 62–29). Brooks AFB, Tex.: USAF Aerospace Medical Division, Radiation Laboratory, Brooks AFB, 1962.
11. **Mueller, M. and N. Skreb:** The Effect of Beta-Mercaptoethanol on Young Embryos of White Rats. *Naturwissenschaften 48*:580 (1961) (In German).
12. **Speit, G., M. Wolf, and W. Vogel:** The Effect of Sulfhydryl Compounds on Sister-Chromatid Exchanges. *Mutation Research 78*:267–272 (1980).
13. **Jackson, J.F.:** Toxicity of Sulfhydryl Compounds to Cultured Human Lymphocytes. *Exptl. Cell Res. 61*:468–469 (1970).
14. **Albertini, S. et al.:** Analysis of Six Additional Chemicals for *In Vitro* Assays of the European Economic Communities EEC Aneuploidy Programme using Saccharomyces Cerevisiae D61.M and the *In Vitro* Porcine Brain Tubulin Assay. *Environ. Mol. Mutagen. 21(2)*:180–192 (1993).
15. **Lambe, R.F. and D.C. Williams:** The Enzymatic Reduction of Nicotinamide Adenine Dinucleotide by 2-Mercaptoethanol. *Biochem. J. 97*:475–478 (1965).
16. **Sabourault, D., Y. Giudicelli, R. Nordmann, and J. Nordmann:** Is Fatty Liver Induction a General Feature of the Administration of Foreign Sulfhydryl Compounds? *Biochim. Biophys. Acta. 431*:241–248 (1976).
17. **Dupre, S., G. Federici, G. Ricci, G. Spoto, A. Antonucci, and D. Cavallini:** Enzymatic Oxidation of Mercaptoethanol to Isethinic Acid and Isethionic Acid. *Enzyme 23*:307–313 (1978).
18. **Brookhaven National Laboratory:** *Toxic Material Advisory Report, 2-Mercaptoethanol* by Bernholc, N.M., O. White, R.S. Baloyi, and B.D. Silverstein (BNL 51669). Upton, New York: Brookhaven National Laboratory, US Department of Energy, 1983.

The following literature searches were performed in developing the revised WEEL in 2002:

CCInfoDisk (Cheminfo)
DART
HSDB
RTECS
TOXLINE