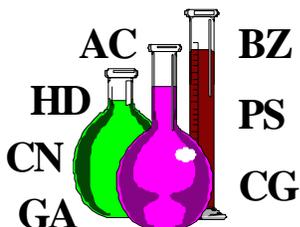


*U.S. Army Center for Health Promotion and Preventive Medicine*



*Detailed Facts About Sulfur Mustard Agents  
H and HD*

218-08-1096

*Physical Properties of Sulfur Mustard HD*

*Chemical Structure  
Chemical Formula*

$\text{ClCH}_2\text{CH}_2\text{-S-CH}_2\text{CH}_2\text{Cl}$   
 $\text{C}_4(\text{H}_8)\text{C}_{12}(\text{S})$

*Description*

Mustard agent *liquid* is colorless when pure, but it is normally a yellow to brown oily substance. Mustard agent *vapor* is colorless with a slight garlic- or mustard-like odor.

*Molecular Weight*

159.08

*Vapor Pressure (mm Hg)*

0.072 @ 20°C  
0.11 @ 25°C

*Boiling Point*

215-217°C; slowly vaporizes at ordinary temperatures.

*Freezing Point*

14.5°C

*Density*

Liquid = 1.27  
Vapor = 5.4 (air = 1)

*Solubility*

Very sparingly soluble in H<sub>2</sub>O; freely soluble in animal oils, fats, organic solvents.

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*Agent HD* - The chemical Distilled mustard or bis(2-chloroethyl) sulfide; HD is H that has been purified by washing and vacuum distillation to reduce sulfur impurities, Chemical Abstract Service Registry No. 505-60-2.

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*Flash Point*

105°C

*Volatility*

75 mg/m<sup>3</sup> @ 0°C (solid)  
610 mg/m<sup>3</sup> @ 20°C (liquid)  
2,860 mg/m<sup>3</sup> @ 40°C

### ***Toxicity Values***

IC <sub>t50</sub> (eyes)	= 200 mg-min/m <sup>3</sup>
IC <sub>t50</sub> (inhalation)	= 1,500 mg-min/m <sup>3</sup>
IC <sub>t50</sub> (skin)	= 2,000 mg-min/m <sup>3</sup> @70° to 80°F (humid environment) = 1,000 mg-min/m <sup>3</sup> @90°C (dry environment)
LC <sub>t50</sub> (inhalation)	= 1,500 mg-min/m <sup>3</sup>
LCL <sub>0</sub> (inhalation, 10 min)	= 1,496 mg-min/m <sup>3</sup>
LD <sub>50</sub> (skin)	= 100 mg/kg
LD <sub>50</sub> (oral)	= 0.7 mg/kg
1% Lethality	= 150 mg-min/m <sup>3</sup>
No Deaths Level	= 100 mg-min/m <sup>3</sup>
NOAEL (inhalation)	= 1.4 mg-min/m <sup>3</sup>

### ***Exposure Limits***

Workplace Time-Weighted Average -	0.003 mg/m <sup>3</sup>
General Population Limits -	0.0001 mg/m <sup>3</sup>

## ***Toxic Properties of Sulfur Mustard***

*Mustard agents stored in the unitary stockpile are in ton containers, artillery shells, and other munitions. Stockpiled at Aberdeen Proving Ground, MD; Anniston Army Depot, AL; Blue Grass Army Depot, KY; Pine Bluff, AR; Pueblo Depot Activity, CO; Tooele Army Depot, UT; and Umatilla Depot Activity, OR.*

### ***Overexposure Effects***

HD is a vesicant (blister agent) and alkylating agent producing cytotoxic action on the hematopoietic (blood forming) tissues, which are especially sensitive. The rate of detoxification of HD in the body is very slow, and repeated exposures produce a cumulative effect. The physiological action of HD may be classified as local and systemic. The local action results in conjunctivitis or inflammation of the eyes, erythema which may be followed by blistering or ulceration; inflammation of the nose, throat, trachea, bronchi, and lung tissue. Injuries produced by HD heal much more slowly and are more susceptible to infection than burns of similar intensity produced by physical means or by most other chemicals. Systemic effects of mustard may include malaise, vomiting, and fever, with onset time about the same as that of the skin erythema.

With amounts approaching the lethal dose, injury to bone marrow, lymph nodes, and spleen may result. HD has been determined to be a human carcinogen by the International Agency for Research on Cancer.

### ***Emergency and First Aid Procedures***

Inhalation: remove victim from the source immediately; administer artificial respiration if breathing has stopped; administer oxygen if breathing is difficult; seek medical attention immediately.

Eye Contact: speed in decontaminating the eyes is absolutely essential; remove person from the liquid source, flush the eyes immediately with water by tilting the head to the side, pulling the eyelids apart with the fingers, and pouring water slowly into the eyes; do not cover eyes with bandages; but if necessary, protect eyes by means of dark or opaque goggles; seek medical attention immediately.

Skin Contact: don respiratory protective masks and gloves; remove victim from agent source immediately; flush skin and clothes with 5 percent solution of sodium hypochlorite or liquid household bleach within 1 minute; cut and remove contaminated clothing; flush contaminated skin area again with 5 percent sodium hypochlorite solution; then wash contaminated skin area with soap and water; seek medical attention immediately.

Ingestion: do not induce vomiting; give victim milk to drink; seek medical attention immediately.

### ***Protective Equipment***

Protective Gloves: MANDATORY - Wear Butyl toxicological agent protective gloves (M3, M4, gloveset).

Eye Protection: Wear chemical goggles as a minimum; use goggles and face shield for splash hazard.

Other: Wear gloves and lab coat with M9 or M17 mask readily available for general lab work.

In addition, wear daily clean smock, foot covers, and head cover when handling contaminated lab animals.

### ***Reactivity Data***

Stability: Stable at ambient temperatures; decomposition temperatures is 149°C to 177°C; can be active for at least three years in soil; stable for days-week, under normal atmospheric temperature; slowly hydrolyzed by water; destroyed by strong oxidizing agents.

Incompatibility: Rapidly corrosive to brass @ 65°C; will corrode steel at

.001 in. of steel per month @ 65°C.

Hazardous Decomposition: Mustard will hydrolyze to form HCl and thiodiglycol.

Hazardous Polymerization: Will not occur.

**Persistency** Depends on munition used and the weather; heavily splashed liquid persists 1 to 2 days in concentration to provide casualties of military significance under average weather conditions, and a week to months under very cold conditions.

### **References**

1. Department of the Army Pamphlet (DA PAM) 40-173, *Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Mustard Agents H, HD, and HT*, 30 August 1991.
2. Department of the Army Field Manual (DA FM) 3-9, *Potential Military Chemical/Biological Agents and Compounds*, 1990.
3. Institute of Medicine, National Academy of Sciences, C.M. Pechura and D.P. Rall, eds., *Veterans at Risk: The Health Effects of Mustard Gas and Lewisite*, National Academy Press, Washington, D.C., 1993.
4. Papirmeister, B., et al., *Medical Defense Against Mustard Gas: Toxic Mechanisms and Pharmacological Implications*, Boca Raton, Florida: CRC Press, 1991.
5. U.S. Army Chemical Command Materiel Destruction Agency, *Site Monitoring Concept Study*, 15 September 1993.

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