

Occupational Health Guideline for Hydrogen Selenide

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: H_2Se
- Synonyms: Selenium hydride
- Appearance and odor: Colorless gas with a very offensive odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for hydrogen selenide is 0.05 part of hydrogen selenide per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 0.2 milligram of hydrogen selenide per cubic meter of air (mg/m^3).

HEALTH HAZARD INFORMATION

- **Routes of exposure**
Hydrogen selenide can affect the body if it is inhaled or if it comes in contact with the eyes or skin.
- **Effects of overexposure**
Exposure to hydrogen selenide may cause irritation of the eyes, nose, throat, and lungs, nausea, vomiting, and diarrhea. Subsequently, there may be a metallic taste in the mouth, garlic odor of the breath, dizziness, and extreme tiredness. Hydrogen selenide has been known to cause pneumonia and liver damage in animals.
- **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 hydrogen selenide.

- **Recommended medical surveillance**

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

1. Initial Medical Screening: Employees should be screened for history of certain medical conditions (listed below) which might place the employee at increased risk from hydrogen selenide exposure.

—Chronic respiratory disease: Hydrogen selenide causes respiratory irritation in animals. In persons with impaired pulmonary function, especially those with obstructive airway diseases, the breathing of hydrogen selenide might cause exacerbation of symptoms due to its irritant properties.

—Liver disease: Hydrogen selenide causes liver damage in animals. The importance of this organ in the biotransformation and detoxification of foreign substances should be considered before exposing persons with impaired liver function.

2. Periodic Medical Examination: Any employee developing the above-listed conditions should be referred for further medical examination.

- **Summary of toxicology**

Hydrogen selenide gas irritates the eyes, nose, and throat and causes pulmonary irritation in animals. Guinea pigs exposed to 10 ppm for 2 hours exhibited immediate irritation of the eyes and nose; a high percentage of the animals died, apparently from pneumonitis. Exposure of guinea pigs to $1 mg/m^3$ (0.3 ppm) for 8 hours produced death in half of the animals; pulmonary irritation and liver damage were observed. In humans, a concentration of 1.5 ppm is said to produce intolerable irritation of the eyes and nose. Five workers exposed to concentrations of less than 0.2 ppm of hydrogen selenide and possibly other selenium compounds for 1 month developed nausea, vomiting, diarrhea, metallic taste in the mouth, garlic odor of the breath, dizziness, lassitude, and fatigability; following cessation of exposure, there was a gradual regression of symptoms during the succeeding months. Urinary selenium levels of the workers

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.

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ranged from 0 to 13.1 mg Se/100 cc urine; there was no correlation between symptoms and levels of urinary excretion.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 81
2. Boiling point (760 mm Hg): $-41.3\text{ C } (-42\text{ F})$
3. Specific gravity (water = 1): Liquid = 2.1 at boiling point
4. Vapor density (air = 1 at boiling point of hydrogen selenide): 2.8
5. Melting point: $-65.7\text{ C } (-86.5\text{ F})$
6. Vapor pressure at 20 C (68 F): Greater than 1 atmosphere
7. Solubility in water, g/100 g water at 20 C (68 F): 0.73
8. Evaporation rate (butyl acetate = 1): Not applicable

• Reactivity

1. Conditions contributing to instability: None
2. Incompatibilities: Contact with oxidizers, acids, water, and halogenated hydrocarbons may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as selenium dioxide fume) may be released in a fire involving hydrogen selenide.
4. Special precautions: None

• Flammability

1. Flash point: Not applicable (gas)
2. Autoignition temperature: Data not available
3. Flammable limits in air, % by volume: Data not available
4. Extinguishant: Shut off flow of gas; carbon dioxide

• Warning properties

1. Odor Threshold: May and Summer report odor thresholds for hydrogen selenide of 0.3 ppm and 3 ppm, respectively.

2. Irritation Level: Grant states that "a concentration of 1.5 ppm in air is said to produce intolerable irritation of the eyes and nose which tends to limit exposure and safeguard against injury. However, below 1 ppm the ocular and respiratory warning properties are insufficient to prevent exposure which may cause systemic intoxication." Dudley and Miller state that at 0.001 mg/l (0.3 ppm) "no eye or nasal irritation is produced in man."

3. Evaluation of Warning Properties: Since the odor and irritation thresholds of hydrogen selenide are not within three times the permissible exposure limit, hydrogen selenide is treated as a material with poor warning properties. In addition, the AIHA *Hygienic Guide* states that "the odor perception of it (hydrogen selenide) is soon lost."

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

At the time of publication of this guideline, no measurement method for hydrogen selenide had been published by NIOSH.

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.

COMMON OPERATIONS AND CONTROLS

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

Operation	Controls
Use in preparation of semi-conductor materials; use in chemical synthesis for metal selenides and organoselenium, lasers, and emulsions	Process enclosure; local exhaust ventilation; personal protective equipment

Liberation from roasting of metal ores and pyrites, production of glass and ceramics, vulcanization of rubber, and etching with inks

Liberation from overloaded selenium rectifiers

Liberation from bacterial action of selenium-contaminated clothing

Local exhaust ventilation; personal protective equipment

Local exhaust ventilation; personal protective equipment

Good personal hygiene practice

EMERGENCY FIRST AID PROCEDURES

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

• Breathing

If a person breathes in large amounts of hydrogen selenide, 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.

• 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.

LEAK AND DISPOSAL PROCEDURES

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

• If hydrogen selenide is leaked, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of leak to disperse gas.
3. Stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair the leak or allow the cylinder to empty.

• Waste disposal method:

Hydrogen selenide may be disposed of by burning in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.

REFERENCES

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RESPIRATORY PROTECTION FOR HYDROGEN SELENIDE

Condition	Minimum Respiratory Protection* Required Above 0.05 ppm
Gas Concentration	
0.5 ppm or less	Any supplied-air respirator. Any self-contained breathing apparatus.
2 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 2 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 providing protection against hydrogen selenide. Any escape self-contained breathing apparatus.

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