

Occupational Health Guideline for Osmium Tetroxide

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: OsO₄
- Synonyms: Osmic acid
- Appearance and odor: Colorless to pale yellow solid with a sharp, choking, chlorine-like odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for osmium tetroxide is 0.002 milligrams of osmium tetroxide per cubic meter of air (mg/m³) averaged over an eight-hour work shift. The American Conference of Governmental Industrial Hygienists has recommended for osmium tetroxide a Threshold Limit Value of 0.0002 mg/m³.

HEALTH HAZARD INFORMATION

- **Routes of exposure**
Osmium tetroxide can affect the body if it is inhaled or if it comes in contact with the eyes or skin. It can also affect the body if it is swallowed.
- **Effects of overexposure**
Exposure to osmium tetroxide may cause severe eye damage accompanied by irritation with tearing. This may occur several hours after exposure has ceased. After exposure, halos may be seen around lights. Exposure to osmium tetroxide may also cause severe irritation of the nose, throat, and bronchial tubes with cough, wheezing, shortness of breath, and pneumonia. In addition, exposure to this chemical may also cause skin burns, skin rash, skin discoloration, and kidney damage.
- **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 osmium tetroxide.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to osmium tetroxide 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 osmium tetroxide exposure.

—Eye disease: Osmium tetroxide is an eye irritant and in workers has caused symptoms and signs of keratitis epithelia with corneal edema. Persons with pre-existing eye disorders may be more susceptible to the effects of this agent.

—Chronic respiratory disease: In persons with impaired pulmonary function, especially those with obstructive airway diseases, the breathing of osmium tetroxide might cause exacerbation of symptoms due to its irritant properties.

—Kidney disease: Osmium tetroxide causes mild kidney damage in animals. Persons with pre-existing kidney disease may be more susceptible to the effects of this agent.

—Skin disease: Osmium tetroxide is a primary skin irritant. Persons with pre-existing skin disorders may be more susceptible to the effects of this agent.

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

- **Summary of toxicology**

Osmium tetroxide as dust or vapor is a severe irritant of the eyes and respiratory tract. Rabbits exposed for 30 minutes to vapor at estimated concentrations of 130 mg/m³ developed irritation of mucous membranes and labored breathing; at autopsy there was bronchopneumonia, as well as slight kidney damage. A laboratory investigator exposed to a high concentration of vapor experienced a sensation of chest constriction and diffi-

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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culty in breathing. Irritation of the eyes is usually the first symptom of exposure to low concentrations of the vapor; lacrimation, a gritty feeling in the eyes, and the appearance of rings around lights are frequently reported; in most cases, recovery occurs within a few days. Workers exposed to fume concentrations up to 0.6 mg/m³ developed lacrimation, visual disturbances, and, in some cases, frontal headache, conjunctivitis, and cough. Application of a drop of 1% solution of osmium tetroxide to a rabbit eye caused severe corneal damage; there was permanent opacity and superficial vascularization. Osmium compounds have a caustic action on the skin resulting in eczema and dermatitis. Osmium tetroxide is a very irritating material to the skin due to its ability to precipitate protein.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 2.54
2. Boiling point (760 mm Hg): 130 C (266 F) (sublimes well below boiling point)
3. Specific gravity (water = 1): 4.9
4. Vapor density (air = 1 at boiling point of osmium tetroxide): 8.8
5. Melting point: 42 C (108 F)
6. Vapor pressure at 20 C (68 F): 7 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 7
8. Evaporation rate (butyl acetate = 1): Not applicable

• Reactivity

1. Conditions contributing to instability: None
2. Incompatibilities: Contact with hydrochloric acid will cause formation of poisonous chlorine gas. Contact with easily oxidized organic materials may cause fires and explosions.

3. Hazardous decomposition products: None

4. Special precautions: None

• Flammability

1. Not combustible

• Warning properties

1. Odor Threshold: According to Hunter, osmium tetroxide has an irritating odor, but no quantitative information is available concerning the odor threshold.

2. Eye Irritation Level: Grant states that "the eyes are particularly susceptible to injury by vapors of osmium tetroxide. With sufficient concentrations a sensation of irritation with lacrimation and sensation of foreign body is induced immediately. This may be accompanied by irritation of the nose and throat . . . Concentrations of vapor which do not cause immediate sensation of irritation have an insidious cumulative action with a latent period before the onset of smarting and lacrimation, which may be delayed from 1 to several hours after start of exposure. In either case the symptoms and signs are those of keratitis epithelialis with corneal epithelial edema . . . No permanent effect has been noted, even when several episodes of keratitis epithelialis have been experienced." Grant later states,

however, that application of a drop of 1% solution of osmium tetroxide on rabbit eyes resulted in "moderate permanent opacity."

3. Evaluation of Warning Properties: Since there is no quantitative information relating warning properties to air concentrations of osmium tetroxide, and since this is such an extremely toxic substance, it should be treated as a material with poor warning properties.

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 osmium tetroxide 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.

PERSONAL PROTECTIVE EQUIPMENT

• Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent skin contact with osmium tetroxide or liquids containing osmium tetroxide, where skin contact may occur.

• If employees' clothing may have become contaminated with solid osmium tetroxide, employees should

change into uncontaminated clothing before leaving the work premises.

- Clothing contaminated with osmium tetroxide should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of osmium tetroxide from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the osmium tetroxide, the person performing the operation should be informed of osmium tetroxide's hazardous properties.

- Non-impervious clothing which becomes contaminated with osmium tetroxide should be removed promptly and not reworn until the osmium tetroxide is removed from the clothing.

- Employees should be provided with and required to use dust- and splash-proof safety goggles where there is any possibility of solid or liquid osmium tetroxide or liquids containing osmium tetroxide contacting the eyes.

- Where there is any possibility that employees' eyes may be exposed to solid or liquid osmium tetroxide or liquids containing osmium tetroxide, an eye-wash fountain should be provided within the immediate work area for emergency use.

SANITATION

- Skin that becomes contaminated with osmium tetroxide should be promptly washed or showered to remove any osmium tetroxide.

- Eating and smoking should not be permitted in areas where solid or liquid osmium tetroxide or liquids containing osmium tetroxide are handled, processed, or stored.

- Employees who handle solid or liquid osmium tetroxide or liquids containing osmium tetroxide should wash their hands thoroughly before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

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

Operation	Controls
By-product during refining and processing of osmiridium and other platinum metal ores; during production of alloys; during casting and annealing operations in manufacture of	Local exhaust ventilation; general dilution ventilation; personal protective equipment

Operation

specialty metal products

Use as an intermediate for separation of metals and ores of osmium from platinum; use as a catalyst for oxidizing agent in organic synthesis; use as a staining and fixing agent in pathological and histological analysis; use as a laboratory reagent

Controls

Local exhaust ventilation; general dilution ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

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

• Eye Exposure

If osmium tetroxide gets into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

• Skin Exposure

If solid or liquid osmium tetroxide or liquids containing osmium tetroxide get on the skin, immediately wash the contaminated skin using soap or mild detergent and water. If solid or liquid osmium tetroxide or liquids containing osmium tetroxide penetrate through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. If irritation persists after washing, get medical attention.

• Breathing

If a person breathes in large amounts of osmium tetroxide, 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.

• Swallowing

When osmium tetroxide has been swallowed and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

• 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.

SPILL, LEAK, AND DISPOSAL PROCEDURES

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

- If solid or liquid osmium tetroxide or liquids containing osmium tetroxide are spilled or leaked, the following steps should be taken:

1. Ventilate area of spill or leak.

2. Collect material in the most convenient and safe manner for reclamation or for disposal in a secured sanitary landfill. Liquid containing osmium tetroxide should be absorbed in vermiculite, dry sand, earth, or a similar material.

- Waste disposal method:

Osmium tetroxide may be disposed of in sealed containers in a secured sanitary landfill.

REFERENCES

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RESPIRATORY PROTECTION FOR OSMIUM TETROXIDE

Condition	Minimum Respiratory Protection* Required Above 0.002 mg/m ³
Particulate and Vapor Concentration	
0.1 mg/m ³ or less	Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
1 mg/m ³ or less	A Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure mode or with a full facepiece, helmet, or hood operated in continuous-flow mode.
Greater than 1 mg/m ³ 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 with a high efficiency filter providing protection against osmium tetroxide vapors and particulates. Any escape self-contained breathing apparatus.

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

