



Tufts University Standard Operating Procedure (SOP) for Osmium Tetroxide

CAS # 20816-12-0

Synonyms: osmic acid, perosmic oxide, and osmium(IV) oxide

NFPA 4, HMIS 4-most hazardous poison.

Toxicity

Osmium tetroxide (OsO_4) is highly poisonous, pale yellow solid that is volatile. It is a corrosive oxidizer that produces acrid chlorine like odor. Upon exposure to air or skin, it will be reduced to the less hazardous osmium dioxide, OsO_2 , which is a black powder, often mistaken for mold in refrigerators or cabinets.

Osmium tetroxide can cause nervous system damage, eye irritation and skin sensitization and/or allergic reactions. Osmium tetroxide is suspected to cause male reproductive disorders, is a suspected carcinogen and possible mutagen.

Inhalation at concentrations well below those at which a smell can be perceived can lead to pulmonary edema and subsequent death. Symptoms can take hours to appear after exposure.

OsO_4 can stain the human cornea, which can lead to blindness. Irritation is generally the initial symptom of exposure to low concentrations of OsO_4 vapor. It causes tearing and a gritty sand in the eye feeling. The eyes can temporarily cloud, and the appearance of rings around lights may also be noted. In most cases, recovery occurs in a few days. Concentrations of vapor that do not cause immediate irritation can have an insidious cumulative effect; symptoms may not be noted until several hours after exposure.

The material if brought in contact with skin causes severe burns. May also cause sensitization by inhalation and skin contact, and when contact does occur, the effects are usually irreversible.

The permissible inhalation exposure limit for OsO_4 (8 hour time-weighted average) is 2 ppm or $2 \mu\text{g}/\text{m}^3$.

Good Practices and Personal Protective Equipment (PPE)

OsO_4 sublimates easily and releases poisonous and highly irritating vapors. Osmium tetroxide can penetrate plastics and therefore needs to be stored in glass in a laboratory refrigerator. All work with OsO_4 must be performed in a chemical fume hood and handled with double nitrile gloves. Change gloves frequently and when contaminated, punctured or torn. Wash hands immediately after removing gloves. **When using or pouring OsO_4 no area of the skin or eyes should be exposed.** Chemical goggles should be worn. Safety glasses alone are not adequate protection because of osmium tetroxide's severe effects on the eyes. A standard or disposable laboratory coat or disposable coveralls should be worn. A standard laboratory coat may be reused before laundering if it has not been contaminated with OsO_4 . If a garment is contaminated, remove, place in chemical hood, and decontaminate with corn oil or aqueous solutions of sodium sulfide or sodium sulfite before disposing of in hazardous waste or laundering. Closed-toed, leather shoes (not fabric or mesh) should be worn. The locations of safety showers and eye wash stations should be clearly marked and easily accessible.

The main application in the world for OsO_4 is in the field of electron microscopy. It can be purchased as a 4% aqueous solution or pure 1 g ampoules of crystals. We recommend OsO_4 be purchased as a liquid to avoid particulate exposure from the powdered form. Stock solutions should be mixed as 4% aqueous solution (or less) and no more than 25 ml quantities should be prepared and stored at a time. The solutions should be stored in labeled tightly sealed container, in either a glass flask with ground glass top wrapped tightly with parafilm or a glass-vacuum-type blood collection tube to prevent vapors from escaping into the refrigerator. This should be placed in secondary containment inside the refrigerator. Secondary containment should also be used anytime the material is transported to another lab location. When OsO_4 is freshly prepared and active, it is colorless to pale yellow in color. When the material oxidizes it turns into black OsO_2 . This is helpful to know especially in the event of a splash or spill (see below).

Osmium tetroxide is very volatile and also reactive. Repeatedly check and replace any parafilm that has turned black. By replacing the parafilm wrappings on a regular basis, you should be successful at keeping osmium tetroxide vapors from leaking out into the environment and turning the entire refrigerator black. Therefore it is important that you have set up, as part of your safety procedures, the constant checking of your stock solution bottle to make sure that nothing is leaking out into the refrigerator or the environment.

All lab ware that has contacted OsO_4 should be decontaminated by rinsing or dipping in corn oil or aqueous solutions of sodium sulfide or sodium sulfite before removing from the hood. The literature on osmium tetroxide decontamination also mentions using a “mild” solution of sodium hydroxide in water. However, corn oil is recommended for decontamination as it reacts with and thus quenches the reactive osmium tetroxide. Similarly, aqueous solutions of sodium sulfide or sodium sulfite reduce OsO_4 to less hazardous forms.

Incompatibilities

Osmium tetroxide can penetrate plastics and therefore needs to be stored in glass in a laboratory refrigerator and always in a secondary container. Osmium tetroxide reacts with hydrochloric acid to form chlorine gas. Store away from acids, bases, metals, strong reducing agents, and strong oxidizing agents. Contact with combustible material could cause fire.

Spills

If you spill a small amount (minor spill) of OsO_4 notify your supervisor for cleanup assistance. We recommend a liter of vegetable oil and either kitty litter, vermiculite or dry sand in addition to the normal spill kit, for small spills.

Small Spills: When the spill is small and manageable, (usually less than 10 mL OsO_4), lab personnel will:

- Alert personnel in the immediate area.
- Isolate the area to prevent the spread of contamination.
- Don appropriate PPE (at a minimum use double nitrile gloves, buttoned lab coat, safety goggles).
- Cover the spill with kitty litter, vermiculite or sand soaked in corn oil.
- Scoop the material up and place it in a sealed plastic bag.
- Wash the area with aqueous solution of sodium sulfite or sodium sulfide.
- Clean the area with detergent solution.
- Remove contaminated PPE carefully and place it in the bag.
- Label the bag or container with a completed hazardous chemical waste label/tag and write **osmium tetroxide** clearly on the label.
- Arrange with TEHS for pickup and appropriate disposal.

Large Spills: A large spill is any amount of chemical that the lab staff cannot easily and safely clean up without outside assistance. **Evacuate the room and immediately report this to your supervisor and the Tufts Police at x 6-6911 for cleanup.**

Accidents/Releases and Exposures

Treat any skin, eye or inhalation exposure seriously, no matter how slight the exposure may seem.

Exposure to skin can cause a greenish or black discoloration. **May be fatal if inhaled, swallowed, or absorbed through the skin.** Allergic like reactions are also possible.

If skin is exposed, proceed immediately to the nearest safety shower, flush exposed skin with water for at least 15 minutes. In case of eye contact, rinse the eyes with large amounts of water for a minimum of 15 min. and seek medical attention. Affected individuals may need help holding their eyes open. If OsO_4 is ingested, seek medical help. If OsO_4 vapor is inhaled, move the person to fresh air and seek medical attention at once.

Chronic exposure to low levels of OsO_4 can result in vision abnormalities. Those exposed have reported seeing "halos" in their vision or color rings around lights. Should such symptoms occur, *immediately* leave the area to fresh air and keep anyone else from entering the area without proper approved respiratory protection.

Disposal:

Working solutions of OsO_4 should be neutralized before disposal. To reduce hazards involved in discarding osmium tetroxide, the following neutralization procedures should be performed in a fume hood:

- A. A 2% solution of osmium tetroxide can be fully neutralized by twice its volume of vegetable oil (corn oil is preferred because of its high percentage of unsaturated bonds). For every 10 mL of 2% osmium tetroxide solution, 20 mL of corn oil is required. Pour the corn oil into the osmium tetroxide solution. Wait for the oil to completely turn black. To test if osmium tetroxide is fully neutralized, hold a piece of filter paper soaked in corn oil over the solution. Blackening indicates that osmium tetroxide is still present and more corn oil should be added.
- B. Aqueous solutions contaminated with osmium tetroxide can be fully neutralized by adding sodium sulfide or sodium sulfite to reduce osmium tetroxide to less hazardous forms. Test with filter paper soaked in corn oil. Dispose of neutralized solutions as hazardous waste.

Unused OsO_4 should be recycled. If you plan to ship this material for recycling or reuse, assure you are trained and are familiar with the requirements for shipping hazardous materials. Contact TEHS for assistance.

References:

- SPI Supplies MSDS sheet
- NIOHS Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication NO. 2001-149. Osmium Tetroxide.
- Prudent Practices in the Laboratory: Handling and Disposal of Chemicals (1995). National Research Council.
- Occupational Health guideline for Osmium Tetroxide. CDC. <http://www.cdc.gov/niosh/docs/81-123/pdfs/0473.pdf>
- UC San Diego. *Handling Osmium Tetroxide*. <http://blink.ucsd.edu/safety/research-lab/chemical/specific/osmium.html#Follow-these-training-guideline>