

# Standard Operating Procedure

## Working with Osmium Tetroxide

Osmium tetroxide, aka Osmic acid, perosmic oxide, osmium(IV) oxide, OsO<sub>4</sub> CAS 20816-12-0

**I. PERMISSIBLE EXPOSURE LIMIT:** Cal-OSHA PEL= 0.0002 ppm (0.002 mg/m<sup>3</sup>)  
Mp 40 °C, bp 130 °C, Vapor Pressure 7 mm Hg at 20 °C,

**II. MEDICAL SURVEILLANCE:** Under usual circumstances medical evaluation is not necessary. However, in the case of skin contamination and/or possible personal exposure including symptoms such as eye irritation, the personnel must get a medical evaluation. The exposure must be reported to the Chemical Safety Officer.

**III. HAZARDS SUMMARY:** Oxidizing material. Highly toxic. Contact with combustible materials may cause fire. May cause sensitization by inhalation or skin contact.

**ACUTE:** The acute toxicity of osmium tetroxide is high, and it is a severe irritant of the eyes and respiratory tract. Exposure to osmium tetroxide vapor can damage the cornea of the eye. Irritation is generally the initial symptom of exposure to low concentrations of osmium tetroxide vapor, and lacrimation, a gritty feeling in the eyes, 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. Contact of the eyes with concentrated solutions of this substance can cause severe damage and possible blindness.

Inhalation can cause headache, coughing, dizziness, lung damage, and difficult breathing and may be fatal. Contact of the vapor with skin can cause dermatitis, and direct contact with the solid can lead to severe irritation and burns. Exposure to osmium tetroxide via inhalation, skin contact, or ingestion can lead to systemic toxic effects involving liver and kidney damage. Osmium tetroxide is regarded as a substance with poor warning properties.

**CHRONIC:** Chronic exposure to osmium tetroxide can result in accumulation of osmium compounds in the liver and kidney and damage to these organs. Osmium tetroxide has been reported to cause reproductive toxicity in animals; this substance has not been shown to be carcinogenic or to show reproductive or developmental toxicity in humans.

### IV. CONTROL MEASURES

#### Engineering Controls

- Osmium tetroxide solutions must be prepared and handled in a certified chemical hood.
- Choose a hood with minimal equipment or obstructions to ensure good containment of vapors.
- Working surfaces should be protected with plastic backed absorbent pads to insure containment of any spills.
- Post the hood with a warning sign to alert others to the hazards, see warning sign at the end of this SOP.
- Ensure that the safety shower and eyewash are operational and access is unblocked .

#### Administrative Controls

The laboratory supervisor is responsible to ensure that this procedure is available, understood and adhered to by staff using osmium tetroxide in the laboratory. The MSDS must be readily available and the warning sign should be posted where the material is in use or stored.

#### Personal Protective Equipment

Lab coat, buttoned and sleeves rolled down, chemically-resistant wrist guards, safety goggles, double Nitrile gloves. If working outside a hood, a NOISH approved full-face respirator must be used. Use of a respirator requires medical clearance, training and fit-testing. Contact EH&S, 4- 8240 for assistance.

### V. SAFE USE PROCEDURES

Because of its high acute toxicity and powerful oxidizing ability, osmium tetroxide must be handled in the laboratory using prudent practices. In particular, all work with osmium tetroxide must be conducted in a fume hood to prevent exposure by inhalation, and personal protective equipment (see section below) must be worn at all times to prevent eye and skin contact.

Osmium tetroxide should be purchased as a liquid to avoid particulate exposure from the powdered form. The solutions should be stored in labeled tightly sealed containers, and these should be placed in secondary containment. Secondary containment should be used anytime the material is transported to another lab location.

When osmium tetroxide is freshly prepared and active, it is colorless to pale yellow in color. When the material reacts and causes oxidation, it turns black. This is helpful to know especially in the event of a splash or spill (see below) or inadvertent dermal exposure (black dots on skin).

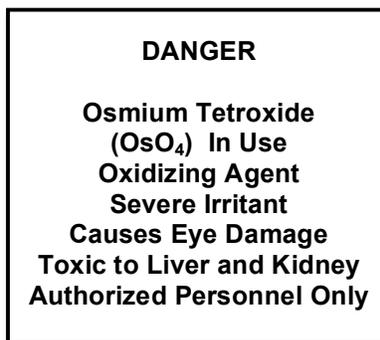
#### A. Training

1. Prior to conducting any work with osmium tetroxide, the Principal Investigator must provide training to his/her laboratory personnel specific to the hazards involved in working with this substance, work area decontamination, and emergency procedures.
2. The Principal Investigator must provide his/her laboratory personnel with a copy of this SOP and a copy of the osmium tetroxide MSDS provided by the manufacturer.
3. The Principal Investigator must ensure that his/her laboratory personnel have attended appropriate laboratory safety training or refresher training within the last two years.

**NOTE:** EH&S is available to assist in the education and training of personnel concerning safe work practices.

#### B. Signage

When osmium tetroxide is in use, warning signs (ie below and at the end of this SOP) must be posted on the chemical hood until the osmium tetroxide has been returned to storage.



#### C. Storage

1. Pure osmium tetroxide and concentrated solutions should be stored in a location that is secure to unauthorized access. Examples are a locked drawer or cabinet, or a refrigerator within a laboratory that is locked when authorized personnel are not present. A refrigerator containing osmium tetroxide must be labeled with a caution sign noting the presence of osmium tetroxide and its hazards.
2. Store pure osmium tetroxide and its concentrated solutions in appropriate, sealed glass containers within unbreakable secondary containment (i.e., a bottle or vial within a sealed compatible plastic jar or metal can with lid). Label all containers, including secondary containment, with the chemical name and hazard warning.

#### D. Handling and Solution Preparation

1. When moving pure osmium tetroxide to a chemical hood, do not remove it from the secondary containment until it is in the hood.
2. Prepare the smallest amount of solution necessary for the procedure, typically 50 mL or less. Prepare the solution volumetrically rather than gravimetrically. If a balance must be used, weighing must take place in the chemical hood.
3. Pure osmium tetroxide or its concentrated solutions must be opened only in a chemical hood that has been certified within the last 12 months. Just before use, the operation of the chemical hood must be verified by the use of an installed chemical hood monitoring device, a smoke test using a smoke generating tube, or a mechanical or electronic device that indicates air flow. During use, the sash must be lowered to operating height.
4. All lab ware that has contacted osmium tetroxide must be decontaminated by rinsing or dipping in corn oil or aqueous solutions of sodium sulfide or sodium sulfite before removing from the hood.
5. Immediately after work with osmium tetroxide, decontaminate any spills with kitty litter soaked with corn oil. Discard kitty litter as hazardous waste. Or use aqueous solutions of sodium sulfide or sodium sulfite.

**NOTE:** 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 osmium tetroxide to less hazardous forms.

## E. Personal Protective Equipment

The following minimum Personal Protective Equipment must be worn during operations with pure osmium tetroxide and concentrated solutions:

1. Chemical goggles (safety glasses alone are not adequate protection because of osmium tetroxide's severe effects on the eyes).
2. Disposable nitrile gloves (NOT latex). Double-gloving is recommended when working with pure osmium tetroxide or concentrated solutions. Change gloves frequently and when contaminated, punctured or torn. Wash hands immediately after removing gloves.
3. A standard or disposable laboratory coat or disposable coveralls. A standard laboratory coat may be reused before laundering if it has not been contaminated with osmium tetroxide. 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.
4. Closed-toed, leather shoes (not fabric or mesh).
5. Wash hands thoroughly immediately after working with any concentration of osmium tetroxide.

## F. Neutralizing Osmium Tetroxide

To reduce hazards involved in discarding osmium tetroxide, the following neutralization procedure should be employed:

1. Perform neutralization in a chemical hood.
2. 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.
3. Wait for the oil to completely turn black.
4. 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.
5. 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.
6. Dispose of neutralized solutions as hazardous waste.

## VI. SPILL GUIDANCE

In the event of a spill, it is most important to think through an appropriate response to avoid exposure of osmium tetroxide to anyone and to avoid further contamination of the location.

**Small Spills:** When the spill is small and manageable, quantity spilled is less than 2 mL, 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 gloves, buttoned lab coat, safety goggles).
- Cover the spill with corn oil-soaked kitty litter.
- Scoop the material up and place it in a sealed plastic bag.
- Wash the area with aqueous solution of sodium sulfite.
- 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 EH&S for pickup and appropriate disposal.

**Large Spills:** When the quantity spilled is greater than 2 mL, lab personnel will:

- Advise lab personnel to evacuate the area as soon as possible, without creating panic.
- Close all doors leading to lab.
- Place OSMIUM TETROXIDE SPILL; DO NOT ENTER sign on the door to inform others of the spill.
- Call 911 from a campus phone or 310-825-1491 from a cell phone to request the EH&S Hazmat Team.
- Notify the Research Advisor.
- Notify the Chemical Safety Officer.
- Provide EH&S Hazmat Team with as much information as possible.
- Provide EH&S Hazmat Team with corn oil-soaked kitty litter if needed for spill decontamination.

### ***Accidental Exposure to Osmium Tetroxide***

- If osmium tetroxide vapor has been inhaled from a spill, move the victim to fresh air immediately.
  - If osmium tetroxide has been spilled on skin or clothing, rinse the affected area with water, using a safety shower or eyewash, as appropriate, for a minimum of 15 minutes. During washing, remove contaminated clothing. A disposable laboratory coat or jumpsuit should be available for the exposed individual to wear after using a safety shower.
  - Notify the Research Advisor.
  - Notify the Chemical Safety Officer.
  - Seek medical attention as appropriate.
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- If an ambulance is needed because of injury, call 911 from a campus phone or 310-825-1491 from a cell phone.

### **VII. SAFE DISPOSAL PRACTICES**

SOLUTIONS: DO NOT dispose of leftover or spent solutions of osmium tetroxide by emptying into the laboratory sink. Collect solutions and solid osmium tetroxide in a labeled leak proof waste container for pickup and proper disposal by EH&S Hazardous Waste Pickup service. A completed waste label must be attached to the container.

SOLIDS: Collect pipette tips, gloves, ampoules, etc in a rigid leak proof container. Affix a completed waste label to the container. Due to the toxicity of osmium tetroxide, empty containers must also be collected and disposed as hazardous waste.

### **VIII. REFERENCES**

- 1) Prudent Practices in the Laboratory: Handling and Disposal of Chemicals (1995)  
<http://books.nap.edu/openbook.php?isbn=0309052297&page=364>
- 2) <http://www.umdj.edu/eohssweb/publications/OsmiumTetroxideSOP.pdf>
- 3) <http://www.scripps.edu/researchservices/ehs/chemicalsafety/ChemicalAgentSOP/OsmiumTetroxideSOP.pdf>
- 4) Cooper, K. "Neutralization of Osmium Tetroxide in case of accidental spillage and for disposal." *Bulletin of the Microscopical Society of Canada* **1988**, 8, 24-28.
- 5) Lunn, G.; Sansone, E.B. Osmium Tetroxide. Destruction of Hazardous Chemicals in the Laboratory; Program Resources, Inc. Frederick, MD; p 211 - 213.
- 6) Typical usage:
  - a) McKee, B. H.; Gilheany, D. G.; Sharpless, K. B. "(R,R)-1,2-Diphenyl-1,2-ethanediol (Stilbene Diol)" *Organic Syntheses* **1998**, Coll. Vol. 9, 383. [1992, 70, 47]
  - b) Herranz, E.; Sharpless, K. B. "Osmium-Catalyzed Vicinal Oxyamination of Olefins by Chloramine-T" *Organic Syntheses* **1990**, Coll. Vol. 7, 375. [1983, 61, 85]

# **DANGER**

## **Osmium Tetroxide (OsO<sub>4</sub>) In Use**

**Oxidizing Agent  
Severe Irritant  
Causes Eye Damage  
Toxic to Liver and Kidney**

### **Authorized Personnel Only**