

Occupational Health Guideline for Oxygen Difluoride

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: OF_2
- Synonyms: Difluorine monoxide; fluorine monoxide
- Appearance and odor: Colorless gas with a foul odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for oxygen difluoride is 0.05 part of oxygen difluoride per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 0.1 milligram of oxygen difluoride per cubic meter of air (mg/m^3).

HEALTH HAZARD INFORMATION

• Routes of exposure

Oxygen difluoride can affect the body if it is inhaled or if strong concentrations of oxygen difluoride gas contact the eyes or skin.

• Effects of overexposure

1. Short-term Exposure: Inhalation of oxygen difluoride has produced severe headaches in humans. Although there are no reports regarding the effects of exposure to this chemical on the eyes or skin of humans, it would be expected that contact of the gas under pressure with the eyes or skin would cause burns. In animal experiments, inhalation of oxygen difluoride has caused tearing, shortness of breath, muscular weakness, vomiting, severe breathing difficulties (which are sometimes delayed in onset), and death.

2. Long-term Exposure: None known

3. 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 oxygen difluoride.

• Recommended medical surveillance

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

1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the lungs and eyes should be stressed.

—14" x 17" chest roentgenogram: Oxygen difluoride causes lung damage. Surveillance of the lungs is indicated.

—FVC and FEV (1 sec): Oxygen difluoride is a severe pulmonary irritant. Persons with impaired pulmonary function may be at increased risk from exposure. Periodic surveillance is indicated.

2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis, except that an x-ray is necessary only when indicated by the results of pulmonary function testing, or by signs and symptoms of respiratory disease.

• Summary of toxicology

Oxygen difluoride gas is a severe respiratory irritant. In monkeys and dogs, the LC50 was 26 ppm for 60 minutes; signs of toxicity were lacrimation, dyspnea, muscular weakness, and vomiting; at autopsy, massive pulmonary edema and hemorrhage were observed. In mice, exposure to a low concentration (1 ppm for 60 minutes) produced tolerance to subsequent exposures 8 days later at levels which would otherwise have been fatal (4.25 ppm for 60 minutes). In humans, inhalation of the gas at fractions of a ppm produced intractable headache. Although there are no reports of effects on the eyes or skin of humans, it would be expected that

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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the gas under pressure impinging upon the eyes or skin would produce serious burns.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 54
2. Boiling point (760 mm Hg): $-145\text{ C } (-229\text{ F})$
3. Specific gravity (water = 1): 1.5 (liquid at boiling point)
4. Vapor density (air = 1 at boiling point of oxygen difluoride): 1.86
5. Melting point: $-224\text{ C } (-371\text{ F})$
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): 0.02 (reacts slowly)
8. Evaporation rate (butyl acetate = 1): Not applicable

• Reactivity

1. Conditions contributing to instability: Temperatures greater than 250 C (482 F) will cause oxygen difluoride to decompose and cause pressure increases in cylinders.

2. Incompatibilities: Contact with all combustible materials, chlorine, bromine, iodine, platinum, and many other metals, metal oxides, and moist air may cause fires and explosions.

3. Hazardous decomposition products: Toxic gases and vapors (such as hydrogen fluoride and carbon monoxide) may be released when oxygen difluoride decomposes.

4. Special precautions: Oxygen difluoride will attack some forms of plastics, rubber, and coatings. See 29 CFR 1910.101 for specific regulations on storage of compressed gas cylinders.

• Flammability

1. Not combustible, but strong oxidizing agent

• Warning properties

1. Odor Threshold: The AIHA *Hygienic Guide* states that "the odor of oxygen difluoride can be detected by some persons at 0.1 ppm and by most at 0.5 ppm. The odor, however, may not be relied upon for warning purposes, as it is not characteristic and because olfactory fatigue develops rapidly."

2. Eye Irritation Level: The AIHA *Hygienic Guide* states that "no signs of irritation of the external mucosa of the eye were observed in rats subjected to the lethal exposure of 15 ppm oxygen difluoride for 15 minutes."

3. Evaluation of Warning Properties: Since the *Hygienic Guide* points out that "olfactory fatigue develops rapidly" upon exposure to oxygen difluoride, and since no other quantitative information is available relating its warning properties to air concentrations, this gas is 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 oxygen difluoride 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 oxygen difluoride may occur and control methods which may be effective in each case:

Operation	Controls
Liberation during use as an oxidizer in rocket propellants	Process enclosure; local exhaust 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 strong concentrations of oxygen difluoride gas get into the eyes, wash eyes immediately with large

amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately.

- **Skin Exposure**

If strong concentrations of oxygen difluoride gas get on the skin, immediately wash the skin with large quantities of water. If irritation persists after washing, get medical attention.

- **Breathing**

If a person breathes in large amounts of oxygen difluoride, 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 PROCEDURES

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

- If oxygen difluoride is leaked, the following steps should be taken:

1. Ventilate area of leak to disperse gas.

2. 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 with a mixed solution of caustic soda and slaked lime.

REFERENCES

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RESPIRATORY PROTECTION FOR OXYGEN DIFLUORIDE

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.
Greater than 0.5 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 containing non-oxidizable sorbents and providing protection against oxygen difluoride.*** Any escape self-contained breathing apparatus.

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

**Use of supplied-air suits may be necessary to prevent skin contact while providing respiratory protection from airborne concentrations of oxygen difluoride; however, this equipment should be selected, used, and maintained under the immediate supervision of trained personnel. Where supplied-air suits are used above a concentration of 0.5 ppm, an auxiliary self-contained breathing apparatus operated in positive pressure mode should also be worn.

***Oxygen difluoride is a strong oxidizer and should not come in contact with oxidizable materials. Some cartridges and canisters may contain oxidizable materials, such as activated charcoal, and therefore should not be used to provide protection against oxygen difluoride. Only non-oxidizable sorbents should be used.