

Occupational Health Guideline for Hydrogen Peroxide

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_2O_2
- Synonyms: High-strength hydrogen peroxide; peroxide; hydrogen dioxide
- Appearance and odor: Colorless liquid with a slightly sharp odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for hydrogen peroxide is 1 part of hydrogen peroxide per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 1.4 milligrams of hydrogen peroxide per cubic meter of air (mg/m^3).

HEALTH HAZARD INFORMATION

• Routes of exposure

Hydrogen peroxide 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 vapor from hydrogen peroxide may cause extreme irritation of the eyes, nose, and throat. Splashes of hydrogen peroxide in the eyes may cause severe damage and possible blindness. Eye damage may appear a week or more after exposure. If the liquid is splashed on the skin, it may cause tingling and temporary whitening. If the skin is washed promptly, the skin will return to normal in 2 or 3 hours. If the hydrogen peroxide is not removed, redness and blister formation may result. If swallowed, hydrogen peroxide may cause injury to

the mouth and throat with possible bleeding from the esophagus and stomach. The swallowed hydrogen peroxide may produce large quantities of oxygen gas which may distend the esophagus and stomach and cause severe 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 hydrogen peroxide.

• Recommended medical surveillance

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

—Eye disease: Hydrogen peroxide, 90 percent, is an eye irritant. Persons with pre-existing eye disorders may be more susceptible to the effects of this agent.

—Chronic respiratory disease: Hydrogen peroxide, 90 percent, causes respiratory irritation in animals. In persons with impaired pulmonary function, especially those with obstructive airway diseases, the breathing of hydrogen peroxide, 90 percent, might cause exacerbation of symptoms due to its irritant properties.

—Skin disease: Hydrogen peroxide, 90 percent, 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

Ninety percent hydrogen peroxide vapor, mist, or liquid irritates the eyes, mucous membranes, and skin. Repeated exposure of dogs to 7 ppm for 6 months caused sneezing, lacrimation, and bleaching of hair; at autopsy there was local atelectasis. In humans, inhalation of high concentrations of vapor or mist may cause extreme irritation and inflammation of the nose and

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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throat. Exposure for a short period to mist or diffused spray may cause stinging of the eyes and lacrimation. Splashes of the liquid in the eyes may cause severe damage, including ulceration of the cornea; there may be a delayed appearance of damage to the eyes, and corneal ulceration has, on rare occasions, appeared even a week or more after exposure. Skin contact with the liquid for a short time will cause a temporary whitening or bleaching of the skin; if splashes on the skin are not removed, erythema and formation of vesicles may occur. Ingestion may cause irritation of the upper gastrointestinal tract; decomposition of the hydrogen peroxide will result in the rapid liberation of oxygen, which may distend and damage the esophagus or stomach.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 34
2. Boiling point (760 mm Hg): 141 C (286 F) (calculated)
3. Specific gravity (water = 1): 1.38
4. Vapor density (air = 1 at boiling point of hydrogen peroxide): Not applicable (decomposes)
5. Melting point: -11 C (12 F)
6. Vapor pressure at 30 C (86 F): 5 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): Miscible in all proportions
8. Evaporation rate (butyl acetate = 1): Data not available

• Reactivity

1. Conditions contributing to instability: Hydrogen peroxide decomposes slowly at ordinary temperatures and builds up pressure if the container is closed. The rate of decomposition doubles for each 10 C rise (1.5 times 10 C rise) in temperature and becomes self-sustaining at 141 C (285 F). Contaminated hydrogen peroxide can decompose at a rate that will exceed the capacity of the vent in the container. Hydrogen peroxide in concentrations up to about 90% does not readily detonate. Higher concentrations or elevated temperatures may facilitate detonation.

2. Incompatibilities: Contact with most organic or readily oxidizable materials and combustibles causes fires and explosions. Contact with iron, copper, brass, bronze, chromium, zinc, lead, manganese, silver, and other catalytic metals (or their salts) causes rapid decomposition with evolution of oxygen gas and heat which may increase container pressure.

3. Hazardous decomposition products: None

4. Special precautions: Liquid hydrogen peroxide will attack some forms of plastics, rubber, and coatings; many will ignite. The adiabatic decomposition temperature is 740 C (1364 F), so that most combustible materials in contact with the decomposition products will readily burst into flames.

• Flammability

1. Not combustible, but a powerful oxidizing agent

• Warning properties

1. Odor Threshold: No quantitative information is available concerning the odor threshold of hydrogen peroxide.

2. Eye Irritation Level: The AIHA *Hygienic Guide* states that "the eyes do not appear to be damaged from exposure to the vapor." Grant reports, "Injuries of human eyes have been rare. Workers exposed to vapors from 90% hydrogen peroxide have noted primarily respiratory irritation, but a splash of such high concentration is generally feared as a potential cause of severe corneal damage"

'Experimental exposure of dogs to 7 ppm hydrogen peroxide in air 6 hours a day caused no adverse effect during 23 weeks but then began to cause sneezing and lacrimation. Rabbits similarly exposed for 10 weeks suffered no corneal damage.'

Deichmann and Gerarde, however, note that "vapors are irritating to the eyes, nose and throat."

According to the *Hygienic Guide*, hydrogen peroxide can be "recognized only by irritant effects, especially in nasal passages." They give an irritation threshold of approximately 100 ppm.

3. Evaluation of Warning Properties: Hydrogen peroxide has 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 hydrogen peroxide 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 Enforce-

ment 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 any possibility of skin contact with liquid hydrogen peroxide.
- Clothing contaminated with hydrogen peroxide should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of hydrogen peroxide from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the hydrogen peroxide, the person performing the operation should be informed of hydrogen peroxide's hazardous properties.
- Where there is any possibility of exposure of an employee's body to liquid hydrogen peroxide, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.
- Non-impervious clothing which becomes contaminated with hydrogen peroxide should be removed immediately and not reworn until the hydrogen peroxide is removed from the clothing.
- Employees should be provided with and required to use splash-proof safety goggles where there is any possibility of liquid hydrogen peroxide contacting the eyes.
- Where there is any possibility that employees' eyes may be exposed to liquid hydrogen peroxide, an eye-wash fountain should be provided within the immediate work area for emergency use.

SANITATION

- Skin that becomes contaminated with hydrogen peroxide should be promptly washed or showered to remove any hydrogen peroxide.
- Employees who handle liquid hydrogen peroxide 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 hydrogen peroxide may occur and control methods which may be effective in each case:

Operation

Use in manufacture of propellants for military and space programs; use as a component of explosives

Use in chemical synthesis as an oxidant in organic and inorganic synthesis

Use as a polymerization promoter; use as a bleaching agent for oils, waxes, fats, and discolored concentrated acids

Controls

Process enclosure; general dilution ventilation; personal protective equipment; vented containers; ample available water supply

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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 liquid hydrogen peroxide 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 liquid hydrogen peroxide gets on the skin, immediately flush the contaminated skin with water. If liquid hydrogen peroxide soaks through the clothing, remove the clothing immediately and flush the skin with water. Get medical attention promptly.

• Breathing

If a person breathes in large amounts of hydrogen peroxide, 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 hydrogen peroxide 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 hydrogen peroxide is spilled or leaked, the following steps should be taken:

1. Ventilate area of spill or leak.
2. Dilute with copious quantities of water.

- Waste disposal method:

After dilution with copious quantities of water, hydrogen peroxide may be flushed into a sewer.

REFERENCES

- American Conference of Governmental Industrial Hygienists: "Hydrogen Peroxide (90%)," *Documentation of the Threshold Limit Values for Substances in Workroom Air* (3rd ed., 2nd printing), Cincinnati, 1974.

- American Industrial Hygiene Association: "Hydrogen Peroxide (90%)," *Hygienic Guide Series*, Detroit, Michigan, 1957.

- Deichmann, W. B., and Gerarde, H. W.: *Toxicology of Drugs and Chemicals*, Academic Press, New York, 1969.

- Grant, W. M.: *Toxicology of the Eye* (2nd ed.), C. C. Thomas, Springfield, Illinois, 1974.

- International Labour Office: *Encyclopedia of Occupational Health and Safety*, McGraw-Hill, New York, 1971.

- Manufacturing Chemists Association, Inc.: *Chemical Safety Data Sheet SD-53, Hydrogen Peroxide*, Washington, D.C., 1969.

- Oberst, F. W., et al.: "Inhalation Toxicity of Ninety Per Cent Hydrogen Peroxide Vapor - Acute, Subacute, and Chronic Exposures of Laboratory Animals," *A.M.A. Archives of Industrial Hygiene and Occupational Medicine*, 10:319-327, 1954.

- Spector, W. S. (Vols. I, II), Negherbon, W. O. (Vol. III), Grebe, R. M. (Vol. IV), and Dittmer, D. S. (Vol. V) (eds.): *Handbook of Toxicology*, Saunders, Philadelphia, 1956-1959.

RESPIRATORY PROTECTION FOR HYDROGEN PEROXIDE (90%)

Condition	Minimum Respiratory Protection* Required Above 1 ppm
Vapor Concentration	
10 ppm or less	Any supplied-air respirator. Any self-contained breathing apparatus.
50 ppm or less	Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
75 ppm or less	A Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous-flow mode.
Greater than 75 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 hydrogen peroxide. 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 hydrogen peroxide; 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 75 ppm, an auxiliary self-contained breathing apparatus operated in positive pressure mode should also be worn.

