

Occupational Health Guideline for Sodium Hydroxide

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: NaOH
- Synonyms: Caustic soda, soda lye, lye
- Appearance and odor: White, odorless solid.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for sodium hydroxide is 2 milligrams of sodium hydroxide per cubic meter of air (mg/m^3) averaged over an eight-hour work shift. NIOSH has recommended that the permissible exposure limit be changed to a ceiling of $2 \text{ mg}/\text{m}^3$ over a 15-minute period. The NIOSH Criteria Document for Sodium Hydroxide should be consulted for more detailed information.

HEALTH HAZARD INFORMATION

• Routes of exposure

Sodium hydroxide 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

Sodium hydroxide is a strong alkali and is corrosive to any tissue with which it comes in contact. Effects from inhalation of the dusts and mists will vary from mild irritation to destructive burns depending on the severity of exposure. Severe pneumonitis may occur. Sodium hydroxide as a solid or in dusts, mists or solutions may cause irritation of the eyes and, with greater exposure, severe burns with possible blindness. Contact of the skin with sodium hydroxide as a solid or in dusts, mists or

solutions may cause skin irritation and, with greater exposure, severe burns with scarring. Swallowing solid sodium hydroxide or solutions of sodium hydroxide may cause severe burns of the mouth, throat, and stomach. Death may result. Severe scarring of the throat may occur on recovery after swallowing sodium hydroxide. An increased number of esophageal cancer cases have been reported to occur in individuals who have scarring of the esophagus from swallowing sodium hydroxide.

• 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 sodium hydroxide.

• Recommended medical surveillance

The following medical procedures should be made available to each employee who is exposed to sodium hydroxide 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 eyes and respiratory tract should be stressed. The skin should be examined for evidence of chronic disorders.

—14" x 17" chest roentgenogram: Sodium hydroxide causes human lung damage. Surveillance of the lungs is indicated.

—FVC and FEV (1 sec): Sodium hydroxide is a respiratory 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 considered necessary only when indicated by the results of pulmonary function testing, or by signs and symptoms of respiratory disease.

• Summary of toxicology

Sodium hydroxide is a strong alkali; the mist, dust and solutions cause severe injury to the eyes, mucous mem-

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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branes, and skin. Although inhalation is usually of secondary importance in industrial exposures, the effects from the dust or mist will vary from mild irritation of the nose at 2 mg/m³ to severe pneumonitis, depending on the severity of exposure. The greatest industrial hazard is rapid tissue destruction of eyes or skin upon contact with either the solid or with concentrated solutions. Contact with the eyes causes disintegration and sloughing of conjunctival and corneal epithelium, corneal opacification, marked edema, and ulceration; after 7 to 13 days either gradual recovery begins, or there is progression of ulceration and corneal opacification. Complications of severe eye burns are symblepharon (adhesion of the lid to the eyeball) with overgrowth of the cornea by a vascularized membrane, progressive or recurrent corneal ulceration, and permanent corneal opacification. On the skin, solutions of 25 to 50% cause the sensation of irritation within about 3 minutes; with solutions of 4%, this does not occur until after several hours. If not removed from the skin, severe burns with deep ulceration will occur; exposure to the dust or mist may cause multiple small burns, with temporary loss of hair. Ingestion produces severe pain in the esophagus and stomach, corrosion of the lips, mouth, tongue, and pharynx and the vomiting of large pieces of mucosa; cases of squamous cell carcinoma of the esophagus have occurred with latent periods of 12 to 42 years after ingestion; these cancers may have been sequelae of tissue destruction and possibly scar formation rather than from a direct carcinogenic action of sodium hydroxide itself.

CHEMICAL AND PHYSICAL PROPERTIES

• Physical data

1. Molecular weight: 40
2. Boiling point (760 mm Hg): 1390 C (2534 F)
3. Specific gravity (water = 1): 2.13
4. Vapor density (air = 1 at boiling point of sodium hydroxide): Not applicable
5. Melting point: 310 C (590 F)
6. Vapor pressure at 20 C (68 F): Essentially zero
7. Solubility in water, g/100 g water at 20 C (68 F): 50
8. Evaporation rate (butyl acetate = 1): Not applicable

• Reactivity

1. Conditions contributing to instability: None
2. Incompatibilities: Contact with water, acids, flammable liquids, and organic halogen compounds, especially trichloroethylene, may cause fires and explosions. Contact with metals such as aluminum, tin, and zinc causes formation of flammable hydrogen gas. Contact with nitromethane and other similar nitro compounds causes formation of shock-sensitive salts.
3. Hazardous decomposition products: None
4. Special precautions: Sodium hydroxide will attack some forms of plastics, rubber, and coatings.

• Flammability

1. Not combustible

• Warning properties

Grant states that sodium hydroxide "is severely injurious to all tissues, and causes some of the most severe injuries of the eye. The serious problem presented by sodium hydroxide and other alkalis which cause devastating injuries of the eye have been succinctly and well described by Stanley, emphasizing particularly the dangers of caustic household drain cleaners that contain sodium hydroxide.

"The effects of splashes of sodium hydroxide on the eyes of human beings have been described innumerable times Damage of the cornea, conjunctiva, and episcleral tissues is usual, but damage of intraocular structures is relatively rare."

MONITORING AND MEASUREMENT PROCEDURES

• Eight-Hour Exposure Evaluation

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).

• Ceiling Evaluation

Measurements to determine employee ceiling exposure are best taken during periods of maximum expected airborne concentrations of sodium hydroxide. Each measurement should consist of a fifteen (15) minute sample or series of consecutive samples totalling fifteen (15) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

• Method

Sampling and analyses may be performed by collection of sodium hydroxide in a glass bubbler containing hydrochloric acid, followed by subsequent titration. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure sodium hydroxide may be used. An analytical method for sodium hydroxide is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 1, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00267-3).

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 any possibility of skin contact with sodium hydroxide or solutions of sodium hydroxide.

- If employees' clothing may have become contaminated with solid sodium hydroxide, employees should change into uncontaminated clothing before leaving the work premises.

- Where there is any possibility of exposure of an employee's body to sodium hydroxide or solutions of sodium hydroxide, 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 sodium hydroxide should be removed immediately and not reworn until the sodium hydroxide is removed from the clothing.

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

- Employees should be provided with and required to use dust- and splash-proof safety goggles where there is any possibility of sodium hydroxide or solutions of sodium hydroxide contacting the eyes.

- Where there is any possibility that employees' eyes may be exposed to sodium hydroxide or solutions of sodium hydroxide, an eye-wash fountain should be provided within the immediate work area for emergency use.

SANITATION

- Skin that becomes contaminated with sodium hydroxide should be immediately washed or showered to remove any sodium hydroxide.
- Eating and smoking should not be permitted in areas where sodium hydroxide or solutions containing sodium hydroxide are stored.

COMMON OPERATIONS AND CONTROLS

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

Operation	Controls
Use in chemical manufacture; explosives manufacture; use in boiler water and as a laboratory reagent; use in pH control in textiles, paper, and chemical industries	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Use in manufacture of synthetic fibers and plastics	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Use in manufacture of pulp and paper; in pulping Kraft process; manufacture of insulating board	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Use in metal processing and refining; use in petroleum refining for removal of sulfur compounds; as a flotation reagent; as a modifier and slime depressant; in pH control	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Use in manufacture of soaps and detergents; as a saponifying agent; use in metal cleaning; in laundering, bleaching, and dishwashing; use in drain cleaners and oven cleaners	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Use in food processing to peel fruits and vegetables, process olives, and refine vegetable oils	Local exhaust ventilation; general dilution ventilation; personal protective equipment

Use in glass manufacture as a source of sodium oxide

Local exhaust ventilation; general dilution ventilation; personal protective equipment

Sodium hydroxide may be disposed of in sealed containers in a secured sanitary landfill.

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 sodium hydroxide, as a solid or in dusts, mists, or solutions, get 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 sodium hydroxide, as a solid or in dusts, mists, or solutions, gets on the skin, immediately flush the contaminated skin with water. If sodium hydroxide, as a solid or in dusts, mists, or solutions, penetrates through the clothing, remove the clothing immediately and flush the skin with water. Get medical attention immediately.

• Breathing

If a person breathes in large amounts of sodium hydroxide, 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

If solutions of sodium hydroxide have been swallowed and the person is conscious, give him large quantities of water immediately to dilute the sodium hydroxide. Do not attempt to make the exposed 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 AND DISPOSAL PROCEDURES

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

• If sodium hydroxide is spilled, the following steps should be taken:

1. Ventilate area of spill.
2. Dilute with water and neutralize with 6 molar hydrochloric acid.

• Waste disposal method:

ADDITIONAL INFORMATION

To find additional information on sodium hydroxide, look up sodium hydroxide in the following documents:

- Medical Surveillance for Chemical Hazards
- Respiratory Protection for Chemical Hazards
- Personal Protection and Sanitation for Chemical Hazards
- NIOSH Criteria Document for Sodium Hydroxide (September 1975)

These documents are available through the NIOSH Division of Technical Services, 4676 Columbia Parkway, Cincinnati, Ohio 45226.

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RESPIRATORY PROTECTION FOR SODIUM HYDROXIDE

Condition	Minimum Respiratory Protection* Required Above 2 mg/m ³
Particulate Concentration	
100 mg/m ³ or less	A high efficiency particulate filter respirator with a full facepiece. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
200 mg/m ³ or less	A powered air-purifying respirator with a full facepiece and a high efficiency particulate filter. 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 200 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 dust and mist respirator with a full facepiece, except single-use. Any escape self-contained breathing apparatus with a full facepiece.

*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 sodium hydroxide; 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 200 mg/m³, an auxiliary self-contained breathing apparatus operated in positive pressure mode should also be worn.