OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR CALCIUM HYDROXIDE

INTRODUCTION

This guideline summarizes pertinent information about calcium hydroxide for workers and employers as well as for physicians, industrial hygienists, and other occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments in these fields; readers are therefore advised to regard these recommendations as general guidelines and to determine periodically whether new information is available.

SUBSTANCE IDENTIFICATION

- **Formula**

  $Ca(OH)_2$

- **Synonyms**

  Bell mine, calcium hydrate, hydrated lime, caustic lime, Kemikal, slaked lime

- **Identifiers**

  1. CAS No: 1305-62-0
  2. RTECS No.: EW2800000
  3. DOT UN: None
  4. DOT label: None

- **Appearance and odor**

  Calcium hydroxide is a soft, white, powder or granule, noncombustible material with a bitter taste and no odor.

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

  1. Molecular weight: 74.1
  2. Boiling point (760 mm Hg): Decomposes at 580°C (1,076°F)
  3. Specific gravity (water = 1): 2.24 at 20°C (68°F)
  4. Vapor density: Not applicable
  5. Melting point: 580°C (1,076°F) (loses its water)
  6. Vapor pressure: Not applicable
  7. Solubility: Soluble in water, sugar or ammonium solutions, acids, and glycerol; insoluble in alcohol
  8. Evaporation rate: Not applicable

- **Reactivity**

  1. Conditions contributing to instability: Heat, sparks, and open flame
  2. Incompatibilities: Explosions may result from con-

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tact of calcium hydroxide with maleic anhydride, phosphorus, nitroethane, nitromethane, nitroparaffins, or nitropropane.

3. Hazardous decomposition products: Toxic particulates (such as calcium oxide) may be released in a fire involving calcium hydroxide.

ACGIH TLV

The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned calcium hydroxide a threshold limit value (TLV) of 5 mg/m^3 as a TWA for a normal 8-hr workday and a 40-hr workweek [ACGIH 1993].

- **Rationale for limits**

The OSHA and ACGIH limits are based on the risk of irritation associated with exposure to calcium hydroxide.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

Exposure to calcium hydroxide can occur through inhalation, eye or skin contact, and ingestion.

- **Summary of toxicology**

1. *Effects on Animals:* Calcium hydroxide is a corrosive that affects all tissues it contacts. Direct application of an aqueous 10% calcium hydroxide solution to the central corneal surface of rabbit eyes resulted in corrosion with persisting severe irritation beyond 21 days [NLM 1992]. The oral LD_{50}s in rats and mice are 7,340 and 7,300 mg/kg, respectively [NIOSH 1991]. The eyes of rabbits were severely affected by the application of 10 mg calcium hydroxide [Grant 1986; Sax and Lewis 1989]. Rats whose drinking water contained 50 or 350 mg calcium hydroxide/liter became restless and aggressive after 2 months and showed a loss in body weight, decreased phagocyte and erythrocyte counts, and decreased hemoglobin after 3 months on this regimen. Autopsy showed inflammation of the small intestines and dystrophic changes in the stomach, kidneys, and liver of these animals [Proctor et al. 1988].

2. *Effects on Humans:* Calcium hydroxide is a tissue corrosive and one of the most common causes of corrosive chemical eye burns. Direct contact of the skin with calcium hydroxide causes skin irritation and may also lead to corrosive chemical burns [Grant 1986; Clayton and Clayton 1981]. Because calcium hydroxide slowly penetrates the skin, the degree of damage is directly related to the degree and duration of exposure [NLM 1992]. Prolonged contact of the skin with calcium hydroxide may cause skin desquamation and a vesicular rash, skin ulceration, and corrosion in some cases [Parmeggiani 1983; NLM 1992]. Ingestion of this material has caused severe pain, vomiting, tissue corrosion, perforation, and death. Survivors may develop esophageal strictures [NLM 1992]. Chronic dermatitis can also be induced by repeated exposure to this alkali [NLM 1992]. Chronic inhalation of calcium hydroxide dust is reported to have caused bronchitis and pneumonia [Parmeggiani 1983].

- **Signs and symptoms of exposure**

1. *Acute exposure:* Calcium hydroxide can induce redness, tearing, irritation, or corrosion of the eyes; runny nose, upper respiratory tract irritation, bronchitis, and pneumonia; and redness, rashes, irritation, or corrosion of the skin.

2. *Chronic exposure:* Calcium hydroxide can cause chronic skin dermatitis, desquamation, vesiculation, and ulceration, as well as coughing, fluid in the lungs, and difficult breathing.

- **Emergency procedure**

> **WARNING!**
>
> **Transport victims immediately to emergency medical facility!**

Keep unconscious victims warm and on their sides to avoid choking if vomiting occurs. ***Immediately*** initiate the following emergency procedures, continuing them as appropriate en route to the emergency medical facility:

1. *Eye exposure:* Tissue destruction and blindness may result! ***Immediately but gently*** flush the eyes with large amounts of water for at least 15 min, occasionally lifting the upper and lower eyelids.

2. *Skin exposure:* Severe burns and skin corrosion may result! ***Immediately*** remove all contaminated clothing! ***Immediately, continuously, and gently*** wash

skin for at least 15 min. Use soap and water if skin is intact; use only water if skin is not intact.

3. *Inhalation exposure:* Move the victim to fresh air ***immediately.*** Have the victim blow his or her nose, or use a soft tissue to remove particulates or residues from the nostrils.

   If the victim is not breathing, clean any chemical contamination from the victim's lips and perform cardiopulmonary resuscitation (CPR); if breathing is difficult, give oxygen.

4. *Ingestion exposure:* Take the following steps if calcium hydroxide or any material containing it is ingested:

   —Do ***not*** induce vomiting.

   —Have the victim rinse the contaminated mouth cavity several times with a fluid such as water. Immediately after rinsing, have the victim drink one cup (8 oz) of fluid and ***no more***.

   —Do ***not*** permit the victim to drink milk or carbonated beverages!

   —Do ***not*** permit the victim to drink any fluid if more than 60 min have passed since initial ingestion.

NOTE: These instructions must be followed exactly. Drinking a carbonated beverage or more than one cup of fluid could create enough pressure to perforate already damaged stomach tissue. The tissue-coating action of milk can sometimes impede medical assessment of tissue damage. Ingestion of any fluid more than 60 min after initial exposure could further weaken damaged tissue and result in perforation.

5. *Rescue:* Remove an incapacitated worker from further exposure and implement appropriate emergency procedures (e.g., those listed on the material safety data sheet required by OSHA's hazard communication standard [29 CFR 1910.1200]). All workers should be familiar with emergency procedures and the location and proper use of emergency equipment.

EXPOSURE SOURCES AND CONTROL METHODS

The following operations may involve calcium hydroxide and may result in worker exposures to this substance:

—Manufacture of medicinal antacids, fecal deodorants, polysaccharides, mortar, plaster, whitewash, cement, and other paving and building materials

—Use as an intermediate in the production of propylene oxide and calcium hypochlorite, as a flux in iron and steel manufacture, and as a buffering agent for metals, pearls, and celluloid

—Use in lubricants, drilling fluids, fertilizers, and pesticides

—Use to dehair hides

—Use in water softening and treatment and in water-based paints

—Use in fireproofing compounds, fireproof coatings, and in soil treatment

—Use as a scrubbing and neutralizing agent in the chemical industry

—Manufacture of calcium salts, causticizing soda, and depilatories

—Use in ammonia recovery, in gas manufacture, in paper pulp manufacture, in the purification of sugar juices, as a disinfectant, as an accelerator for low-grade rubber compounds, in petrochemicals, and as a shell-forming agent in the poultry industry

The following methods are effective in controlling worker exposures to calcium hydroxide, depending on the feasibility of implementation:

—Process enclosure

—Local exhaust ventilation

—General dilution ventilation

—Personal protective equipment

Good sources of information about control methods are as follows:

1. ACGIH [1992]. Industrial ventilation—a manual of recommended practice. 21st ed. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

2. Burton DJ [1986]. Industrial ventilation—a self study companion. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

3. Alden JL, Kane JM [1982]. Design of industrial ventilation systems. New York, NY: Industrial Press, Inc.

4. Wadden RA, Scheff PA [1987]. Engineering design for control of workplace hazards. New York, NY: McGraw-Hill.

5. Plog BA [1988]. Fundamentals of industrial hygiene. Chicago, IL: National Safety Council.

MEDICAL MONITORING

Workers who may be exposed to chemical hazards should be monitored in a systematic program of medical surveillance that is intended to prevent occupational injury and disease. The program should include education of employers and workers about work-related hazards, early detection of adverse health effects, and referral of workers for diagnosis and treatment. The occurrence of disease or other work-related adverse health effects should prompt immediate evaluation of primary preventive measures (e.g., industrial hygiene monitoring, engineering controls, and personal protective equipment). A medical monitoring program is intended to supplement, not replace, such measures. To place workers effectively and to detect and control work-related health effects, medical evaluations should be performed (1) before job placement, (2) periodically during the term of employment, and (3) at the time of job transfer or termination.

- **Preplacement medical evaluation**

  Before a worker is placed in a job with a potential for exposure to calcium hydroxide, the licensed health care professional should evaluate and document the worker's baseline health status with thorough medical, environmental, and occupational histories, a physical examination, and physiologic and laboratory tests appropriate for the anticipated occupational risks. These should concentrate on the function and integrity of the skin and respiratory tract. Medical monitoring for respiratory disease should be conducted using the principles and methods recommended by the American Thoracic Society [ATS 1987].

  A preplacement medical evaluation is recommended to detect and assess medical conditions that may be aggravated or may result in increased risk when a worker is exposed to calcium hydroxide at or below the prescribed exposure limit. The licensed health care professional should consider the probable frequency, intensity, and duration of exposure as well as the nature and degree of any applicable medical condition. Such conditions (which should not be regarded as absolute contraindications to job placement) include a history and other findings consistent with skin or respiratory tract diseases.

- **Periodic medical examinations and biological monitoring**

  Occupational health interviews and physical examinations should be performed at regular intervals during the employment period, as mandated by any applicable Federal, State, or local standard. Where no standard exists and the hazard is minimal, evaluations should be conducted every 3 to 5 years or as frequently as recommended by an experienced occupational health physician. Additional examinations may be necessary if a worker develops symptoms attributable to calcium hydroxide exposure. The interviews, examinations, and medical screening tests should focus on identifying the adverse effects of calcium hydroxide on the skin and respiratory tract. Current health status should be compared with the baseline health status of the individual worker or with expected values for a suitable reference population.

  Biological monitoring involves sampling and analyzing body tissues or fluids to provide an index of exposure to a toxic substance or metabolite. No biological monitoring test acceptable for routine use has yet been developed for calcium hydroxide.

- **Medical examinations recommended at the time of job transfer or termination**

  The medical, environmental, and occupational history interviews, the physical examination, and selected physiologic or laboratory tests that were conducted at the time of placement should be repeated at the time of job transfer or termination. Any changes in the worker's health status should be compared with those expected for a suitable reference population.

WORKPLACE MONITORING AND MEASUREMENT

A worker's exposure to airborne calcium hydroxide is determined by using a mixed cellulose ester filter (0.8 micron). Samples are collected at a maximum flow rate of 2 liters/min until a maximum air volume of 480 liters is collected. The sample is then treated with water to extract the calcium hydroxide. Analysis is conducted by atomic absorption spectroscopy. This method has a sampling and analytical error of 0.28 and is included in the OSHA Laboratory In-House Methods File [OSHA 1989].

PERSONAL HYGIENE

If calcium hydroxide contacts the skin, workers should immediately wash the affected areas with soap and water.

Clothing contaminated with calcium hydroxide should be removed immediately, and provisions should be made for safely removing this chemical from these articles. Persons laundering contaminated clothing should be informed of the hazardous properties of calcium hydroxide, particularly its potential to cause skin burns.

A worker who handles calcium hydroxide should thoroughly wash hands, forearms, and face with soap and water before eating, using tobacco products, using toilet facilities, or applying cosmetics.

Workers should not eat, drink, use tobacco products, or apply cosmetics in areas where calcium hydroxide or a solution containing calcium hydroxide is handled, processed, or stored.

STORAGE

Calcium hydroxide should be stored in a cool, dry, well-ventilated area in tightly sealed containers that are labeled in accordance with OSHA's hazard communication standard [29 CFR 1910.1200]. Containers of calcium hydroxide should be protected from physical damage and should be stored separately from acidic materials, maleic anhydride, nitroethane, nitromethane, nitropropane, nitroparaffins, phosphorus, heat, sparks, and open flame. Because containers that formerly contained calcium hydroxide may still hold product residues, they should be handled appropriately.

SPILLS

In the event of a spill involving calcium hydroxide, persons not wearing protective equipment and clothing should be restricted from contaminated areas until cleanup is complete. The following steps should be undertaken following a spill:

1. Do not touch the spilled material.
2. Notify safety personnel.
3. Ventilate the area of the spill to reduce dust concentration.
4. To the extent possible, avoid generating dust during cleanup.
5. For small spills, use a clean shovel and gently place the material into a clean, dry container creating as little dust as possible; cover and remove the container from the spill area for later reclamation or disposal.

SPECIAL REQUIREMENTS

U.S. Environmental Protection Agency (EPA) requirements for emergency planning, reportable quantities of hazardous releases, community right-to-know, and hazardous waste management may change over time. Users are therefore advised to determine periodically whether new information is available.

- **Emergency planning requirements**

  Calcium hydroxide is not subject to EPA emergency planning requirements under the Superfund Amendments and Reauthorization Act (SARA) [42 USC 11022].

- **Reportable quantity requirements for hazardous releases**

  Employers are not required by the emergency release notification provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) [40 CFR 355.40] to notify the National Response Center of an accidental release of calcium hydroxide; there is no reportable quantity for this substance.

- **Community right-to-know requirements**

  Employers are not required by Section 313 of SARA to submit a Toxic Chemical Release Inventory Form (Form R) to EPA reporting the amount of calcium hydroxide emitted or released from their facility annually.

- **Hazardous waste management requirements**

  EPA considers a waste to be hazardous if it exhibits any of the following characteristics: ignitability, corrosivity, reactivity, or toxicity as defined in 40 CFR 261.21-261.24. Although calcium hydroxide is not specifically listed as a hazardous waste under the Resource Conservation and Recovery Act (RCRA) [40 USC 6901 et seq.], EPA requires employers to treat waste as hazardous if it exhibits any of the characteristics discussed above.

Providing detailed information about the removal and disposal of specific chemicals is beyond the scope of this guideline. The U.S. Department of Transportation, EPA, and State and local regulations should be followed to ensure that removal, transport, and disposal of this substance are conducted in accordance with existing regulations. To be certain that chemical waste disposal meets EPA regulatory requirements, employers should address any questions to the RCRA hotline at (800) 424-9346 or at (202) 382-3000 in Washington, D.C. In addition, relevant State and local authorities should be contacted for information about their requirements for waste removal and disposal.

RESPIRATORY PROTECTION

- **Conditions for respirator use**

Good industrial hygiene practice requires that engineering controls be used where feasible to reduce workplace concentrations of hazardous materials to the prescribed exposure limit. However, some situations may require the use of respirators to control exposure. Respirators must be worn if the ambient concentration of calcium hydroxide exceeds prescribed exposure limits. Respirators may be used (1) before engineering controls have been installed, (2) during work operations such as maintenance or repair activities that involve unknown exposures, (3) during operations that require entry into tanks or closed vessels, and (4) during emergencies. Workers should use only respirators that have been approved by NIOSH and the Mine Safety and Health Administration (MSHA).

- **Respiratory protection program**

Employers should institute a complete respiratory protection program that, at a minimum, complies with the requirements of OSHA's respiratory protection standard [29 CFR 1910.134]. Such a program must include respirator selection, an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, respirator fit testing, periodic workplace monitoring, and regular respirator maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program (including selection of the correct respirator) requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly. For additional information about the selection and use of respirators and about the medical screening of respirator users, consult the *NIOSH Respirator Decision Logic* [NIOSH 1987b] and the *NIOSH Guide to Industrial Respiratory Protection* [NIOSH 1987a].

PERSONAL PROTECTIVE EQUIPMENT

Protective clothing should be worn to prevent skin contact with calcium hydroxide. Chemically resistant clothing, gloves, boots, and other protective clothing are recommended when handling this substance. Chemical protective clothing should be selected on the basis of available performance data, manufacturers' recommendations, and evaluation of the clothing under actual conditions of use. The following materials have been recommended for use against permeation by calcium hydroxide and may provide protection for periods greater than 8 hr: natural rubber, nitrile rubber, and neoprene rubber. Polyvinyl chloride has also demonstrated good-to-excellent resistance when tested against calcium hydroxide.

Safety glasses, goggles, or face shields should be worn during operations in which calcium hydroxide might contact the eyes (e.g., through dust particles). Eyewash fountains and emergency showers should be available within the immediate work area whenever the potential exists for eye or skin contact with calcium hydroxide. Contact lenses should not be worn if the potential exists for calcium hydroxide exposure.

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