OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR CALCIUM SULFATE

INTRODUCTION

This guideline summarizes pertinent information about calcium sulfate 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 Recommendations may be superseded by new developments in these fields; readers are therefore advised to regard these recommendations as general guidelines and to determine periodically whether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**

  $CaSO_4$

- **Synonyms**

  Anhydrous calcium sulfate; anhydrous gypsum; anhydrous sulfate of lime; crysalba; dead-burned gypsum; drierite; gibs; karstenite; muriacite; natural anhydrite; sulfuric acid, calcium salt; thiolite

- **Identifiers**

  1. CAS No.: 7778-18-9
  2. RTECS No.: WS6920000
  3. DOT UN: None
  4. DOT label: None

- **Appearance and odor**

  Calcium sulfate is an odorless, noncombustible solid. The natural form of anhydrous calcium sulfate is known as the mineral anhydrite consisting of crystals or granules of varying color (e.g., white with a blue, gray, or reddish tinge or brick red). Insoluble anhydrite, which has the same crystal structure as the mineral, is obtained upon complete dehydration of gypsum at above 650°C. Soluble anhydrite is obtained in granular or powder form by complete dehydration of gypsum at or below 300°C in an electric oven.

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

  1. Molecular weight: 136.14
  2. Boiling point (760 mm Hg): 1,193°C (2,179.4°F)
  3. Specific gravity (water = 1): 2.96 at 20°C (68°F)
  4. Vapor density: Not applicable
  5. Melting point: 1,450°C (2,642°F)
  6. Vapor pressure at 20°C (68°F): Not applicable
  7. Solubility: Anhydrous calcium sulfate is insoluble in water but soluble in acid, ammonium salts, sodium thiosulfate, and glycerin.
  8. Evaporation rate: Not applicable

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
Education and Information Division

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

Reactivity

1. Conditions contributing to instability: None reported

2. Incompatibilities: Explosions may result from contact of calcium sulfate with diazomethane, aluminum, or phosphorus.

3. Hazardous decomposition products: Toxic gases and particulates (such as oxides of sulfur) may be released in a fire involving calcium sulfate.

4. Special precautions: None reported

Flammability

The National Fire Protection Association has not assigned a flammability rating to calcium sulfate; this substance is not combustible.

1. Flash point: Not applicable

2. Autoignition temperature: Not applicable

3. Flammable limits in air: Not applicable

4. Extinguishant: Calcium sulfate will not burn. Use an extinguishant that is suitable for the materials involved in the surrounding fire.

Fires involving calcium sulfate should be fought upwind from the maximum distance possible. Isolate the hazard area and deny access to unnecessary personnel. Firefighters should wear a full set of protective clothing and self-contained breathing apparatus when fighting fires involving calcium sulfate.

EXPOSURE LIMITS

OSHA PEL

The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for calcium sulfate is 15 mg/m^3 of air (total dust) and 5 mg/m^3 (respirable fraction) as 8-hr time-weighted average (TWA) concentrations [29 CFR 1910.1000, Table Z-1].

NIOSH REL

The National Institute for Occupational Safety and Health (NIOSH) has established recommended exposure limit (REL) of 10 mg/m^3 (total dust) and 5 mg/m^3 (respirable fraction) as TWAs for up to a 10-hr workday and a 40-hr workweek [NIOSH 1992].

- **ACGIH TLV**

The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned calcium sulfate (total dust) a threshold limit value (TLV) of 10 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 physical irritation associated with exposure to calcium sulfate.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

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

- **Summary of toxicology**

1. *Effects on Animals:* There is no acute information on the effects of calcium sulfate exposure in experimental animals. A month-long exposure study in animals (undefined species, route, and doses) induced bronchitis and interstitial pneumonia while exposure for 9 months caused pulmonary changes resembling those found for pneumosclerosis [Voropaev 1967]. Female rats that received four 25-mg intraperitoneal injections of calcium sulfate (gypsum) showed a slight increase in cancer rates when compared to the controls 5.7% and 0%, respectively. Mean survival rates were similar 587 days for gypsum and 592 days for controls [Pott et al. 1976].

2. *Effects on Humans:* Calcium sulfate causes irritation of the eyes, skin, mucous membranes, and upper respiratory tract in humans. Conjunctivitis, rhinitis, laryngitis, sore throat, tracheal and bronchial irritation, nosebleeds, and impaired sense of smell and taste have been reported in workers exposed to this substance [Parmeggiani 1983; Genium 1990; NLM 1991]. Although chronic lung disease has not been reported among domestic calcium sulfate workers [ACGIH 1991], a Russian paper reported that unfavorable ambient dust loads among female workers in

the gypsum industry caused increased incidences of alveolar modular fibrosis, subatrophic rhinitis, laryngitis, and pharyngitis [Voropaev 1967]. It is unclear whether the gypsum processed in Russia also contained other lung toxicants such as quartz [NLM 1991].

- **Signs and symptoms of exposure**

1. *Acute exposure:* Acute exposure to calcium sulfate can cause redness and itching of the eyes, runny nose, sore throat, and irritation of the respiratory tract and skin.

2. *Chronic exposure:* Calcium sulfate is a mucous membrane irritant that can also affect the eyes, impair the sense of smell and taste, and can cause nosebleeds. It may also cause pulmonary nodular fibrosis.

- **Emergency procedures**

> **WARNING!**
>
> **Seek immediate medical attention for severely affected victims or for victims with signs and symptoms of toxicity or irritation!**

Keep unconscious victims warm and on their sides to avoid choking if vomiting occurs. Initiate the following emergency procedures:

1. *Eye exposure:* Irritation may result. ***Immediately and thoroughly*** flush the eyes with large amounts of water, occasionally lifting the upper and lower eyelids.

2. *Skin exposure:* Irritation may result. ***Immediately and thoroughly*** wash contaminated skin with soap and water.

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 sulfate or any material containing it is ingested:

   —Have the victim rinse the contaminated mouth cavity several times with a fluid such as water.

   —Have the victim drink a glass (8 oz) of fluid such as water.

   —Induce vomiting by giving syrup of ipecac as directed on the package. If ipecac is unavailable, have the victim touch the back of the throat with a finger until productive vomiting ceases.

   —Do ***not*** force an unconscious or convulsing person to drink fluid or to vomit.

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 sulfate and may result in worker exposures to this substance:

—Manufacture of phosphoric acid from phosphate rock

—Use as a drying agent for solids, organic liquids, and gases

—Use as a chemical intermediate in the manufacture of sulfuric acid and as a reagent in the laboratory detection of aflatoxins

—Use in the manufacture of tofu and as a dietary source of calcium in poultry

—Use as a food additive in canned vegetables, bakery products, cheeses, and as a bleaching agent in flour

—Use as an ingredient in a copper poisoning antidote in sheep

—Use as a paper filler and a component of cement

The following methods are effective in controlling worker exposures to calcium sulfate, 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 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 sulfate, a 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 eyes, skin, and respiratory system. 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 sulfate 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 diseases of the eyes, skin, or respiratory system.

- **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 sulfate exposure. The interviews, examinations, and medical screening tests should focus on identifying the adverse effects of calcium silicate on the eyes, 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 silicate.

- **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 job 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

OSHA's method for the determination of worker exposure to airborne concentrations of calcium sulfate (total dust) is made by using a tared, low-ash polyvinyl chloride filter with a 5 micron pore size; the filter is contained in a 37-mm cassette. Samples are collected at a maximum flow rate of 2.0 liters/min until a maximum air volume of 960 liters is collected. Analysis is conducted by gravimetric measurement (weighing) of the filter. This method has a sampling and analytical error of 0.10 and is included in the *OSHA Chemical Information Manual* as Dust, Total [OSHA 1987]. NIOSH has a similar method (Method 0500), which also involves gravimetric analysis [NIOSH 1984a]. The sample flow rate in the NIOSH method is between 1.5 and 2.0 liters/min. The minimum sample volume for an airborne concentration of 15 mg/m^3 is 15 liters, and the maximum sample volume is 133 liters. The overall precision for the NIOSH method is 0.056.

OSHA's method for the determination of worker exposure to airborne concentrations of calcium sulfate (respirable fraction) is made by using a tared, low-ash polyvinyl chloride filter with a 5 micron pore size; the filter is contained in a 37-mm cassette. Air is drawn through the filter cassette, which is preceded by a 10-mm nylon cyclone, at a flow rate of 1.7 liter/min until a maximum air volume of 816 liters is collected. Analysis is conducted by gravimetric measurement (weighing) of the filter. This method has a sampling and analytical error of 0.10 and is included in the *OSHA Chemical Information Manual* as Dust (Respirable Nuisance) [OSHA 1987]. NIOSH has a similar method (Method 0600), which also involves gravimetric analysis [NIOSH 1984b]. The sample flow rate in the NIOSH method is 1.7 liter/min. The minimum sample volume for an airborne concentration of 5 mg/m^3 is 75 liters, and the maximum sample volume is 1,000 liters. The overall precision for the NIOSH method ranges from 0.043 to 0.145 in laboratory tests and from 0.144 to 0.227 in field tests.

PERSONAL HYGIENE

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

Clothing contaminated with calcium sulfate should be removed, and provisions should be made for safely removing this chemical from these articles.

A worker who handles calcium sulfate 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 sulfate is handled, processed, or stored.

STORAGE

Calcium sulfate 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 sulfate should be protected from physical damage and should be stored separately from aluminum, diazomethane, phosphorus, heat, sparks, and open flame. Because containers that formerly contained calcium sulfate may still hold product residues, they should be handled appropriately.

SPILLS

In the event of a spill involving calcium sulfate, 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. Avoid dust generation and remove all sources of heat and ignition.
2. Ventilate the area of the spill.
3. 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.

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 sulfate 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 sulfate; 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 sulfate 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 sulfate 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 sulfate 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 repeated or prolonged skin contact with calcium sulfate. 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. No reports have been published on the resistance of various protective clothing materials to calcium sulfate permeation. If permeability data are not readily available, protective clothing manufacturers should be requested to provide information on the best chemical protective clothing for workers to wear when they are exposed to calcium sulfate.

If calcium sulfate is dissolved in an organic solvent, the permeation properties of both the solvent and the mixture must be considered when selecting personal protective equipment and clothing.

Safety glasses, goggles, or face shields should be worn during operations in which calcium sulfate 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 sulfate. Contact lenses should not be worn if the potential exists for calcium sulfate exposure.

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