PROTECTIVE EQUIPMENT

General

Personal protective equipment should not be considered as a substitute for safe working conditions where better engineering controls and safer work practices can be implemented. It is, however, in certain instances, the only practical means of protecting the worker.

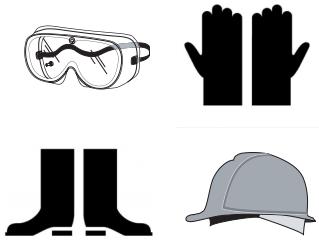
The personal protective equipment described in this section should be worn whenever skin contact with sulfuric acid is possible or whenever the airborne concentration of sulfuric acid may exceed acceptable exposure limits.

The protective equipment to be used includes:

- Chemical safety goggles and face shield (eight-inch high minimum);
- Rubber or polyvinyl chloride gloves with gauntlets large enough to cover the forearm;
- Rubber or polyvinyl chloride high-top safety toe shoes or boots, the tops of which should be covered by the trousers;
- Acid-proof outer clothing that fits snugly at neck and wrists. The wrists of the outer clothing should be positioned to prevent drainage of acid into the gloves. Jackets with attached gloves are available;
- Hard hat or other form of head protection (e.g., full cover acid hood);
- A respirator for protection against airborne concentrations of sulfuric acid.

  (See section on Respiratory protection that follows.)

CAUTION: CONTACT LENSES SHOULD NEVER BE WORN WHILE HANDLING SULFURIC ACID



Respiratory protection

If the airborne concentrations of sulfuric acid cannot be controlled to acceptable levels, potentially exposed individuals should be protected through the use of NIOSH/MSHA-approved respiratory equipment. Care should be taken in choosing and using a respirator. All aspects of any respiratory protection program should be thoroughly reviewed and approved by a competent safety or health professional.

The Occupational Health Guidelines for Chemical Hazards, published by the U.S. Department of Health and Human Services and the U.S. Department of Labor (DHHS (NIOSH) Publication No. 81-123) provides information regarding the proper selection of respiratory equipment (refer to section entitled "Occupational Health Guidelines for Sulfuric Acid").

Respiratory protections should be used whenever there is potential exposure to oleum. Oleum will liberate sulfur trioxide (SO_3) gas, exposure to which can be extremely damaging to the lungs.

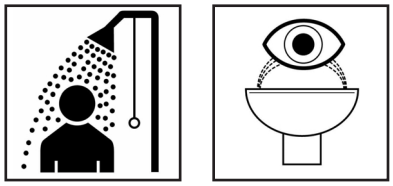
Water supply-safety showers and eyewash fountains

Rapid action freeze-proof safety showers and eyewash fountains that are readily accessible and well-identified should be installed in all areas where individuals may come in contact with sulfuric acid.

When unusual or non-routine circumstances may result in individuals being potentially exposed to sulfuric acid at work stations where safety showers and eyewash fountains are not available, a hand-held drench hose or other adequate source of continuous water flow should always be available.

Recommendations regarding equipment design and installation are given in ANSI A358.1- American National Standard for Emergency Eyewash and Shower Equipment.

CAUTION: SAFETY SHOWERS, EYE-WASH FOUNTAINS, AND OTHER DESIGNATED WATER SUPPLIES SHOULD BE ROUTINELY TESTED, AT LEAST WEEKLY. WHERE APPROPRIATE, THESE FACILITIES SHOULD ALWAYS BE TESTED BEFORE EACH JOB.



Fire and explosion hazards

Sulfuric acid is not flammable; however, under some conditions, it can cause the ignition of other combustible materials if it is allowed to come in contact with these materials. In general, concentrated sulfuric acid should be isolated from organic materials and nitrates, chlorates, carbides, and metallic powders.

Hydrogen, a highly flammable, odorless, colorless gas, is generated by the corrosive action of acid on most metals. Consequently, hydrogen can be generated inside a drum, tank car, tank truck, or metal storage tank containing sulfuric acid. As hydrogen will form flammable mixtures with air over a wide range of concentrations, ignition sources should not be permitted near drums, storage tanks, tank cars, or tank trucks, particularly when these containers are being opened after an extended period of being closed.

Dilution

Except when large quantities of water are used to dilute spills (See section on Spill cleanup below), water or alkaline solutions containing water should never be added to sulfuric acid. A violent reaction will take place which may cause spattering to occur. If it is necessary to mix acid and water, the acid should always be slowly and cautiously added to the water.

Emergency Response

Adequate protective and rescue equipment should be readily available for each individual who may be required to respond to an emergency situation involving sulfuric acid. This equipment should include a hood-type face shield, chemical safety goggles, impervious gloves, rubber or polyvinyl chloride gloves, head protection, and self-contained/supplied-air respiratory protective equipment operated in pressure demand or other positive pressure mode. This equipment should be routinely maintained. Where confined space entry is possible, those items specifically required for safe entry should also be readily available (See section on Confined space entry that follows). Review pertinent emergency response requirements in 29 CFR 1910.120. Other Federal and State regulations should also be followed.

Confined Space Entry

Precautions must be taken before any individual is allowed to enter a confined space (e.g., tank truck, rail car, storage tank, process equipment, open sump) which has contained sulfuric acid. Requirements for the elements of a proper confined space entry permit procedure are given in 29 CFR 1910.146. Applicable State regulations should also be followed.

Spill Cleanup

Sulfuric acid should always be handled with extreme caution. In the event of a sulfuric acid spill, entry to the contaminated area should immediately be closed to personnel unless they are wearing the required protective equipment.

The spilled acid should be contained and cautiously diluted (See section above on Dilution) to a minimum of 5 or 6 times its original volume with water. The water should be added gradually to the acid to minimize spattering.* During the dilution process, personnel should stand as far away as possible from the spill to avoid contact with the acid and with the corrosive fumes that will be emitted. In the case of an oleum spill, highly toxic sulfur trioxide gas will be emitted.

A qualified person should determine the degree of dilution and the need for neutralizing the acid before recovering it or discharging it to a wastewater treatment facility.

CAUTION: CARE MUST BE TAKEN WHEN ADDING SODA ASH OR LIME TO SULFURIC ACID BECAUSE OF THE HEAT LIBERATED BY THE REACTION.

Care should be taken to ensure that acid leaks, spills, or drainage do not come in contact with sulfide materials, because of the danger of evolving toxic and flammable hydrogen sulfide gas.

Once the spilled acid has been cleaned up, the contaminated area should be thoroughly washed or saturated with water. When the washwater can be collected, it should be discharged to a wastewater treatment facility designed to neutralize acidic wastes. Applicable Federal/State regulations should be followed.

HEALTH EFFECTS

Toxicity

Sulfuric acid is highly corrosive; direct contact with eyes or skin, or ingestion can cause severe tissue injury, blindness, and death. Sulfuric acid is highly toxic via inhalation and moderately toxic by ingestion. Chronic conjunctivitis, frequent respiratory infections, emphysema, digestive disturbances, erosion and/or discoloration of teeth have been reported in persons exposed to sulfuric acid over the course of many years.

The acute oral LD_{50} in rats (lethal ingested dose for 50% of the animals) has been found to be 2140 mg/kg. Accidental ingestion of an unspecified quantity of 50% w/w sulfuric acid (presumably aqueous) by humans has resulted in necrosis (death of tissue) at all areas of contact with acid, including the digestive tract. Healing is slow, with stricture and scar formation.

Exposure to concentrations in air of 18 to 60 Mg/M^3 for 18 hours has been found to be lethal to guinea pigs. Lower concentrations in guinea pigs have been shown to produce damage to the respiratory tract, with severity of damage depending largely on concentration and duration of exposure. Studies have also indicated that aerosol size and humidity may affect the toxicity of sulfuric acid.

In humans, concentrations of about 5 mg/M^3 may be very objectionable, usually causing cough, with marked alterations in respiration. Inhalation exposure to sulfuric acid by splash or spray has resulted in pulmonary edema and chronic pulmonary fibrosis, bronchial lesions, and pulmonary emphysema.

Carcinogenicity

The International Agency for Research on Cancer (IARC) has concluded that long-term exposure to strong inorganic acid mists containing sulfuric acid is carcinogenic to humans (Category 1 human carcinogen). This conclusion is based on epidemiology studies and studies in laboratory animals which suggest that an increased risk of cancer can result from prolonged and repeated exposure to mists of sulfuric acid.

A more detailed discussion on the health effects of sulfuric acid can be found in the following references:

1. NIOSH. Review and Evaluation of Recent Literature. Occupational Exposure to Sulfuric Acid. 1981, DHHS (NIOSH) Publication No. 82-104.

2. NIOSH. Criteria for a Recommended Standard. Occupational Exposure to Sulfuric Acid. 1974, HEW Publication No. (NIOSH) 74-128.

3. American Conference of Governmental Industrial Hygienists. Documentation of the Threshold Limit Values. Fourth Edition, 1980, ACGIH, Cincinnati.

Workplace Exposure Criteria

The American Conference of Governmental Industrial Hygienists (ACGIH) has established a threshold limit value* of 1 mg/M^3 for sulfuric acid (1 milligram of sulfuric acid per cubic meter of air). The Occupational Safety and Health Administration (OSHA) has adopted the same value as their permissible exposure to limit (PEL).

Exposure Measurements

The actual concentration of sulfuric acid to which an individual is exposed can be determined by measuring the acid concentration in the ambient air which the individual breathes. Tests of this nature are generally conducted by an industrial hygienist, who is trained in the recognition, evaluation and control of occupational health hazards.

*SPATTERING MAY BE REDUCED THROUGH THE USE OF A WATER SUPPLY