Hydrofluoric Acid Standard Operating Procedure

Occupational Health and Safety Information

MSDS Link

Revised 07/28/09

HEALTH HAZARDS

Hydrofluoric acid (HF) is an extremely corrosive acid used for many purposes including mineral digestion, surface cleaning, etching, and biological staining. HF's unique properties make it significantly more hazardous than many of the other acids used. This SOP discusses how to safely use HF while protecting yourself against the dangers of HF exposure. Attached you'll also find emergency procedures for dealing with HF exposures. The health hazards of HF are dependent upon the type of exposure and the concentration.

EYE AND SKIN EXPOSURE

HF is corrosive and readily destroys tissue. Exposure of the eyes to HF may **result in blindness** or **permanent eye damage**. HF readily penetrates human skin, allowing it to **destroy soft tissues** and **decalcify bone**. Chemical burns from HF are typically very painful and slow to heal. Skin exposure to high concentration HF (approximately 50% or greater) immediately results in serious and painful destruction of tissue. Not only can skin contact cause burns, but systemic fluoride poisoning may also result. One of HF's most insidious properties is that skin contact at lower concentrations may not produce pain or burning sensations until hours after the exposure.

The pathogenesis of tissue damage in an HF burn is quite distinct from other acids. The high electronegativity of the fluoride ion means that dilute concentrations of HF remain relatively non-ionized. It is, in fact, 1000 times less dissociated than hydrochloric acid. HF does cause cutaneous burns by hydrogen ion degeneration and corrosion but causes significantly less surface damage than equimolar solutions of stronger acids like hydrochloric and sulfuric acids. HF, however, unlike other acids, readily crosses lipid membranes and has a potent diffusing capacity into the tissues. Once in the deeper tissue layers the molecule releases the freely dissociable fluoride ion, which produces extensive liquefactive necrosis of the soft tissues and decalcification and corrosion of bone. This secondary damage can continue for several days if untreated. The characteristic pain of HF is thought to be due to the immobilization of calcium ions in the tissues, causing nerve stimulation by the shifting of potassium ions. The progressive action of HF on skin is due to dehydration, low pH, and the specific toxic effect of high concentrations of fluoride ions: these remove Ca^{2+} from tissues as insoluble CaF_2 and thereby delay healing; in addition the immobilization of Ca^{2+} results in a relative excess of K^+ within the tissue, so that nerve stimulation ensues.

Because of the ability of HF to produce severe delayed tissue damage without necessarily producing pain, all skin, eye, or tissue contact with HF should receive immediate first aid and medical evaluation, even if the injury appears minor or no pain is felt. The salient feature of HF burns is the delayed onset of discomfit and the development of a characteristic white lesion that is excruciatingly painful.

Skin contact with HF is probably the most common route of exposure for laboratory personnel (often under fingernails), however HF can cause damage through eye contact, inhalation, or ingestion. Exposures to concentrated (>50%) HF solutions will cause immediate, severe, penetrating burns. Exposure to less concentrated solutions may have equally serious effects, but the appearance of symptoms can be delayed for up to 8 hours for concentrations of 20-50% and up to 24 hours for concentrations less than 20% HF.

Concentrated HF burns can be **fatal** even if only 2 % (~ an 8-inch square) of the body is exposed. Working with anhydrous HF is extremely dangerous from the mist produced, which presents a severe inhalation hazard.

If you are exposed to hydrofluoric acid seek medical attention immediately, even if you do not feel pain.

Medical treatment of HF burns involves **copious sluicing with water** for at least **15 min** followed by (a) immersion in (or application of wet packs of) cold $MgSO_4$, or (b) subcutaneous injection of a 10% solution of calcium gluconate (which gives rapid relief from pain), or (c) surgical excision of the burn lesion. Medical attention is essential, even if the initial effects appear slight, because of the slow onset of the more serious medical symptoms." ***DO NOT ASSUME MOST DOCTORS KNOW HOW TO TREAT HF BURNS* *EXPLAIN THE MEDICAL EFFECT OF HF ON TISSUES***

INHALATION OF HF VAPOR

Inhaling HF vapors can seriously damage the lungs. Delayed reactions up to and including fatal pulmonary edema (flooding of the lungs with body fluids) may not be apparent for hours after the initial exposure. OR-OSHA limits employees' exposure to airborne concentrations of HF to an average of 3 parts per million (ppm) over an 8-hour work day. Airborne concentrations of 10 to 15 ppm will irritate the eyes, skin, and respiratory tract. Thirty ppm is considered immediately dangerous to life and health and may have irreversible health effects. At airborne concentrations above 50 ppm, even brief exposure may be fatal.

CHRONIC HF EXPOSURE

Long-term or chronic exposure to HF may result in fluorosis, a syndrome characterized by weight loss, bone embrittlement, anemia, and general ill health.

INFORMATION AND STANDARD OPERATING PROCEDURE

HF is a colorless liquid with a strong irritating odor at low concentrations (3 ppm). Laboratory members who handle HF will review these documented training on the hazards of HF and what to do in the event of an exposure or a spill. A Material Safety Data Sheet (MSDS) on HF should always be kept in the immediate work area where HF is used. We strongly recommend that HF users review the HF link (http://www.honeywell.com/sites/sm/chemicals/hfacid/)from Honeywell for additional safety information.

ENGINEERING CONTROLS AND PERSONAL PROTECTION

Ventilation

HF should be used with adequate ventilation to minimize inhalation of vapor. Concentrations greater than 5% should always be handled inside a properly functioning chemical fume hood. The chemical fume hood needs to have a current calibration sticker (within 1 year). Call (x5-2550) if the hood you are using has not been calibrated within 1 year.

Eye Protection

Always use **chemical safety glasses** together with a **face shield** when handling HF.

Body Protection

Wear a laboratory coat with a **chemical splash** apron will **full sleeves** and elastic wrists made out of natural rubber, neoprene, or viton. **Never wear shorts or open-toed shoes** when handling HF or other corrosive chemicals.

Gloves

Long Sleeved medium or heavyweight viton, nitrile, or natural rubber gloves must be worn when working with HF. A second pair of nitrile or latex exam gloves must be worn under the gloves for protection against leaks. Gloves that have not been contaminated with HF may be disposed of in the common trash. If gloves become contaminated with HF, remove them immediately, thoroughly wash your hands, and check your hands for any sign of contamination. Contaminated gloves must be disposed of as HF waste (see"Spill, Storage, and Waste Issues" section).

FIRST AID AND EMERGENCY PROCEDURES (also refer to MSDS)

Eyewash and Shower

Since HF is corrosive and rapidly damages tissue, OR-OSHA requires an eyewash and shower to be nearby and accessible. Each must be tested monthly to ensure it will operate when needed.

Eye exposure:

Immediately irrigate eyes at eyewash for at least **15 minutes** with copious quantities of water keeping eyelids apart and away from eyeballs. Do not apply calcium gluconate gel to eyes. In all cases of eye exposure seek prompt medical attention.

Skin Exposure:

Immediately wash affected area of skin at sink if a small area of hand or forearm has been contaminated or at a drench shower if upper arms, torso, or legs are contaminated. Calcium gluconate gel must be readily available. Limit rinsing to 5 minutes so that application can be quickly initiated to limit the migration of the fluoride ion. Reapply and massage calcium gluconate gel into affected area of skin every **15 minutes**. In the event that calcium gluconate gel is not available rinse skin for a minimum of 15 minutes. Remove all contaminated clothing and place in hood or plastic bag. In all cases of skin exposure **seek prompt medical attention**.

Ingestion:

Drink large amounts of water to dilute. Do not induce vomiting. Several glasses of milk or several ounces of milk of magnesia may be given for their soothing effect. In all cases of ingestion seek prompt medical attention.

Inhalation:

Move victim to fresh air. In all cases of overexposure through inhalation seek prompt medical attention.

Calcium Gluconate Gel

Calcium gluconate gel is a topical antidote for HF skin exposure. Calcium gluconate works by combining with HF to form insoluble calcium fluoride, thus preventing the extraction of calcium from tissues and bones. Keep calcium gluconate gel nearby whenever you're working with HF. Calcium gluconate has a limited shelf life and should be stored in a refrigerator if possible and replaced with a fresh supply after its expiration date has passed. Use disposable gloves to apply calcium gluconate gel. **Even after applying calcium gluconate, it is essential that a medical evaluation be made.**

SAFETY PRECAUTIONS FOR HANDLING AND STORAGE OF HF

Safe Work Practices

Never work alone when you're using HF. Do not eat, smoke, or drink where HF is handled, since the chemical can be swallowed. Wash hands thoroughly after handling HF.

HF Spills

If HF is spilled outside a chemical hood, evacuate the area, close the doors, post the area with a sign to prevent others from entering, and call REHS (x5-2550). Small spills of HF inside a chemical fume hood can be cleaned up by laboratory members. HF neutralizing agents must be available before working with HF. Lime soda, ash, sodium bicarbonate, or a spill absorbent specified for HF should be used for clean up. Organic spill kits that contain Floor-Dri, kitty litter, or sand should not be used because HF reacts with silica to produce silicon tetrafluoride, a toxic gas.

Storage

Store all HF and HF waste in labeled chemically compatible containers (e.g., polyethylene or Teflon). **Glass, metal, and ceramic containers are not compatible with HF**. HF should never be stored with incompatible chemicals such as ammonia or other alkaline materials. Always place HF on a low protected shelf or other location where it will not be accidentally spilled or knocked over.

Waste

HF waste should be placed in a chemically compatible container with a sealed lid and clearly labeled. Complete a Hazardous Chemical Label and submit a pickup request through REHS

SPECIFIC SOP FOR USING HF IN THE BME CLEANROOM

1. **Never use Hydrofluoric Acid when working alone or after hours**. Hydrofluoric Acid may be used when working alone during normal working hours provided knowledgeable laboratory personnel have been alerted and at least one is in the general vicinity.
2. All work, storage and disposable of HF must be use Teflon or Polyethylene containers. **Never use glass containers for holding HF.** All Containers should be loosely covered with Saran Wrap for vapor containment.
3. All lab personnel, not just those who will be using Hydrofluoric Acid, should be informed of the dangers of this chemical and the emergency procedures necessary in case of an accident. **A sign should be posted to alert people that work with Hydrofluoric Acid is in progress.**
4. All persons who will be using Hydrofluoric Acid must be made aware of its properties and trained in proper procedures for use and disposal.
5. A supply of HF neutralizing agent (calcium carbonate or calcium hydroxide) for spills should also be kept near the hood where the work will be conducted. If a small quantity (100 ml or less) of dilute Hydrofluoric Acid solution is spilled, clean it up by applying powdered calcium carbonate or calcium hydroxide, or use a commercial Hydrofluoric Acid spill kit. Call REHS to dispose of the residue. If a larger amount is spilled, or the acid is concentrated, contain the spill as best you can, evacuate the area, and call 911 and/or campus police (732/932-7211). Avoid exposure to the vapors. REHS guidelines can be found at http://rehs.rutgers.edu/rehs_emer.htm#chemspill
6. All waste must be stored within a compatible labeled polyethylene storage bottle. Dispose of unwanted hydrofluoric acid by completing a request for waste disposal and submitting it to REHS.
6. All HF handling should be conducted in dedicated Teflon or Polyethylene dishes. **These dishes, HF work area, concentration of HF being used, date of work and approximate usage time** should be clearly labeled within and around the work area.

Additional References:

http://www.pp.pdx.edu/FAC/Safety/Hydrofluoric_Acid_Safety.htm
Honeywell HF Information http://www.hfacid.com/
CHAS article on first aid unique to HF http://www.adpub.com/ctimes/features3/Hydrofluoric.cfm
Article on HF burns http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6T52-4D75KXM-6&_user=526750&_rdoc=1&_fmt=&_orig=search&_sort=d&_docanchor=&view=c&_searchStrId=968177679&_rerunOrigin=google&_acct=C000023759&_version=1&_urlVersion=0&_userid=526750&md5=efe937cf4e38f8d58b74a928582ca710

Calcium gluconate gel distributers
Attard Minerals, http://www.attminerals.com/
Fisher Scientific, https://www1.fishersci.com/
Lab Safety Supply, http://www.lifesafety.com/

HF Spill Kits
Fisher Scientific, https://www1.fishersci.com/
Lab Safety Supply, https://www.labsafety.com
VWR, http://www.vwrsp.com/

HF First Aid Kits
Lab Safety Supply, https://www.labsafety.com