

Physics Division ESH Bulletin 2007-01

Working with Hydrofluoric Acid Solutions

The Physics Division has a procedure, *Using Hydrofluoric Acid*, that must be followed when working with this acid. The information presented here satisfies the procedural requirement for becoming approved to work with hydrofluoric acid.

Definition:

Hydrofluoric acid (HF) is a very corrosive solution of hydrogen fluoride and water. It has an irritating odor that typically can be detected at low concentrations (3 ppm). Hydrofluoric acid is commercially available over a range of concentrations, from a weak 3% solution to >50% concentrations.

OSHA has an online safety guideline for HF (see reference below) that includes properties of HF, exposure limits and health hazard information, medical response, and PPE information.

Health Hazards:

HF is an extremely hazardous chemical. Direct skin contact can cause severe burns that may not be immediately visible or painful and which are slow to heal. The vapor is also highly corrosive and damaging to the eyes and the respiratory system.

HF that contacts skin can penetrate deep into tissue layers where the HF dissociates; the F⁻ ion binds with calcium, magnesium, or other elements causing nerves to fail, cell membranes to collapse, and potentially fatal cardiac arrhythmias. Damage can occur to bones and joints due to decalcification. Inhalation of HF can result in serious lung damage that leads to pulmonary edema and death. Hemorrhage may develop after a delay of several hours. Even brief exposure (5-min) at 50-250 ppm may be fatal.

The onset and degree of symptoms depends on the HF concentration. At concentrations 50% and above immediate burns appear with rapid destruction of tissue as noted by a whitish discoloration, usually proceeding to blisters, and accompanied by severe pain. At concentrations less than 50% pain may not be felt immediately. Below 20% effects may not be noticed for several hours. *Any contact with HF requires medical attention even though symptoms may not be immediately evident.*

HF has a NFPA health rating of 4, flammability rating of 0, and a reactivity rating of 1. Note, however, that adding water to anhydrous HF can result in a violent reaction with the release of heat.

Incompatibilities:

Prior planning is essential when working with HF since it is incompatible with some materials. For example,

- HF corrodes rubber, organics, and leather.
- HF reacts with glass, concrete and other silicon bearing materials to produce SiF₄. HF etches glass and should not be stored in glass containers.
- HF reacts with carbonates, cyanides, and sulfates to produce toxic gases.
- HF reacts with common metals to release H₂ which can become a fire hazard.
- Adding water to HF results in a violent reaction.

PPE:

The Physics Division procedure *Using Hydrofluoric Acid* prescribes specific PPE to be used when working with HF, including goggles, a face shield, lab coat or apron, and neoprene gloves. In addition, a long-sleeved shirt, long pants, and closed-toed shoes are required.

The appropriate glove selection depends on the strength of the HF and the anticipated exposure time. Gloves that extend beyond the wrist should be used.

The OSHA Guideline[1] lists the breakthrough time for various glove materials. In addition, numerous websites have information on PPE for HF use.[see for example ref. 2,3] Glove manufacturers typically publish guidelines listing the chemical resistance for their gloves.[4] Accessing several sources of information is recommended to determine what gloves should be chosen. For example, while OSHA does not recommend nitrile or polyvinyl gloves due to the breakthrough time (<1 hr), other information sources and manufacturers indicate such gloves can provide good incidental contact protection when working with HF if they are changed out after being contaminated.[4]

Thick (10-20 mil) PVC or neoprene rubber gloves provide good resistance to HF[1-4] but because they don't provide the necessary dexterity for most lab procedures they may not be a suitable choice. Thinner PVC or polyvinyl gloves provide some resistance to HF penetration,[2] but should be disposed of when contaminated. Likewise, nitrile gloves provide a barrier only for incidental contact[2,3] but they nonetheless can be used to handle HF when paired with another glove and changed out after contact.

The suitability of gloves stocked in Physics stores for HF work is given below.

Brand	Glove	Material	Rating
MAPA	AF-18	Nitrile 18-mil	Not rated at the MAPA website but the gloves are thicker than MAPA A-10 nitrile (A-14) gloves which are rated for a minimum of 181-min (61-min) use before changeout.
Microflex	Safegrip	Natural rubber latex (blue) 11.4-mil palm 16.5-mil fingers	Fair for 48% HF
Ansell	34-500 Dura-Touch	Polyvinylchloride 5-mil	Not marketed for use with chemicals
VWR	Multi-flex Nitrile T Ambi	Nitrile 4-mil average thickness	Marketed as medical exam gloves and use with medicines
		Neoprene	Good HF resistance (see Ref. 1-4). Note gloves are stiff and may not be the best choice.

A combination of the MAPA nitrile glove over a latex glove can be used to provide protection if change out when contamination is suspected.

Ratings for these gloves with *other* acids and chemicals can also be obtained from manufacturer's websites.[see ref. 4 for example] If other acids or chemicals are being used

along with the HF, choice(s) of gloves should be based on effectiveness in creating a barrier to each of the chemicals.

First Aid and Emergency Treatment:[5]

HF burns pose unique dangers distinct from other acids. Because of the fluoride ion's acute as well as chronic toxicity and its ability to move through the body, the following prompt first aid response to HF exposures is essential. If an unaffected person is available, they should contact a medical professional while first aid is being administered. All HF burns should be evaluated by a physician experienced in medical toxicology and treatment of chemical burns.

The following is extracted primarily from an article by Eileen B. Segel that first appeared in the ACS's Chemical Safety and Health, January/February 2000.

A. Skin Contact:

1. Immediately (within seconds) rinse affected area with plenty of water. Shower if large area is affected. After rinsing for 5 min, continue with other first aid.
2. Remove contaminated clothing (if feasible, start rinsing then remove). Note: remove goggles last.
3. Apply 2.5% calcium gluconate gel, with gloved hand if feasible. Massage the gel repeatedly into burned area until pain is relieved or until professional medical help is available.
4. Call the LSS Office or dial 911 and request help if they have not already been called.

B. Inhalation:

1. Immediately get to fresh air.
2. Call the LSS Office or dial 911 to summons medical help.

C. Eye Contact:

1. Immediately (within seconds) rinse affected area with plenty of water.
2. Call the LSS or 911 and request help if they have not already been called.
3. Trained personnel should drip sterile 1% calcium gluconate solution into eye.

D. Ingestion:

1. Do not induce vomiting
2. Dilute acid by drinking 2-3 glasses of water.
3. Call the LSS Office or dial 911 to summons medical help.

References:

1. OSHA Guideline for Hydrogen Fluoride:
<http://www.osha.gov/SLTC/healthguidelines/hydrogenfluoride/recognition.html>
2. See UC San Diego: How to Handle Hydrogen Fluoride
http://blink.ucsd.edu/Blink/External/Topics/How_To/0,1260,14632,00.html and links from this url and their glove selection chart
http://blink.ucsd.edu/Blink/External/Topics/Policy/0,1162,13315,00.html?coming_from=Content
3. See <http://ehs.unc.edu/pdf/HydrofluoricAcid.pdf>
4. For example, Mapa Glove Guide at
<http://www.mapaglove.com/ChemicalSearch.cfm?id=0>, the Ansell *Chemical Resistance Guide* at
http://www2.umaine.edu/SEM/Documents/MiscTrainingAndGuides/Ansell_7thEditionChemicalResistanceGuide.pdf, and the Microflex Guide at
<http://www.microflex.com/ChemChartLatexNitrile.pdf>
5. *First Aid for a Unique Acid: Hydrofluoric Acid*, Eileen B. Segal,
<http://www.adpub.com/ctimes/features3/hydrofluoric.cfm>. For additional information on first aid for treating HF burns refer to a MSDS or the online guides referenced in [1-3].