

# Working With HF and Fluorine Safely

**Materials**  
*Science and Technology*  
Division

# Objectives

- Review hazards of HF, fluorine gas and other fluorine compounds
- Understand safe operating guidelines
- Review protective measures
- Discuss emergency procedures



# Hazards Associated with HF, F<sub>2</sub> and Other Fluorine Compounds

- Many chemicals containing fluorine, such as ammonium fluoride, sodium fluoride, sulfur tetrafluoride, and ammonium bifluoride, may react with acid or water to produce HF.
- Review the MSDS of all fluoride compounds carefully for safety precautions to reduce the risk of creating a HF hazard.
- If your chosen usage of a fluorine compound can create HF, follow the precautions for HF and keep topical antidote on hand.

# Fluorine Gas (F<sub>2</sub>)

- The halogen F<sub>2</sub> is a pale, yellow strong oxidizer.
- It reacts with virtually every element except Ar, He, and Ne.
- It is lethal at very low levels (the IDLH is 25 ppm).
- F<sub>2</sub> reacts with H<sub>2</sub> and if released into the air, readily becomes HF.
- Used in fluorine (Excimer) lasers and plasma etching, F<sub>2</sub> is one of the most hazardous substances found in MSD laboratories.

# HF Hazards

- HF differs from other acids because the fluoride ion readily penetrates the skin, resulting in destruction of deep tissue layers, including bone.
- Pain associated with exposure to solutions of HF (1 – 50%) may be delayed for up to 24 hours.
- If HF is not rapidly neutralized and the fluoride ion bound, tissue destruction may continue for days and often results in limb loss or death.

# HF Hazards

- **Concentrations less than 20%** - erythema and pain may be delayed up to 24 hours, often not reported until tissue damage is extreme.
- **Concentrations of 20 – 50%** - erythema and pain may be delayed from 1 to 8 hours, and is often not reported until tissue damage is extreme.
- **Concentrations greater than 50%** - produces immediate burning, erythema, and tissue damage.

# ENGINEERING CONTROLS and PERSONAL PROTECTION

## Ventilation

- HF and fluorine gas must be used with adequate ventilation to minimize inhalation of vapor.
- Concentrations greater than 5% must always be handled inside a properly functioning chemical fume hood or gas cabinet as appropriate.

# ENGINEERING CONTROLS and PERSONAL PROTECTION

## Eye Protection

- Always use chemical splash goggles together with a face shield when handling concentrated HF or other fluorine compounds.
- Due to HF's highly corrosive nature, safety glasses with side shields do not provide adequate eye protection.

# ENGINEERING CONTROLS and PERSONAL PROTECTION

## Protective Clothing

- Wear a laboratory coat with a chemical splash apron made out of natural rubber, neoprene, or viton.
- Never wear shorts or open-toed shoes when handling HF or other fluorine compounds.

# ENGINEERING CONTROLS and PERSONAL PROTECTION

## Gloves

- Medium or heavyweight viton, nitrile, or natural rubber gloves are worn when working with HF.
- A second pair of nitrile disposable gloves should be worn under the reusable 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

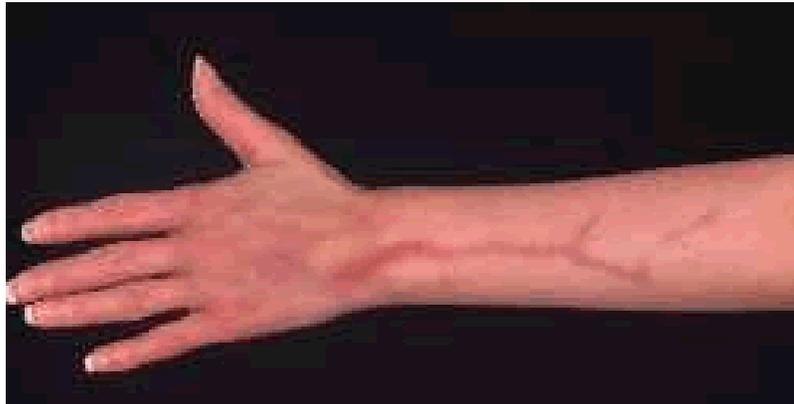
# Safe Work Practices

- If possible, avoid working 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
- In labs where HF is utilized, any unidentified spill of a clear liquid will be handled as if it were HF

# Safe 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 in a secondary container or other location where it will not be accidentally spilled or knocked over.

# HF and Fluorine Injury



# HF and Fluorine Injury



# HF Injury



# First Aid and Emergency Procedures

## Eyewash and Shower

- Since HF is corrosive and rapidly damages tissue, OSHA requires an eyewash and shower to be nearby and accessible.
- Each must be tested monthly to ensure it will operate when needed.
- Know how to find your eye wash/shower with your eyes closed – you may not have your vision when you actually need it.



# F<sub>2</sub> Fires

- **Fire fighting** – The only practical way to extinguish a fluorine fire is to shut off the source of fluorine.
- Water and CO<sub>2</sub> fire extinguishers only add fuel to fire

# First Aid and Emergency 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.

# First Aid and Emergency 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.
- If calcium gluconate gel is 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.
- If 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.

# First Aid and Emergency 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.

# First Aid and Emergency Inhalation

- Move victim to fresh air.
- In all cases of overexposure through inhalation seek prompt medical attention.
- Inhalation of even small amounts of fluorine compounds is a medical emergency.

# Calcium Gluconate Gel



- Calcium gluconate gel is a topical antidote for HF skin exposure. 2.5 to 33% is applied directly or placed in a surgical glove and donned by the victim.
- It works by combining with HF to form insoluble calcium fluoride, thus preventing the extraction of calcium from tissues and bones.
- Researchers utilizing HF must keep calcium gluconate on hand.
- 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.

# Calcium Gluconate Infiltration

- In severe skin exposures, calcium gluconate will be administered subdermally with a 10% solution using a 30 gauge needle or I.V.
- When hand exposures occur (which is the most common exposure), the fingernails are typically removed for infiltration.

# HF lab fatality

- In 1994, an Australian lab worker accidentally splashed about 100 ml of a 70% solution of HF on his right leg.
- The victim immediately attempted to remove the HF by hosing himself down.
- He also immersed himself in a swimming pool while he awaited medical help.
- His leg was amputated; however, he died within 2 weeks of the exposure.

Questions?

# HF Quiz

- What are the physical properties of HF?
- What are the minimum environmental controls for working with F<sub>2</sub> compounds?
- What is the appropriate PPE for F<sub>2</sub> compounds?
- What is the first-aid for HF exposure?
- Characterize the emergency procedures for an HF spill.
- How do you dispose of HF waste?