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## Chemical Fact Sheet

### Hydrofluoric Acid

#### Introduction

*Synonyms:* Hydrogen Fluoride, HF, Fluorohydric Acid, Fluoric Acid, HF in Aqueous Solution

*Melting Point:* -83.55°C

*Chemical Formula:* HF

*Boiling Point:* 19.5°C

*CAS Number:* 7664-39-3

*Density:* 0.993

*Molecular Weight:* 20.0063

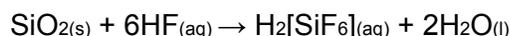
*Vapor Pressure:* 760 mm Hg at 20°C (68°F)

*Water Solubility:* Very Soluble

*Permissible Exposure Limit (PEL):* 3 PPM for Hydrogen Fluoride (as F)

*Comments:* Colorless, fuming liquid or gas with a strong, irritating odor. HYGROSCOPIC.

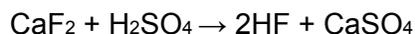
Hydrofluoric acid is a highly toxic and corrosive solution of hydrogen fluoride in water. Gaseous hydrogen fluoride is sometimes called *anhydrous hydrofluoric acid*. Hydrofluoric acid is known to dissolve silicates and glass by reacting with SiO<sub>2</sub>, the major component of most glasses:



Consequently, it must be stored in polyethylene or Teflon containers. It is also unique in its ability to dissolve almost all inorganic metal and semimetal oxides. Perhaps confusingly, it is considered a weak acid because of its low tendency to dissociate to ions in water.

#### Production

Industrially, hydrofluoric acid is produced from the mineral fluorite, also known as calcium fluoride (CaF<sub>2</sub>) and concentrated sulfuric acid. When combined at 250°C, these two substances react to produce hydrogen fluoride according to the following chemical equation:



The vapors from this reaction are a mixture of hydrogen fluoride, sulfuric acid, and a few minor byproducts, from which hydrogen fluoride can be isolated by distillation. Hydrofluoric acid is a known hazard in car engine fires, forming when certain types of synthetic rubber found in some o-rings and hoses are exposed to temperatures in excess of 400°C.

#### Uses

Acute exposures are especially hazardous and can result in severe burns or respiratory damage. Hydrofluoric acid's ability to dissolve oxides makes it important in the purification of both aluminum and uranium. It is also used to dissolve silicates, etch glass, to remove surface oxides from silicon in the semiconductor industry, as a catalyst for the alkylation of iso-butane and butene in oil refineries and to remove oxide impurities from stainless steel in a process called *pickling*.

Recently it has even been used in car washes in "wheel cleaner" compounds. Hydrofluoric acid is also used to clean brickwork. Due to its ability to dissolve silicate compounds, hydrofluoric acid is often used during the rock and mineral analysis process to dissolve rock samples (usually powdered) prior to analysis. Hydrofluoric acid is also used in the synthesis of many fluorine-containing organic compounds, including Teflon<sup>®</sup> and refrigerants such as freon.



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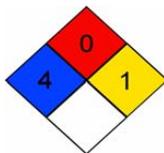
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#### Hazards

National Fire protection Association (NFPA) Hazard Rating

Health	4
Flammability	0
Reactivity	1



#### Acute (Short-Term) Health Effects:

- Skin contact with hydrogen fluoride, or solutions containing more than 30% hydrogen fluoride, produces immediate pain. Reactions to more dilute solutions may be delayed for many hours. The accompanying pain is excruciating, persistent, and healing is delayed.
- Contact with eyes may result in permanent eye damage.
- Hydrofluoric acid is a poison by inhalation. If inhaled hydrofluoric acid can cause severe respiratory damage, including severe irritation of the nose, throat, and lungs and pulmonary edema (fluid build-up in the lungs). At concentrations of 30 parts per million (ppm) hydrofluoric acid is immediately dangerous to life and health.
- Hydrofluoric acid inhalation may also damage the liver and kidneys.

#### Chronic (Long-Term) Health Effects:

- Hydrofluoric acid is not classified as a carcinogen due to lack of data. Increased rates of cancer have been observed in workers exposed to a mixture of chemicals that included fluoride, but no single chemical was identified as the cause of the cancer.
- Hydrofluoric acid is a possible teratogen (reproductive hazard). Occupational studies of women exposed to fluoride identified increased rates of menstrual irregularities. Animal studies have also found that fluoride impairs reproduction and increases the rates of fetal bone and teeth malformation.
- The chronic inhalation of hydrofluoric acid can cause irritation and congestion of the nose and throat and bronchitis. Animal studies have also found increased rates of kidney and liver damage from hydrofluoric acid inhalation.

#### Signs and Symptoms of Exposure

##### Routes of Exposure:

- Skin contact
- Ingestion
- Injection

Symptoms of **skin exposure to dilute HF are not felt immediately**, but exposure of less than 10% of the body to it can be fatal, even with immediate medical treatment. Highly concentrated solutions may lead to acute hypocalcemia, followed by cardiac arrest and death, and will usually be fatal in as little as 2% body exposure (about the size of the sole of the foot). This substance is extremely toxic and has the capacity to kill upon exposure rather than simply damage skin and eyes. It should be handled with extreme care, beyond that given to other mineral acids.



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Due to low dissociation constant, HF can penetrate tissues quickly like a small non-polar particle. Hydrofluoric acid which comes into direct contact with the fingers can severely damage or destroy the tissue underneath the nail without causing any damage to the nail itself. It is this ability to cause little harm to outer tissues but considerable harm to inner tissues which can produce dangerous delays in treatment of hydrofluoric acid exposure. Once the pain starts, it is out of proportion to the burns produced. Patients often describe the feeling as if they have struck their fingers with a hammer. HF that penetrates under the skin causes later development of painful ulcers, which heal slowly.

Solutions of less than 20% HF can produce pain and redness with delay up to 24 hours after skin exposure. 20 to 50% HF produces pain and redness within 8 hours, and solutions of more than 50% produce immediate burning, redness and blister formation. Contact of the skin with the anhydrous liquid produces severe burns.

#### Regulatory Information

A well-known hazard to human and environmental health, the U.S. Occupational Safety and Health Administration (OSHA), U.S. EPA, and Consumer Product Safety Commission regulate hydrofluoric acid.

- The OSHA permissible exposure limit (PEL) for an eight-hour work shift for hydrofluoric acid (as F) is 3 ppm based on a time weighted average (TWA) over an 8-hour work shift.

#### Worker Health

Facilities using hydrofluoric acid must minimize worker exposure:

Use hydrofluoric acid in closed systems. If a closed production system is infeasible, enclose operations and use local exhaust ventilation. If hydrofluoric acid exposure may exceed 3 ppm, use a Mine Safety and Health Administration/National Institute for Occupational Safety and

Health-approved supplied air respirator with a full face piece.

Take precautions to avoid hydrofluoric acid contact. If hydrofluoric acid contacts skin, wash immediately and get medical attention. (See first aid procedures below.)

#### Personal Protection

- Gloves
- Face shield
- Lab coat or rubber apron
- Closed toed shoes (preferably leather)
- Long pants



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#### Glove Selection Guide and Chemical Permeation Chart

CHEMICAL	Silver Shield (4 Mil)			Viton (9 Mil)			Butyl (17 Mil)			Nitrile (11 Mil)			Neoprene (22 Mil)			PVC (20 Mil)		
	D	BT	PR	D	BT	PR	D	BT	PR	D	BT	PR	D	BT	PR	D	BT	PR
Hydrofluoric Acid 50%	G	>6h	ND	G	ID	ID	F	ID	ID	P	ID	ID	E	>8h	ND	E	1.8h	0

**E**= Excellent; **G**=Good; **F**=Fair; **P**=Poor; **ND**=None detected; **ID**=Insufficient Data;

**D**= Degradation;

**BT**= Breakthrough, amount of elapsed time after initial exposure before the chemical can be analytically detected on the inside surface of the glove;

**PR**= Permeation Rate is expressed in mg/m<sup>2</sup>/sec. PR can be used for estimating glove thickness required; for a given material, thicker is more resistant.

Note: Silver Shield gloves may be worn as liners under other glove types to enhance protection.

#### Spill Response

Use extreme caution. Always wear personal protective equipment while cleaning a spill. Because of the vigorous action of sodium bicarbonate as an acid neutralizer, alternative acid neutralizers are recommended to avoid spatter.

- Neutralize with soda ash (sodium carbonate, NaCO<sub>3</sub>) or lime (calcium oxide, CaO) or absorb the spill with a special HF pillow available from commercial vendors.
- Absorb with an inert material.

#### First Aid Procedures

*Seek First Aid Immediately*

##### Skin Contact

1. Immediately flush with copious amounts of water under an emergency shower.
2. Remove all clothing while under the shower. Flush skin for 5 minutes.
3. Apply calcium gluconate gel (10%) while wearing clean impervious gloves (to avoid obtaining an HF burn on the end of the finger applying the gel). If calcium gluconate gel is not available continue to flush skin until medical personnel arrive.
4. Get medical attention immediately.

##### Eye Contact

1. Immediately flush eyes with water under an eyewash for 15 minutes.
2. Get medical attention immediately.

Inform medical personnel that injury involves hydrofluoric acid and give them a copy of the material safety data sheet if possible.

#### Emergency Phone Numbers

**Dial 911**