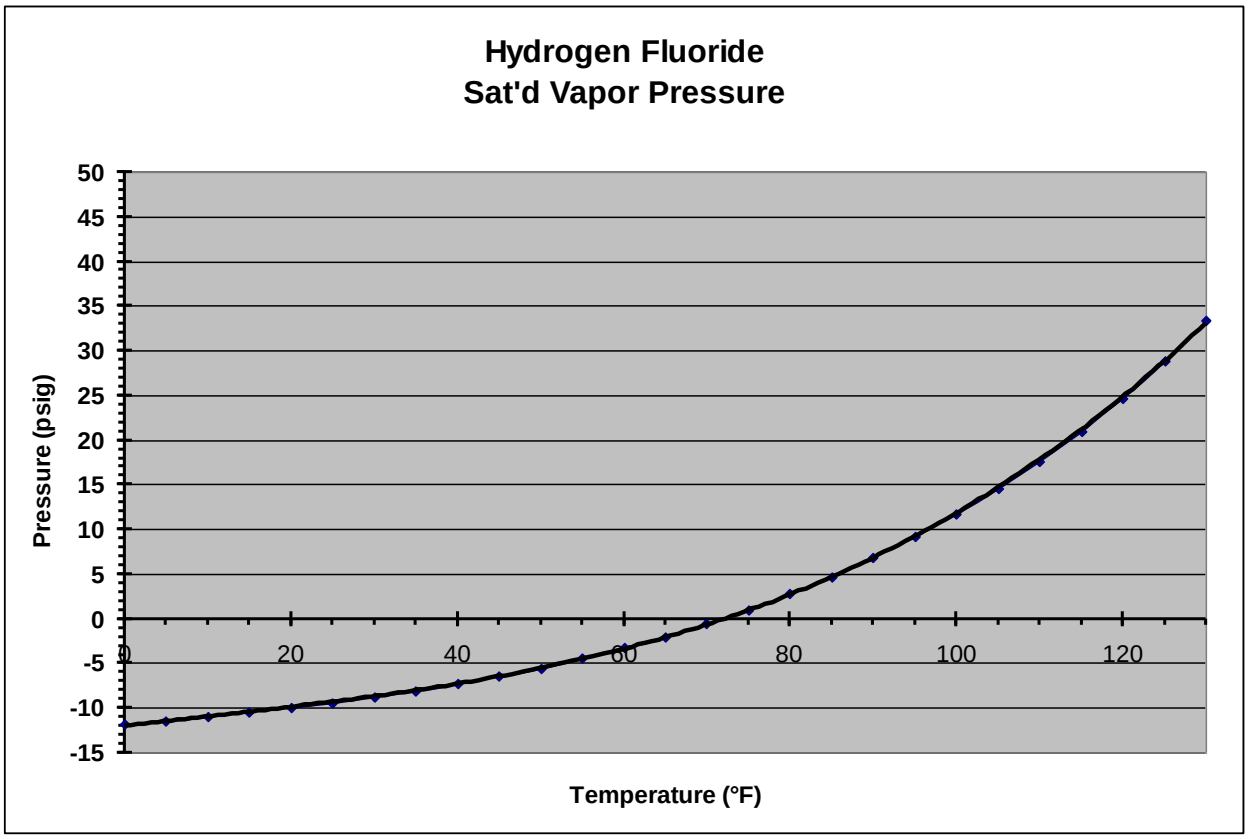
Anhydrous Hydrogen Fluoride

July 2022

Hydrogen Fluoride Chemical & Physical Properties

- Hydrogen Fluoride is a liquefied gas that is colorless and extremely corrosive. DOT does not define it as a compressed gas
- HF, Halogen Acid
- CAS# 7664-39-3
- UN# 1052
- Molecular Weight 20.01
- Liquefied Gas with Vapor Pressure of 0.8 psig @ 70°F (21°C)
- Gas Density of 0.165 lb/ft^3 (2.65 gm/l) @ 70° F (21.1°C)
- Liquid Density of 48.3 lb/ft^3, (959 gm/l) @ 70°F (21.1°C)
- Toxic Gas with PEL of 3 ppm, LC_{50} 1300 ppm, IDLH 30 ppm
- Shipping Labels Corrosive and Poison
- Boiling Point, 1 atm. 67.1°F (19.5°C)
- Freezing Point, 1 atm. -118.4°F (-83.6°C)
- Critical Temperature 370°F (188°C)



- Colorless liquid which forms dense white cloud when released
- Hydrogen Fluoride has a vapor density heavier than air. @ 70°F (21°C) - 2.21 (Honeywell data)
- Gas Specific Volume @ 70° F (21.1°C) – 6.06 ft^3/lb (377 cc/gm)

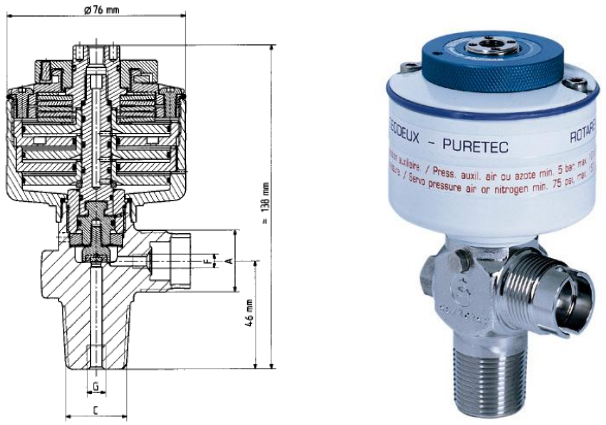
- Autoignition - Not Flammable
- Flammability (LFL -UFL) - Not Flammable
- Thermal Stability - Hydrogen Fluoride is thermally stable
- Water Solubility - Hydrogen Fluoride highly soluble in water forming Hydrofluoric Acid. Water put onto a liquid pool of HF will react violently
- Odor - Hydrogen Fluoride is reported to have a sharp pungent odor (extremely acrid) 0.5 – 3 ppm
- HF in long term storage can develop high pressures from the H_2 generated
- Latent Heat of Vaporization - 161 BTU/lb (373 kJ/kg)

Anhydrous HF is relatively non-corrosive
Anhydrous HF loves water
HF plus water yields hydrofluoric acid
Hydrofluoric acid is a very strong inorganic acid
Moisture can come from the system, atmosphere or human tissue
Hydrofluoric acid etches glass

Package
High pressure carbon steel seamless cylinder

- DOT Spec. 3AA (178.37)
- Minimum working pressure of 2265 psig
- 49 liter
- Seamless Carbon Steel alloy with Chromium & Molybednum
- Burst pressure is 6000 psig minimum

Ceoduex Pneumatic Valve



Since the valve seat is closed using springs, it can chatter open during transportation and handling. A manual lock forces the valve seat closed.
To operate the valve this knob has to be manually opened by turning it counter clockwise before pneumatic pressure is applied.
After the cylinder is empty this must be closed by turning it clockwise before removing the cylinder

To operate the valve a Thread a 1/8” 27 NPT quick connect fitting into valve top to connect the plastic pneumatic tube

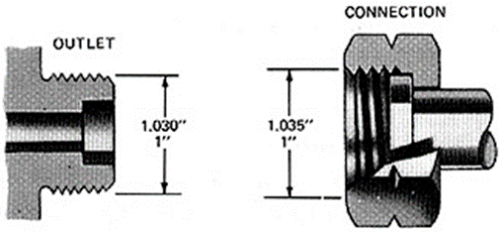
To check the tied diaphragm for leaks, a leak check port is located above it. Sometimes it will just be sealed by a plastic cap in other cases it is sealed with a gas tight plug

CGA 670 Outlet Connection

1 ¼” Nut that compresses a gasket to seal

Reverse Thread (Note notch in the nut) Counterclockwise to tighten

With valve outlet facing right, push wrench upward to tighten onto cylinder connection



AHF penetrates all tissue, it comes in contact with and does not remain on the surface.

Once absorbed AHF/HF rapidly dissociates into ionic Hydrogen and Fluoride. Hydrogen is in this context of less importance.

Fluoride migrates and continues to destroy deep tissue layers as it migrates and will create soluble and insoluble compounds that are the basis for the systemic toxic effects.

And unlike other acids that are rapidly removed or neutralized, the corrosive and toxic effects may continue for days if left untreated

Pain in the affected area is the only indication of severe exposure

No pain killers are to be used as the pain going away is the indication of the treatment working

Exposure to anhydrous HF is not as severe as liquid aqueous solution

Calcium gluconate must be on hand to immediately treat any exposed area

This is followed by treatment at a medical facility where calcium gluconate may be injected into the affected area.

To supply adequate vapor the cylinders may be heated

Pressure Buildup in Cylinder

- Potential pressure buildup in long time storage
- Hydrogen fluoride can react very slowly with the iron in the steel cylinder to form fluoride ion and hydrogen
- The hydrogen collects in the head space
- Use extreme caution handling cylinders that have been stored for extended periods
- Suppliers recommend pressure check every 2 years
- If excess pressure is found, it must be vented through an appropriate scrubber or cylinder returned to vendor

Cylinders have suddenly exploded after many years of storage

1. 1984 United Kingdom, 3.5 liter, 21 yrs (DuPont Report)
2. 1991 Australia, 1.3 liter, 25 yrs (DuPont Report)
3. Date unk Germany
4. 1998 University, Eastern US, 21 yrs
5. 2003 University, Southwestern US, as it was being transported by waste disposal co company

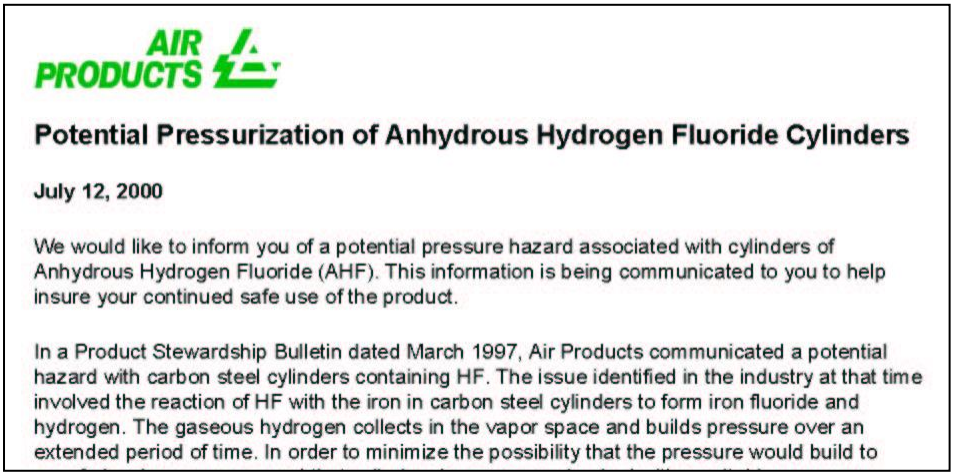
6. 2005 University, Western US, lecture bottle
7. 2010 University, Midwestern US, lecture bottle
8. 2011 University, Midwestern US, 27 yrs, lecture bottle

Other events:

1. In 1998 DuPont reported that 1 lecture bottle stored for 14 years had a pressure of 2400 psig.
2. In 2003, a gas supplier sampled a batch of full cylinders that were in inventory in Singapore after 22 months. All 10 cylinders had pressures greater than 20 psig. The highest was 320 psig and there were others at 220, 190 and 180 psig.
3. In 2005, a waste disposal company in the US was drilling a batch of old lecture bottles with a stuck valves. One cylinder reported the system pressure shooting up to 3000 psig
4. A waste disposal company in the US has been logging the cylinder pressures of all HF cylinders sent for disposal. Out of 60 lecture bottles, 13 has pressures between 700 and 1000 psig, 14 had pressures exceeding 1000 psig with 3 exceeding 3000 psig. It should be noted that this may not be an accurate reflection of the dissociation as it was not known which were still full

Numerous Safety alerts have been issued

1. DuPont 1997
2. Chemical and Engineering News 28 April, 1997, Vol 75, No 17, pg 6
3. Air Products March 1997 and July 2000
4. Matheson 1998 and 2011



AIR PRODUCTS

Potential Pressurization of Anhydrous Hydrogen Fluoride Cylinders

July 12, 2000

We would like to inform you of a potential pressure hazard associated with cylinders of Anhydrous Hydrogen Fluoride (AHF). This information is being communicated to you to help insure your continued safe use of the product.

In a Product Stewardship Bulletin dated March 1997, Air Products communicated a potential hazard with carbon steel cylinders containing HF. The issue identified in the industry at that time involved the reaction of HF with the iron in carbon steel cylinders to form iron fluoride and hydrogen. The gaseous hydrogen collects in the vapor space and builds pressure over an extended period of time. In order to minimize the possibility that the pressure would build to

Best practice is to only have them for 2 years.

Emergency Response

Feels like a hammer on your finger. Throbs every time your heart beats

Pain does not go away until calcium gluconate treatment

Getting it underneath the fingernail is very painful. Must pull it off to treat

Some fill glove with Zephiram (Benzarid) and remove and refill every 5 minutes

ER Items to have on hand

Privacy curtain around safety shower

Robe

Slippers

Towels

EMT Scissors

Faceshields

Goggles

Acid apron

pH paper

Ziplock Bag for valuables

Garbage bags for contaminated clothing

5 gal bucket for immersion treatment

Gloves

Typical disposable gloves are 4-6 mils and only good for contact exposure

Do not use latex gloves; they are not effective against HF. Neoprene or Nitrile (22 mil) are the most appropriate for HF

Hydrogen fluoride requires unique medical treatment, key guidance from

US Health Dept ATSDR Medical Treatment Guidelines

Honeywell Medical Treatment

Eurofluor (European Fluoride Association)

Industrial experience indicates that prompt treatment, as described, will prevent the development of serious injury

Therefore, speed is essential.

Delays in decontamination, first aid care or medical treatment or improper medical treatment will likely result in greater damage or may, in some cases, result in a fatal outcome.

Relief of pain is an important guide to the success of the treatment; therefore local anesthesia should be avoided

All potentially exposed personnel should be trained in first aid for hydrogen fluoride

Emergency Responders must wear PPE to prevent exposure.

Area doctors and hospitals should be notified of the special treatment required, Calcium gluconate gel and Benzarid should be on hand for skin burn aqueous for eyes and respiratory tract

Form to accompany patient to hospital (please note advice to hospital on unique treatment needed by fluoride burns!)

Please make sure that hospital staff is aware of the unique characteristics of injuries caused by AHF/HF exposures and the fact that the systemic toxic effects of the exposure will require prompt serum monitoring of fluorides, calcium, magnesium and sodium, and calcium replacement by infusion.

AHF/HF is corrosive and toxic and may cause:

1. Severe and painful burns of the skin
2. Irritation of air ways that can lead to bronchitis or even pulmonary oedema
3. Asphyxia
4. Severe and painful burns of the eyes
5. Blindness
6. Severe and painful burns of the digestive track
7. Serious toxic systemic effects, that will require specialized metabolic, surgical, thoracic, ophthalmic intervention (Intensive Care)

Note: All or any of the above effects may be delayed in onset and/or be accompanied by toxic systemic effects.

FIRST AID MANAGEMENT OF HYDROFLUORIC ACID INJURIES

Name _____

Sex M / F Age _____ Date and time _____

DIAGNOSTIC (TICK APPROPRIATE)

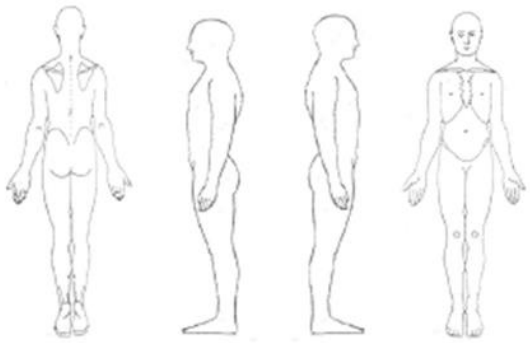
This patient was exposed to

- ❒ Anhydrous Hydrogen Fluoride
- ❒ HF _____% solution (specify)
- ❒ Other Fluoride? (specify _____)

Exposure date _____ Exposure Time _____ AM/PM

Nature of exposure: ❒ Skin ❒ Eyes ❒ Inhalation ❒ Ingestion

Affected body surface:



TREATMENT GIVEN (TICK APPROPRIATE)

- ❒ Showering, decontamination of the skin Duration _____ min.
- ❒ Showering, decontamination of the eyes Duration _____ min.
- ❒ Calcium Gluconate gel Duration _____ min.
- ❒ Eye irrigation with a 1% calcium gluconate solution Duration _____ min.
- ❒ Nebulization of a 2.5% solution of calcium gluconate Duration _____ min.
- ❒ Basic life support Duration _____ min.
- ❒ Other (specify _____) Duration _____ min.

Time between exposure and decontamination with water: _____ min.

Time between decontamination with water and other treatment: _____ min.

- ❒ Dr
- ❒ Nurse
- ❒ 1st Aider

Name and signature

Date _____ Time _____ am/pm place _____

Note to First Aider: Patients should be accompanied by a doctor or nurse whenever possible

FOR FURTHER MEDICAL INFORMATION

Telephone _____

Name _____

Liquid Spill

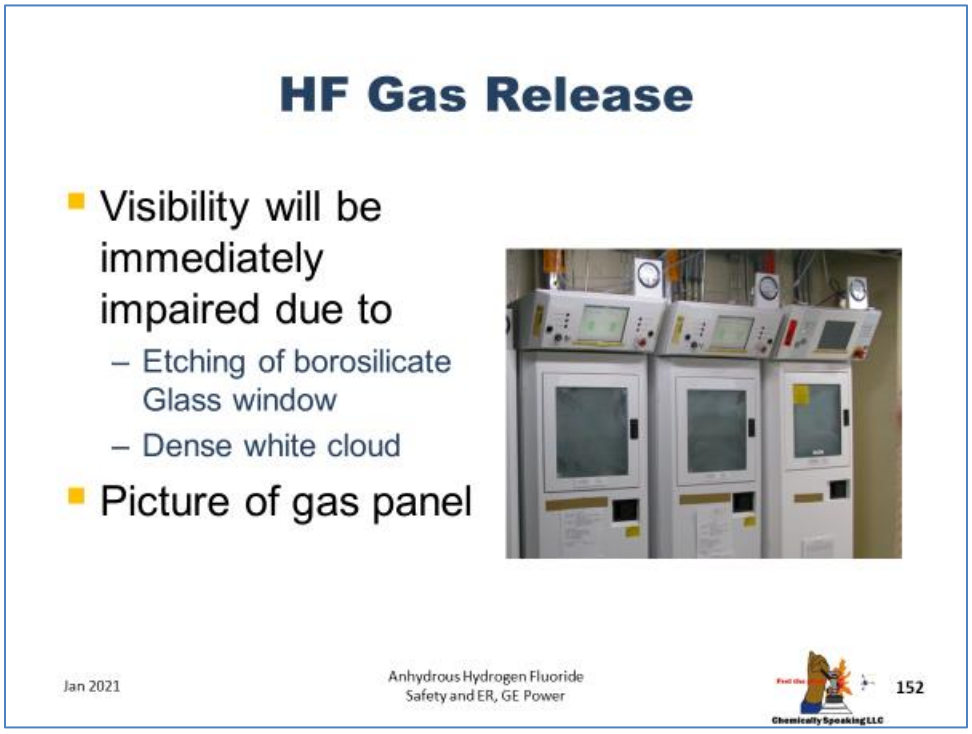
With a boiling point of 67.1°F (19.5°C), it is possible to have a liquid spill

With the moisture in the air a dense white cloud will form above the spill

If the spill is small, allow it to vaporize

If the spill is large, use an absorbent and add sodium bicarbonate or magnesium oxide to neutralize. Floor-dri, kitty litter, vermiculite or sand should not be used because HF reacts with silica to produce silicon tetrafluoride, a toxic gas.

3M's Universal Sorbent is recommended, as it does not react with HF.



Eugene Ngai