

This is a running file of general info found on the web for HF family chemistries.

BWall

Hydrofluoric acid is a [solution](#) of [hydrogen fluoride](#) (HF) in [water](#). It is a precursor to almost all fluorine compounds, including pharmaceuticals such as [fluoxetine](#) ([Prozac](#)), diverse materials such as [PTFE](#) (Teflon), and elemental [fluorine](#) itself. It is a colourless solution that is highly corrosive, capable of dissolving many materials, especially [oxides](#). Its ability to dissolve glass has been known since the 17th century, even before [Carl Wilhelm Scheele](#) prepared it in large quantities in 1771.^[2] Because of its high reactivity toward glass and moderate reactivity toward many metals, hydrofluoric acid is usually stored in [plastic](#) containers (although [PTFE](#) is slightly permeable to it).^[3]

Hydrogen fluoride gas is an acute poison that may immediately and permanently damage lungs and the corneas of the eyes. [Aqueous](#) hydrofluoric acid is a contact-poison with the potential for deep, initially painless burns and ensuing tissue death. By interfering with body calcium metabolism, the concentrated acid may also cause systemic toxicity and eventual [cardiac arrest](#) and fatality, after contact with as little as 160 cm² (25 square inches) of skin.

Acidity

Hydrofluoric acid is classified as a weak acid because of its lower dissociation constant compared to the strong acids. It [ionizes](#) in aqueous solution in a similar fashion to other common acids.^[4]



It is the only [hydrohalic acid](#) that is not considered a [strong acid](#), i.e. it does not fully ionize in dilute aqueous solutions.

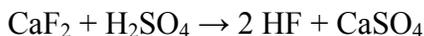
When the concentration of HF approaches 100%, the acidity increases dramatically because of [homoassociation](#):



The [bifluoride](#) (FHF⁻) anion is stabilized by the very strong hydrogen–fluorine [hydrogen bond](#).

Production

Hydrofluoric acid is produced by treatment of the mineral [fluorite](#) (CaF₂) with concentrated [sulfuric acid](#). When combined at 265 °C, these two substances react to produce hydrogen fluoride and [calcium sulfate](#) according to the following [chemical equation](#):



Although bulk fluorite is a suitable precursor and a major source of world HF production, HF is also produced as a by-product of the production of [phosphoric acid](#), which is derived from the mineral [apatite](#). Apatite sources typically contain a few percent of [fluoroapatite](#), acid digestion of which releases gaseous stream consisting of [sulfur dioxide](#) (from the H_2SO_4), water, and HF, as well as particulates. After separation from the solids, the gases are treated with sulfuric acid and [oleum](#) to afford anhydrous HF. Owing to the corrosive nature of HF, its production is accompanied by the dissolution of silicate minerals, and, in this way, significant amounts of [fluorosilicic acid](#) are generated.^[3]

Uses

Oil refining

In a standard [oil refinery](#) process known as [alkylation](#), [isobutane](#) is alkylated with low-molecular-weight [alkenes](#) (primarily a mixture of [propylene](#) and [butylene](#)) in the presence of the strong acid [catalyst](#) derived from hydrofluoric acid. The catalyst protonates the alkenes (propylene, butylene) to produce reactive [carbocations](#), which alkylate isobutane. The reaction is carried out at mild temperatures (0 and 30 °C) in a two-phase reaction.

Production of organofluorine compounds

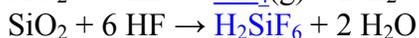
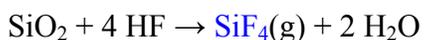
The principal use of hydrofluoric acid is in [organofluorine chemistry](#). Many [organofluorine compounds](#) are prepared using HF as the fluorine source, including [Teflon](#), [fluoropolymers](#), [fluorocarbons](#), and [refrigerants](#) such as [freon](#).^[3]

Production of fluorides

Most high-volume inorganic fluoride compounds are prepared from hydrofluoric acid. Foremost are Na_3AlF_6 , [cryolite](#), and AlF_3 , [aluminium trifluoride](#). A molten mixture of these solids serves as a high-temperature solvent for the production of metallic [aluminium](#). Given concerns about fluorides in the environment, alternative technologies are being sought. Other inorganic fluorides prepared from hydrofluoric acid include [sodium fluoride](#) and [uranium hexafluoride](#).^[3]

Etchant and cleaning agent

In metalworking, hydrofluoric acid is used as a [pickling agent](#) to remove oxides and other impurities from [stainless](#) and [carbon steels](#) because of its limited ability to dissolve steel.^[citation needed] It is used in the [semiconductor](#) industry as a major component of [Wright Etch](#) and [buffered oxide etch](#), which are used to clean [silicon wafers](#). In a similar manner it is also used to [etch glass](#) by reacting with [silicon dioxide](#) to form gaseous or water-soluble silicon fluorides.



A 5% to 9% hydrofluoric acid gel is also commonly used to etch all ceramic dental restorations to improve bonding.^[5] For similar reasons, dilute hydrofluoric acid is a component of household rust stain remover and in [car washes](#) in "wheel cleaner" compounds.^[6] Because of its ability to dissolve iron oxides as well as silica-based contaminants, hydrofluoric acid is used in pre-commissioning boilers that produce high-pressure steam.

Niche applications

Because of its ability to dissolve (most) oxides and silicates, hydrofluoric acid is useful for dissolving rock samples (usually powdered) prior to analysis. In similar manner, this acid is used in [acid macerations](#) to extract organic fossils from silicate rocks. Fossiliferous rock may be immersed directly into the acid, or a [cellulose nitrate](#) film may be applied (dissolved in [amyl acetate](#)), which adheres to the organic component and allows the rock to be dissolved around it.^[7]

Diluted hydrofluoric acid (1 to 3 %wt.) is used in the [petroleum industry](#) in a mixture with other acids (HCl or organic acids) in order to stimulate the production of water, oil, and gas wells specifically where sandstone is involved.^[citation needed]

Hydrofluoric acid is also used by some collectors of antique glass bottles to remove so-called 'sickness' from the glass, caused by acids (usually in the soil the bottle was buried in) attacking the soda content of the glass.^[citation needed]

Offset printing companies use hydrofluoric acid to remove unwanted images from printing plates. Felt-tip markers called "deletion pens" are available to make the process safer for the worker.^[citation needed]

Health and safety



A hydrofluoric acid burn of the hand



HF burns, not evident until a day after

In addition to being a highly [corrosive](#) liquid, hydrofluoric acid is also a contact [poison](#). It should therefore be handled with extreme care, using protective equipment and safety precautions beyond those used with other mineral acids. Owing to its low [acid dissociation constant](#), HF as a neutral lipid-soluble molecule penetrates tissue more rapidly than typical mineral acids. Because of the ability of hydrofluoric acid to penetrate tissue, poisoning can occur readily through exposure of skin or eyes, or when inhaled or swallowed. Symptoms of exposure to hydrofluoric acid may not be immediately evident, and this can provide false reassurance to victims, causing them to delay medical treatment. HF interferes with nerve function, meaning that burns may not initially be painful. Accidental exposures can go unnoticed, delaying treatment and increasing the extent and seriousness of the injury.^[8]

Once absorbed into blood through the skin, it reacts with blood calcium and may cause cardiac arrest. Burns with areas larger than 160 cm² (25 square inches) have the potential to cause serious systemic toxicity from interference with blood and tissue calcium levels.^[9] In the body, hydrofluoric acid reacts with the ubiquitous biologically important [ions Ca²⁺](#) and [Mg²⁺](#). Formation of insoluble [calcium fluoride](#) is proposed as the etiology for both precipitous fall in serum calcium and the severe pain associated with tissue toxicity.^[10] In some cases, exposures can lead to [hypocalcemia](#). Thus, hydrofluoric acid exposure is often treated with [calcium gluconate](#), a source of Ca²⁺ that sequesters the fluoride ions. HF [chemical burns](#) can be treated with a water wash and 2.5% calcium gluconate gel^{[11][12][13]} or special rinsing solutions.^{[14][15]} However, because it is absorbed, medical treatment is necessary;^[9] rinsing off is not enough. Intra-arterial infusions of calcium chloride have also shown great effectiveness in treating burns.^[16]

Hydrogen fluoride is generated upon combustion of many fluorine-containing compounds such as products containing [Viton](#) and [polytetrafluoroethylene \(Teflon\)](#) parts.^[17] [Hydrofluorocarbons](#) in [automatic fire suppression](#) systems can release hydrogen fluoride at high temperatures, and this has led to deaths from acute [respiratory failure](#) in military personnel when a [rocket-propelled grenade](#) hit the fire suppression system in their vehicle.^[18]

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| Hazards | |
|-------------------|---|
| Safety data sheet | duPont MSDS |
| EU classification |  |
| R-phrases | R26/27/28, R35 |
| S-phrases | (S1/2), S7/8, S26, S36/37, S45 |
| NFPA 704 |  |
| Flash point | Non-flammable |

Flammability Code (Red) = 0, Will not burn.

Reactivity Code (Yellow) = 0, Normally stable even under fire conditions

Health Code (Blue) = 4 Very short exposure could cause death or major residual injury

Special Hazard Code (White) = Acid

See MSDS for anhydrous HF, concentrated HF (40-60%), and dilute HF (1%).

There is conflicting information in the MSDS data. Go with the most restrictive.

May not use unless proper gear is used, another person is present, eye wash stations are functional, warning signs are placed, emergency response kit is nearby (skin) emergency response kit is nearby (eyes) and spill kit is nearby.

Glass etchant kit (for home hobby art use?)

Etchant is what? Etching cream "Armour Etch" Watch this guy, no gloves, no ventilation, no eye protection (I assume):

https://video.search.yahoo.com/search/video;_ylt=AwrBT85RlxVWnb4AibdXNyoA;_ylu=X3oDMTB0N2Noc21IBGNvbG8DYmYxBHBvcwMxBHZ0aWQDBHNIYwNwaXZz?p=glass+etch+kit&fr=sfp&fr2=piv-web#id=7&vid=d6bb9f4d500e076619de2242900c422a&action=view



Sodium bifluoride is the [inorganic compound](#) with the formula NaHF₂. It is a [salt](#) of [sodium](#) cation (Na⁺) and [bifluoride anion](#) (HF₂⁻). It is a white, water-soluble solid that decomposes upon heating.^[2] Sodium bifluoride is non-flammable, [hygroscopic](#), and has a pungent smell.^[3] Sodium bifluoride has a number of applications in industry.

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Reactions

Sodium bifluoride dissociates to [hydrofluoric acid](#) and sodium fluoride:

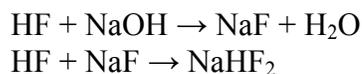


The reverse of this reaction is employed to remove HF from elemental fluorine (F₂) produced by electrolysis.^[4] This equilibrium is manifested when the salt is dissolved and when the solid is heated. Characteristic of other bifluorides, it reacts with [acids](#) to give HF. Illustrative is its reaction with [bisulfate](#) to form [sodium sulfate](#) and hydrogen fluoride.

[Strong bases](#) deprotonate bifluoride. For example [calcium hydroxide](#) gives [calcium fluoride](#).^[5]

Production

Sodium bifluoride is produced by [neutralizing](#) waste [hydrogen fluoride](#), which results from the production of superphosphate fertilizers. Typical bases are sodium carbonate and sodium hydroxide. The process occurs in two steps, illustrated with the hydroxide:^[4]



Sodium bifluoride reacts with water or moist skin to produce [hydrofluoric acid](#). It also gives off hydrofluoric acid and hydrogen gas when it is heated to a [gaseous](#) state. The chemical can decompose upon contact with [strong acids](#), [strong bases](#), [metal](#), water, or glass.^[3] Sodium bifluoride also engages in violent reactions with [chromyl chloride](#), [nitric acid](#), [red phosphorus](#), [sodium peroxide](#), [diethyl sulfoxide](#), and [diethylzinc](#).^[6]

Applications

The main role of sodium bifluoride is as a precursor to [sodium fluoride](#), millions of tons of which are produced annually.^[4]

Cleaning agents and laundry soaps

The compound also has applications in cleaning, capitalizing on the affinity of fluoride for iron and silicon oxides. For example formulations of sodium bifluoride are used for cleaning [brick](#), [stone](#), [ceramics](#), and [masonry](#). It is also used to [etch glass](#).^[3] Another application of sodium bifluoride is in the [chemical industry](#).^[7] Other applications of the compound involve the [galvanization](#) of [baths](#) and [pest](#) control.^[8] Sodium bifluoride's biological applications include the preservation of [zoological](#) and [anatomical](#) samples.^[9]

Other applications of sodium bifluoride include neutralizers of [laundry-rinse](#).^[4]

Other uses

Sodium bifluoride has a role in the process that is used to [plate](#) metal [cans](#).

Sodium bifluoride also aids in the precipitation of [calcium](#) ions during the process of [nickelectroplating](#). The compound also aids in increasing the corrosion resistance of some [magnesium alloys](#).^[10]

Precautions

Sodium bifluoride is [corrosive](#) and an [irritant](#) upon contact with [skin](#) and can cause [blistering](#) and inflammation. It is extremely dangerous to ingest. If the compound is exposed to the eyes, [blindness](#) and [corneal](#) damage can result. Ingestion of sodium bifluoride dust can cause burning, coughing, and sneezing, as a result of irritating the gastrointestinal and respiratory tracts. Exposure of the compound to the eyes can cause redness, itching, and watering. In severe cases, exposure to sodium bifluoride can result in [death](#).^[11] It can take between 0 and 24 hours for the effects of sodium bifluoride poisoning to be noticeable.^[3]

Exposure to sodium bifluoride repeatedly or over a long time can result in [fluorosis](#). Sodium bifluoride is not known to be [carcinogenic](#).^[3]

Biological and environmental role

Sodium bifluoride does not [bioaccumulate](#). It typically only remains in the [environment](#) for several days.^[3]

References

1.

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Ammonium hydrogen fluoride is the [inorganic compound](#) with the formula NH₄HF₂ or NH₄F·HF. It is produced from [ammonia](#) and [hydrogen fluoride](#). This colourless salt is a [glass-etchant](#) and an intermediate in a once-contemplated route to [hydrofluoric acid](#).

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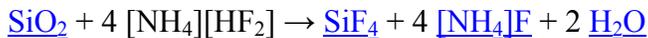
Structure

Ammonium bifluoride, as its name indicates, contains a [bifluoride](#), or hydrogen(difluoride) [anion](#): HF₂⁻. This centrosymmetric triatomic anion features the strongest known [hydrogen bond](#), with a [F–H](#) length of 114 pm.^[2] and a bond energy greater than 155 kJ mol⁻¹.^[3]

In solid [NH₄][HF₂], each [ammonium](#) cation is surrounded by four fluoride centers in a tetrahedron, with hydrogen-fluorine [hydrogen bonds](#) present between the hydrogen atoms of the ammonium ion and the fluorine atoms. Solutions contain tetrahedral [NH₄]⁺ cations and linear [HF₂]⁻ anions.

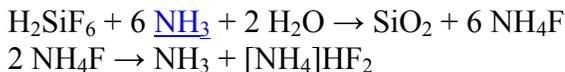
Production and applications

Ammonium bifluoride is a component of some etchants. It attacks [silica](#) component of glass:



[Potassium bifluoride](#) is a related more commonly used etchant.

Ammonium bifluoride has been considered as an intermediate in the production of [hydrofluoric acid](#) from [hexafluorosilicic acid](#). Thus, hexafluorosilicic acid is hydrolyzed to give ammonium fluoride, which thermally decomposes to give the bifluoride:



The resulting ammonium bifluoride is converted to the sodium bifluoride, which thermally decomposes to release HF.^[4]

See also

- [Bifluoride anion](#)
- [Potassium bifluoride](#)

References

1.

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-

Even though they both produce a corrosive fluoride solution, ABF and HF are quite different. HF is water-soluble in all proportions while ABF is soluble only up to ~28% at room temperature. ABF, in solution, yields ~ 1/3 as HF and ~2/3 as ammonium fluoride(AF) and, as such, provides a somewhat buffered solution (a 28% solution of ABF). In fact, semiconductor-chip manufacturers use different ratios of HF and ABF to produce various "Buffered Oxide Etches" that dissolve silica chips at various rates.

The use of (dry) ammonium bifluoride as a "safe" replacement for hydrofluoric acid is an unsafe practice. The uninitiated person who judges this as "safe" can quickly get into trouble since once the ammonium bifluoride (NH₄F)HF is contacted with water; the HF content will be ~ 13% ... very corrosive, toxic and hazardous.

Some folks have used ammonium bifluoride as a substitute for HF and created (what they refer to as) an "acid free" wheel cleaner -- it's a dangerous and deceptive practice.

Bottom line here is that the ABF solution will still produce an extremely hazardous liquid.

Ammonium bifluoride has a molecular weight of 57.0432 and hydrogen fluoride (HF) has a molecular weight of 20.006. Ammonium bifluoride can be viewed as a mixture of ammonium fluoride and hydrogen fluoride. Ammonium bifluoride is therefore 35.072% HF. So if you desire a solution that contains 5% hydrogen fluoride you need 2.85 times as much or 14.25% ammonium bifluoride. If you desire a solution that contains HF equivalent to 5% of the commercial product (typically, but not always, 48% HF) you will want 48% of this or 6.84% ammonium bifluoride. However, the ammonium fluoride will have a buffering effect on the solution and solutions prepared as described above will not be as active as their HF concentration would indicate. The desired strength will have to be determined experimentally. These calculations, though, will give you an idea of where to start your experiments.

One (1) lb of ammonium bifluoride equals 5 ½ oz HF; this is based on the 1:1 molar relationship of molecular weight of HF=20 versus mol weight of ammonium bifluoride=55.

<http://www.monash.edu.au/ohs/topics/hazard-alerts/hydrofluoric-acid-fatality.html>

<http://www.glassbeadmakers.net/forum/viewtopic.php?f=14&t=6844>

Ammonium bifluoride, when mixed with water, "can release hydrogen fluoride" (hydrofluoric acid). http://www.solvaynorthamerica.com/SiteCollectionDocuments/PDF/PS_AmmoniaBifluorideFinal.pdf This does not mean that everything in the solution is HF. It means that there may be SOME in the solution. A 9% solution of ammonium bifluoride does not mean it's 9% hydrofluoric acid. David said above that the HF will be approximately 1/3 of the percentage solution of ammonium bifluoride. I have not verified this, but if it is true, you would be looking at 3% HF.

I'm not debating effects, as I don't know anything about them, but simply discussing how reactive hydrofluoric acid is, and what's actually in that etching solution. It's my understanding that the unseparated HF is what causes cellular issues. As with any chemicals, wearing gloves is key, and safety glasses are a very good idea. I can't remember if we used a fume hood in grade 11 chemistry - it's been a while.

HF is a particularly dangerous acid because of its unique ability among acids to penetrate tissue. Dermal exposure is the most common type of exposure to HF with the digits being the most often affected body part. Related compounds that have similar toxicity profiles include ammonium bifluoride, ammonium fluoride, potassium bifluoride and sodium bifluoride.

<http://www.mnpoison.org/index.asp?pageID=151>

"Whatever cannot be saved for recovery or recycling should be handled as hazardous waste by an approved waste agency. The waste must be neutralised with lime in order to immobilise the fluoride as Calcium Fluoride.

Processing, use or contamination of this product may change the waste management options. Dispose of container and unused contents in accordance with federal, state and local requirements."

"Disposal Consideration

Disposal: A moderate amount of product can be flushed down sewer with plenty of water. Flush with water or neutralize with lime. If a large quantity is being disposed of, comply with all federal, state, and local regulations. No special spill procedures required"

I found the manufacturers site with a little tutorial for etchall showing how to etch a beer glass, no gloves, no eye protection, no mention at all of taking any safety procedures. I wouldn't take the manufacturers advice on the safety of this product at all

Here you go, no gloves, no eye protection

http://www.etchallstore.com/dip_instr.htm

http://www.etchallstore.com/creme_instr.htm

Concentrated hydrofluoric acid and anhydrous hydrogen fluoride gas are extremely dangerous because they are absorbed through the skin without an initial burning sensation. They can then react with bone, forming calcium fluoride and essentially dissolving bone, if not treated immediately.

Ammonium bifluoride solutions are less dangerous but should still be treated with respect. At a

minimum gloves and safety glasses should be used. If it is splashed on the skin, it should be immediately rinsed off and neutralized with an mild alkaline material (baking soda, milk of magnesia, calcium carbonate, Tums, etc). Ammonium bifluoride solutions generally do not present an inhalation hazard since the hydrogen fluoride that is formed is very water soluble and has a low vapor pressure.
