

Hydrofluoric Acid

Properties of Hydrofluoric Acid

Hydrofluoric acid (commonly referred to as HF) is formed when anhydrous hydrogen fluoride dissolves in water to form a weak acid. Hydrofluoric acid is an extremely dangerous substance and can cause severe tissue damage and toxic effects via inhalation, ingestion or skin / eye contact. Both anhydrous hydrogen fluoride and concentrated hydrofluoric acid are clear, colourless, fuming liquids that produce a strong smelling, pungent fumes that are extremely hazardous.

Hydrofluoric acid reacts strongly with several substances including silica, glass, ceramics, leather, concrete and metal oxides but reacts poorly with metals. It is commonly used to etch glass and ceramics and to remove metal oxides from the surface of metals without harming the metal underneath and is therefore in common use in several areas across the university of Glasgow.

Hydrofluoric acid (and hydrogen fluoride) pass readily across the skin into the bloodstream and will cause severe tissue damage to both skin and eyes. Direct contact with a concentrated solution will cause severe, painful burns with a characteristic white or grey colour that may take a long time to heal and can lead to gangrene and loss of tissue. Exposure to more dilute solutions can lead to a delayed reaction meaning that exposures may not be noticed for several hours (in the case of solutions with a concentration <20% the effects may not be observed for up to 24 hours). The ability of hydrofluoric acid to pass through the skin means that burns can be very deep and damage may continue for some time after the initial exposure has occurred.

Hydrofluoric Acid Burns and Toxicity

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Hydrofluoric acid will cause very severe damage to the eyes potentially resulting in blindness due to destruction of the cornea if the exposure is prolonged or severe. Eye splashes should always be treated as quickly as possible using an eye wash and/or suitable "antidote".

Inhalation of hydrogen fluoride vapour should be avoided as the vapour is extremely harmful and can dissolve in body moisture forming hydrofluoric acid, in cases of severe exposure pulmonary oedema could develop due to the destruction of lung tissue. Symptoms of exposure include coughing, choking, tightness of the chest, chills, fever and cyanosis of the skin (blue colouration). The HSE document EH40 sets out the short and long-term exposure limits for HF as follows:

15 STEL	3ppm
8h TWA	1.8ppm

The level of HF vapour in the air can be monitored using Draeger colorimetric tubes to give an indication of the level of risk and effectiveness of control measures.

In addition to causing burns, hydrofluoric acid is highly toxic reacting strongly with calcium in the body to cause hypocalcemia. Large areas of skin contact (around the size of your palm) can cause a risk of hypocalcemia whereas exposure of just 2% of the body's surface to concentrated HF can be fatal.

First Aid Requirements

Due to the potential severity of the injuries caused by hydrofluoric acid it is unsurprising that very specific first aid requirements apply. In the event a person is suspected or confirmed to have been exposed then the following steps should be taken.

- The site should be flushed with copious quantities of water for a few minutes using a sink or emergency shower to remove any hydrofluoric acid residue from the surface of the skin. If an HF "antidote" is not available (or is not suitable for use) this time should be increased to around 15-20min.
- Contaminated clothing and jewellery should be removed while flushing with water and placed in a safe area for disposal, remember to avoid spreading contamination from affected clothing and wear appropriate PPE when assisting someone to remove contaminated clothing.
- If an "antidote" is available then it should be applied following the manufacturer's instructions, remember to avoid coming into contact with contaminated skin or clothing. Note that some "antidotes" are applied immediately instead of flushing first with water, always follow the instructions from the manufacturer / supplier.
- Medical attention should **always** be sought following an exposure to hydrofluoric acid.

Exposure to hydrofluoric acid can be mitigated by application of neutralising agents such as calcium gluconate gel or a commercial product known as Hexafluorine. These agents are commonly referred to as "antidotes" or "neutralising agents" and while this is not strictly the case they do help to mitigate the effects of exposure to HF.

Calcium Gluconate

Calcium gluconate gel is the most common Hf "antidote" in use in the UK. It consists of a small tube of gel containing 2.5% calcium gluconate. Calcium gluconate reacts with hydrofluoric acid producing calcium fluoride which is non-corrosive, insoluble and non-toxic (causing the gel to turn white). Once an exposure has occurred calcium gluconate gel should be applied liberally to the affected area and massaged into the skin using a gloved hand. This should be repeated every 15min until medical attention has arrived or the affected person has been transferred to hospital. Medical attention should be sought as quickly as possible. Calcium gluconate **must not be applied to the eyes** and is therefore not suitable for eye splashes involving HF.

Hexafluorine

Hexafluorine is a commercial HF "antidote" which is supplied as either an eye wash style bottle or in a spray canister intended for use on larger areas. It is recommended that it is used without a prior wash with water and should be applied directly to the affected site. Unlike calcium gluconate hexafluorine can be applied to the eyes and can also be used to rinse out the mouth following ingestion of HF (although it should not be swallowed).

Note: in the event that a person is exposed to hydrofluoric acid by ingestion or direct contact (or inhales HF vapour) they should always be referred to hospital for further treatment even if they have used an HF "antidote". Remember that in some cases exposure may not be immediately obvious.

Note: Before beginning work involving the use of hydrofluoric acid the appropriate first aid materials should be located and placed within easy reach. Calcium gluconate gels or other neutralising agents should be checked to ensure they have not expired.

Working with Hydrofluoric Acid

Due to the hazards presented by hydrofluoric acid we strongly recommend that it is only used by experienced, competent staff and students who have been instructed in safety procedures and handling techniques. The use of hydrofluoric acid should always be supported by a robust CoSHH assessment and Standard operating Procedures (SOPs) should be implemented to help ensure that a safe system of work is implemented. Consider the following precautions:

- Where a viable alternative exists hydrofluoric acid should not be used unless there is a specific reason for doing so, this eliminates the hazard entirely.
- A suitable and sufficient CoSHH assessment should be prepared before any work with hydrofluoric acid (or hydrogen fluoride) is started. We strongly recommend that users are asked to sign the assessment confirming their understanding of the risks and agreeing to adhere to the specified precautions prior to commencing any procedures involving this substance.
- Where possible Standard operating procedures should be in place for routine processes involving the use of HF. These should be regularly reviewed and include key safety information.
- Only staff and students who have received appropriate training should be permitted to work with hydrofluoric acid. This can take the form of “on the job” training under the supervision of an experienced user.
- Hydrofluoric acid should only be used in a controlled area where spillages and leaks can be contained. It is good practice to ensure areas where HF is in use are clearly marked to alert other users and visitors to the potential risk. If HF is used regularly then where possible specific work areas should be designated for HF use and not used for any other purpose.
- Hydrofluoric acid should only be used in a well ventilated area with a suitable extraction system present to remove any vapours. The ideal solution is to use a suitable LEV system such as a fume cupboard. Note that in many applications (e.g. electronics) a laminar air flow cabinet is used to prevent dust contamination of the working area. While these may provide some containment for liquid spills and help to dilute any vapours released they do not fully extract and harmful gases released and in fact may blow them into the working area.
- Where a risk of vapour release is present atmospheric monitoring should be considered to ensure hydrogen fluoride levels are within acceptable limits in working areas.
- Suitable PPE should always be worn when handling hydrofluoric acid even when working in a fume cabinet. As a minimum this should include acid resistant gloves, safety glasses and a suitable lab-coat along with normal laboratory attire which covers exposed skin. It is strongly recommended that double gloving is considered along with the use of an acid resistant apron.
- Lone working should not be permitted when using hydrofluoric acid or hydrogen fluoride gas.
- Glass containers should never be used for the storage or transport of hydrofluoric acid (including dilute solutions) as the acid will react with the glass leading to weakening of the structure and potential failure of containment.
- Disposal procedures should be established before the procedure begins, in general acid waste should be collected for disposal using an appropriate container (see above). Waste should be clearly labelled, stored in an appropriately ventilated area and disposed of as quickly as possible. Neutralisation of HF waste is not recommended due to the formation of reactive intermediates that can re-release HF vapour.
- Emergency procedures / first aid protocols including the use of “antidotes” such as calcium gluconate gel must be established before the process begins. Antidotes, spill kits and washing stations should be located nearby and expiry dates checked to ensure that they are in date. Anyone involved in the process should be clearly briefed on the protocols to be implemented in the event of an exposure.
- In the event of a leak or spillage the area should be evacuated, you should only attempt to clear up small spills if trained to do so, using an HF specific spill kit only. HF will react with sand and some other absorbents and the risk may be increased if attempts are made to neutralise it using inappropriate methods (see above).

Further Information

Hydrofluoric acid is a potentially lethal chemical and should be treated with caution. However, like most hazardous substance it can be used safely if appropriate precautions are taken. Further information can be obtained by contacting Safety and Environmental Protection Services

General Office: 0141 3305532

Chemical Safety Adviser: 0141 3302799