Hydrogen Fluoride (Hydrofluoric Acid)

7664-39-3

Hazard Summary

Hydrogen fluoride is used in the production of aluminum and chlorofluorocarbons, and in the glass etching and chemical industries. Acute (short-term) inhalation exposure to gaseous hydrogen fluoride can cause severe respiratory damage in humans, including severe irritation and lung edema. Severe eye irritation and skin burns may occur following eye or skin exposure in humans. Chronic (long-term) exposure in workers has resulted in skeletal fluorosis, a bone disease. Animal studies have reported effects on the lungs, liver, and kidneys from acute and chronic inhalation exposure to hydrogen fluoride. Studies investigating the carcinogenic potential of hydrogen fluoride are inconclusive. EPA has not classified hydrogen fluoride for carcinogenicity.

Please Note: The main sources of information for this fact sheet are EPA's Integrated Risk Information System (IRIS) on Fluorine (2) and the Agency for Toxic Substances and Disease Registry's (ATSDR's) Toxicological Profile for Fluorides, Hydrogen Fluoride, and Fluorine. (1) An additional secondary source is the Hazardous Substances Data Bank (HSDB) (3), a database of summaries of peer-reviewed literature.

Uses

- Hydrogen fluoride is used in the production of most fluorine-containing chemicals. It is used in the production of refrigerants, herbicides, pharmaceuticals, high-octane gasoline, aluminum, plastics, electrical components, and fluorescent light bulbs. Anhydrous hydrogen fluoride is used as a catalyst in the petroleum alkylation, a process that increases the octane rating of petroleum. In uranium chemicals production, hydrogen fluoride is used to convert uranium oxide (yellow cake, U_3O_8) to UF_4 before further fluorination to UF_6. (1)
- The most important use of hydrogen fluoride is in the production of fluorocarbon chemicals, including hydrofluorocarbons, hydrofluorochlorocarbons, and fluoropolymers; 60% of production is used for this purpose. Demand for hydrogen fluoride for fluorocarbons, broadly used as refrigerants, is increasing as a nonchlorinated alternative to ozone-depleting chlorofluorocarbons. (Production of fluorocarbons uses more hydrogen fluoride than production of chlorofluorocarbons). (1)
- Aqueous hydrofluoric acid is used in stainless steel pickling, glass etching, metal coatings, exotic metal extraction, and quartz purification. (1)

- Fluoride is sometimes added to public drinking water supplies, and is used in a number of dental products, because of the beneficial effect of dental cavity prevention from such low level exposures. (1,2)

Sources and Potential Exposure

- The general population is exposed to fluoride through consumption of fluoridated drinking water, foods, and dentifrices. (1)
- Fluorides are naturally-occurring components of rocks and soil and are also found in air, water, plants, and animals. They enter the atmosphere through volcanic emissions and the resuspension of soil by wind. Volcanoes also emit hydrogen fluoride and some fluorine gas. (1)
- Coal contains small amounts of fluorine, and coal-fired power plants constitute the largest source of anthropogenic hydrogen fluoride emissions. Major sources of industrial fluoride emissions are aluminum production plants and phosphate fertilizer plants; both emit hydrogen fluoride and particulate fluorides. Other industries releasing hydrogen fluoride are: chemical production; steel; magnesium; and brick and structural clay products. Hydrogen fluoride is also released by municipal incinerators as a consequence of the presence of fluoride-containing material in the waste stream. (1)
- Individuals are most likely to be exposed to hydrogen fluoride by inhalation or skin contact in the workplace. (1)
- Individuals may also be exposed to hydrogen fluoride and other fluorides in the environment from emissions from industrial processes and coal combustion, and from natural sources, including volcanic activity and dust from weathering of fluoride-containing rocks and soils. (1,2)
- Fluoride is also a component of cigarette smoke. (1)

Assessing Personal Exposure

- Urine samples can be analyzed to determine whether or not exposure to fluorides has occurred. However, this test cannot distinguish among exposures to different fluorine compounds. (1)

Health Hazard Information

Acute Effects:

- Acute inhalation exposure to gaseous hydrogen fluoride can cause severe respiratory damage in humans, including severe irritation and lung edema. Irritation of the eyes, nose, and upper and lower respiratory tract, tearing of the eyes, sore throat, cough, chest tightness, and wheezing have been reported. (1,3,4)
- Severe eye irritation and skin burns may occur following eye or skin exposure in humans. (1,3,4)
- Convulsions and irregular heartbeat may occur in humans from ingestion of high doses of fluorides. (1)
- Damage to the lungs, liver, and kidneys has been observed in animals acutely exposed to hydrogen fluoride by inhalation. (1)

- Acute animal tests in rats, mice, guinea pigs, and monkeys have demonstrated hydrogen fluoride to have moderate to high acute toxicity from inhalation exposure. (4)

Chronic Effects (Noncancer):

- Chronic inhalation exposure of humans to low levels of hydrogen fluoride has resulted in irritation and congestion of the nose, throat, and lungs. (1,5)
- Skeletal fluorosis, a bone disease, was reported among workers chronically exposed to fluorides (including hydrogen fluoride) via inhalation. (1)
- Damage to the liver, kidneys, and lungs has been observed in animals chronically exposed to hydrogen fluoride by inhalation. (1)
- EPA has not established a Reference Concentration (RfC) or a Reference Dose (RfD) for hydrogen fluoride.
- CalEPA has calculated a chronic inhalation reference exposure level (REL) of 0.014 mg/m^3 for hydrogen fluoride based on effects on the bone (skeletal fluorosis) in humans. The CalEPA chronic REL is a concentration of a chemical at or below which adverse health effects are not likely to occur for long-term exposures for 24 hours a day. It is not a direct estimator of risk but rather a reference point to gauge the potential effects. At lifetime exposures increasingly greater than the REL, the potential for adverse health effects increases. (6)
- Chronic oral exposure to fluoride at low levels has a beneficial effect of dental cavity prevention. Fluoride has also been used for the treatment of osteoporosis. (2)
- Chronic exposure to fluoride through drinking water has been observed to cause dental fluorosis or mottling (staining or pitting of teeth) in humans. At higher intakes through oral or inhalation exposure, skeletal fluorosis (i.e., an accumulation of fluoride in the skeletal tissues associated with pathological bone formation) has been noted in humans. (1,2)
- At high concentrations, chronic oral fluoride exposure has been reported to result in adverse effects on the lung, kidney, thyroid, blood, and skin in humans. (1)

Reproductive/Developmental Effects:

- No information is available on the reproductive or developmental effects from inhalation exposure to hydrogen fluoride in humans. (1)
- Inhalation of hydrogen fluoride resulted in testicular changes in male dogs. (1,5)
- In some animal studies, oral exposure to fluoride has caused impaired reproduction and malformation of fetal bones and teeth. (1)

Cancer Risk:

- Studies investigating the carcinogenic potential of hydrogen fluoride are unreliable due to confounding factors and because of lack of breakdown by type of fluoride exposure. (1)
- EPA has not classified hydrogen fluoride with respect to potential carcinogenicity.

Physical Properties

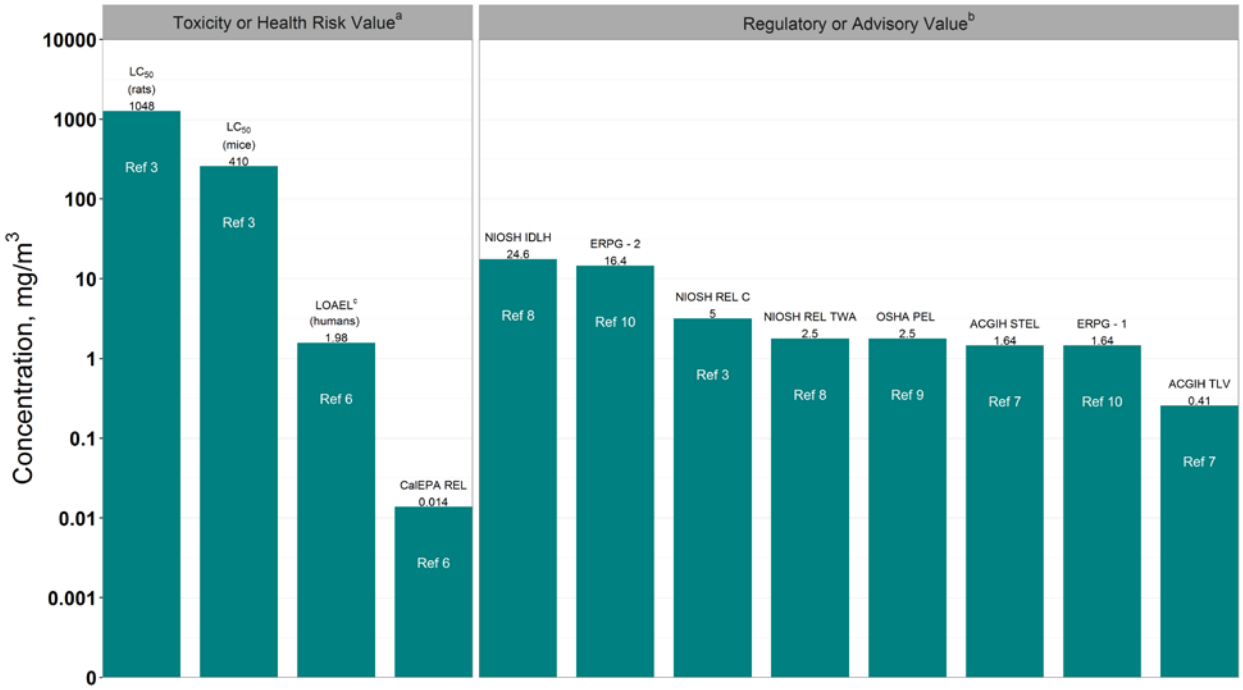
- The chemical formula for hydrogen fluoride is HF, and its molecular weight is 20.01 g/mol. (4)
- Hydrogen fluoride is a colorless gas that is highly soluble in water. (4)
- Hydrogen fluoride has a strong irritating odor; the odor threshold is 0.03 mg/m^3. (4)
- Anhydrous hydrogen fluoride is one of the strongest acids known. (2)

- The chemicals most commonly used by American water works in fluoridation of drinking water are fluorosilicic acid, sodium silicofluoride, and sodium fluoride. Fluorides used in dentifrices are sodium fluoride, sodium monofluorophosphate, and stannous fluoride. (1)

Conversion Factors:

To convert concentrations in air (at 25 °C) from ppm to mg/m³: mg/m³ = (ppm) × (molecular weight of the compound)/(24.45). For hydrogen fluoride: 1 ppm = 0.82 mg/m³.

Health Data from Inhalation Exposure



ACGIH STEL--American Conference of Governmental and Industrial Hygienists' short-term exposure limit; a 15-minute time-weighted average exposure that should not be exceeded at any time during a workday.

ACGIH TLV--American Conference of Governmental and Industrial Hygienists' threshold limit value; the concentration for a conventional 8-hour workday and a 40-hour workweek to which it is believed that nearly all workers may be repeatedly exposed, day after day, for a working lifetime, without adverse effect. For hydrogen fluoride, the TLV is a time-weighted average concentration.

CalEPA REL--California Environmental Protection Agency, Office of Environmental Health Hazard Assessment's Chronic Reference Exposure Level. Chronic RELs are designed to address continuous exposures for up to a lifetime: the exposure metric used is the annual average exposure.

ERPG--American Industrial Hygiene Association's Emergency Response Planning Guidelines. ERPG-1 is the maximum airborne concentration below which nearly all individuals could be exposed for up to one hour without experiencing more than mild, transient adverse health effects or without perceiving a clearly defined objectionable odor; ERPG-2 is the maximum airborne concentration

below which nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair an individual's ability to take protective action.

LC_{50} (Lethal Concentration$_{50}$)--A calculated concentration of a chemical in air to which exposure for a specific length of time is expected to cause death in 50% of a defined experimental animal population.

LOAEL--Lowest-observed-adverse-effect level.

NIOSH IDLH--National Institute of Occupational Safety and Health's immediately dangerous to life or health concentration; NIOSH recommended exposure limit to ensure that a worker can escape from an exposure condition that is likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from the environment.

NIOSH REL C--National Institute of Occupational Safety and Health's recommended exposure limit ceiling; the concentration that should not be exceeded at any time.

NIOSH REL TWA--National Institute of Occupational Safety and Health's recommended exposure limit time-weighted average; time-weighted average concentration for up to a 10-hour workday during a 40-hour workweek.

OSHA PEL--Occupational Safety and Health Administration's permissible exposure limit, which is a time-weighted average for hydrogen fluoride; the concentration of a substance that should not be exceeded during any 8-hour workshift of a 40-hour workweek.

[a] Health numbers are toxicological numbers from animal testing or risk assessment values developed by EPA.

[b] Regulatory numbers are values that have been incorporated in Government regulations, while advisory numbers are nonregulatory values provided by the Government or other groups as advice. OSHA numbers are regulatory, whereas NIOSH, ACGIH, and AIHA numbers are advisory.

[c] This LOAEL is from the critical study used as the basis for the CalEPA chronic reference exposure level.

Summary created in April 1992, updated in September 2016

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