Hydrogen chloride (Hydrochloric acid HCl)

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Hydrogen Chloride (HCl), is a compound of the elements hydrogen and chlorine and a gas at room temperature and pressure. A solution of the gas in water is called hydrochloric acid. At room temperature, hydrogen chloride is a colorless to slightly yellow gas with a characteristic pungent odor. On exposure to air, the gas forms dense white vapors due to condensation with atmospheric moisture. It is heavier than air and may accumulate in low-lying areas [1]. The name HCl often refers somewhat misleadingly to hydrochloric acid instead of the gaseous hydrogen chloride. Upon contact with water, it immediately ionizes, forming hydronium cations H3O+ and chloride anions Cl- through a reversible chemical reaction with the water:

$HCl + H_2O \rightarrow H_3O^+ + Cl^-$

The resulting solution is called hydrochloric acid and is a strong acid. Even in the absence of water, hydrogen chloride can still act as an acid. For example, hydrogen chloride can dissolve in certain other solvents such as methanol, and protonate molecules or ions and act as an acid-catalyst for chemical reactions where anhydrous (water-free) conditions are desired:

$HCl + CH_3OH \rightarrow CH_3O^+H_2 + Cl^-$

Because of its acidic nature, hydrogen chloride is a corrosive gas, particularly in the presence of any moisture.

Usage

- Refining mineral ores;

- Chemical manufacturing;
- Petroleum well extraction;
- Leather tanning;
- Producing polymers, plastics, rubber, fertilizers, dyes;
- Refining of fats, soaps;
- Food processing [2].
- Hydrochloric acid is used in industries that involve acid treatment of metals, where occupational exposure levels to hydrochloric acid mists and gas are frequently above 1 mg/m3. Exposures to hydrochloric acid may also occur during its synthesis and use in various industrial processes [3].

Routes of exposure: dermal, inhalation, oral.

Hydrogen chloride is not absorbed through the skin, but when hydrogen chloride gas comes in contact with moisture, it forms hydrochloric acid, which is corrosive and can cause irritation and burns. Exposure to 0.1 percent by volume of hydrogen chloride gas in the atmosphere may cause death in a few minutes. The vapor is corrosive, and air concentrations above 5 ppm can cause irritation.

Target organs: skin, mucous membranes, eyes, respiratory tract

Health hazards

Acute exposure

Concentrated hydrochloric acid causes burns and inflammation of the skin. Contact with less concentrated acid or with vapor or mist can cause redness of the skin and mild inflammation [4].

Exposure of the eyes to concentrated hydrogen chloride vapor or hydrochloric acid can cause corneal cell death, cataracts, and glaucoma. Exposure to diluted solutions can cause stinging pain and injuries such as ulcers of the eye surface.

Hydrogen chloride gas is intensely irritating to the mucous membranes of the nose, throat, and respiratory tract. Brief exposure to 35 ppm causes throat irritation, and levels of 50 to 100 ppm are barely tolerable for 1 hour. The greatest impact is on the upper respiratory tract; exposure to high concentrations can rapidly lead to swelling and spasm of the throat and suffocation [ATSDR].

Inhalation of a substantial quantity of vapor causes irritation of the upper respiratory tract, acute bronchitis, edema of the glottis and pulmonary edema [5]. After acute exposure, pulmonary function generally returns to baseline in 7 to 14 days.

Exposure to hydrogen chloride can lead to RADS or irritant asthma [6].

Ingesting concentrated hydrochloric acid can cause pain, difficulty swallowing, nausea, and vomiting. It can also cause severe corrosive injury to the mouth, throat, esophagus, and stomach, with bleeding, perforation, scarring, or stricture formation.

Chronic exposure

Chronic exposure may be associated with inflammation of the skin, discoloration and erosion of dental enamel, nasal ulceration, change in pulmonary function, chronic inflammation of the bronchi [7].

Hydrochloric acid is not classifiable as to its carcinogenicity to humans (Group 3) [IARC].

References

1. ATSDR. Medical management Guidelines (MMGs) for Hydrogen Chloride (HCl). <http://www.atsdr.cdc.gov/mmg/mmg.asp?id=758&tid=147>. Accessed 06/11/2015.

2. LaDou J.: Occupational and Environmental Medicine, 2nd ed., p.441 Appleton & Lange, Stamford, 1997.
3. IARC. VOL. 54 p. 9, 1997.
4. Sullivan J.B., Krieger G.R., eds.: Hazardous Materials Toxicology : Clinical Principles of Environmental Health. p.792 Williams & Wilkins, 1992.
5. Parkes W.R.: Occupational Lung Disease. 3d ed. 536-540
6. Beach J.R.: Immunologic versus toxicologic mechanisms in airway responses Occupational Medicine: State of the Art Reviews – Vol 15, No 2, April-June 2000.
7. CDC. NIOSH. Occupational Health Guidelines for Hydrogen Chloride. 1978.

<http://www.cdc.gov/niosh/docs/81-123/pdfs/0332.pdf>