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For a Safer Working Environment with Hydrofluoric Acid in Iraqi Industrial Plants

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Abstract

Hydrofluoric acid has been one of the important chemicals in the industry. In Iraq, there is a considerable consumption of it in petrochemicals and detergents industry. However, so far, there is no genuine evaluation for the hazards and any prospective procedures to minimise the risk of it. In this regard, we show here some accidents took place in some industrial amenities in Iraq and other Arabic countries. In addition, there is an elaborated description of the degree of risk, safety practices, and some feasible treatments for hydrofluoric acid burns and inhalations.

Keywords

Hydrofluoric Acid, Hazards, Safety, Feasible Treatments

1. Introduction

Hydrofluoric acid (HF) is one of the most hazardous chemicals due to its toxicological effects to skin, and respiratory system [1]. Unlike other hydrohalide acids, e.g. Hydrochloric acid, HF does not dissociate completely in water to give hydrogen ions (H^+) and fluoride ions (F^-) owing to the strong electrostatic interactions between fluorine and hydrogen. In reality, the effect of HF acidity becomes less pronounced if dissolved in water. Nevertheless, even at low concentrations HF can cause severe burns to skin accompanied by whitening of skin [2] as shown in **Figure 1**.

In some cases, moderate concentrations of HF (~50%) can lead to an extremely severe burns that may cause death if the burnt area is more than 20% of the total body area [3].

The skin damage is completely attributed to the corrosive effect of HF. The chemical dissociation of it gives F^- and H^+, and the latter depletes the skin tissue to open up a

way for the fluoride F^- penetration inside the skin and to be combined with Ca^{2+} as shown in Figure 2.

As mentioned earlier, there might be a minor effect on skin if HF was diluted. Albeit, the prolonged exposure, delay in symptoms' appearance, and no treatment can give the same severe effect of moderate or highly concentrated HF.

Inhalation of HF vapours may also be very harmful to respiratory system, namely, pulmonary edema, and laryngospasm. Ingestion also can occur and cause poisoning then death.

All of the above adverse effects of HF necessitate raising this issue and suggesting reliable safety measures, precautions, and any possible treatments whenever accidents occur.

2. Potential Risks and Examples

As mentioned earlier, there might be a minor effect on skin if HF was diluted. Albeit, the prolonged exposure, delay in symptoms' appearance, and no treatment can give the same severe effect of moderate or highly concentrated HF. Inhalation of HF vapours may also be very harmful to respiratory system, namely, pulmonary edema, and laryngospasm. Ingestion also can occur and cause poisoning then death. Along with our previous case study on safety protocols [4], we believe that all of the above adverse effects of HF necessitate raising this issue and suggesting reliable safety measures, precautions,

Figure 1. HF burns to skin with a moderately to highly concentrated HF.

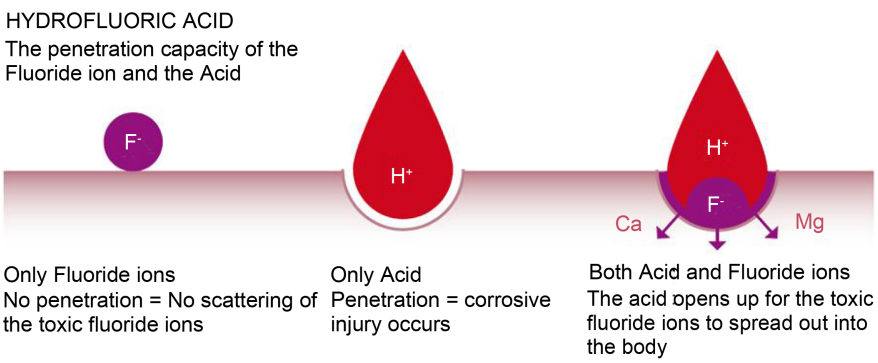

Figure 2. The penetration of F^- into the skin via the help of H^+.

and any possible treatments whenever accidents occur.

3. Safety Precautions and Management

- Conducting a regular inspections for reactors, valves, reservoirs, etc. in order to avoid any possible accidents.
- Reading and understanding the Safety Data Sheet (SDS) of HF by chemists/chemical engineers in advance.
- Preparing a reasonable risk assessment form which includes all the possible risks, determining the risk score, and how to control or prevent any incident.
- Asking all staff members who are working with HF to read the risk assessment form carefully and sign it.
- Wearing PPE (gloves, goggles, and lab coats) is compulsory at all times with no excuses.
- Testing ventilation systems and installing oxygen sensors and they should be checked regularly.
- Providing a first aid kit in the vicinity of production facility.

4. Treatment

For skin burns, the affected area must be irrigated with a tap water for at least 10 - 15 minutes, then apply a copious amount of calcium gel (**Figure 3**). Physicians recommend doing that every 30 minutes. If HF concentration was high and the casualty is still suffering from pain, then an intra-arterial fusion of calcium must be given. They must take 50 mL of calcium gluconate (4%) during a period of 4 hours over a course of 12 hours. However, there might be some side effects for this treatment, for instance, hypercalcemia [5] [6] [7] [8].

For eyes treatment, they should be thoroughly washed with water (eye washed is highly preferred). Thereafter, they either use few drops of calcium gluconate eye drops (1% - 10%) or seek for a medical advice immediately by an ophthalmologist.

5. Conclusion

In the light of the present case study, we would like to emphasise the importance of safety in every industrial plant in Iraq. Offering a reasonably safe and low-risk environment

Figure 3. The calcium gel for treating HF burns.

should be the first priority. Furthermore, working with highly corrosive, and toxic chemicals like HF must be minimised and controlled. A set of procedures and protocols must be put and followed literally and strictly to avoid any potential damage to people and facilities.

Recommendations

In every industrial amenity or laboratory, there must be a full risk assessment folder which contains all risk assessment forms for each chemical reaction performed in these premises. Additionally, supervisors or employers must allow their staff members to access the risk assessment and have some training to control risks and minimise it.

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