

## **CHAPTER 7**

### **SAFETY**

#### **7.1 INTRODUCTION**

Potable water fluoride levels at the recommended concentration of 1.0 mg/l (1 ppm) have been exhaustively studied and firmly established as safe. The fluoride levels to which the water plant operator may be exposed are much higher when handling the chemicals. Therefore the use of safety equipment is strongly recommended when handling fluoride compounds or performing maintenance.

#### **7.2 HANDLING OF FLUORIDE CHEMICALS**

The best safety measure for prevention of overexposure is the proper handling of fluoride chemicals. Proper handling implies adequate knowledge of the material, the use of correct procedures, and the use of proper safety equipment.

Good ventilation is a necessity in work areas, even when there is no visible dust production. If possible, the storage area should be kept locked and not used for any other purpose.

The disposal of empty fluoride containers is usually a problem. The temptation to reuse fibre drums is difficult to overcome, because the drums are convenient and sturdy. Paper bags are dusty and could cause a hazard if burned, and empty acid drums could still contain enough acid to cause contamination. The best approach is to rinse all empty containers with plenty of water. Paper bags are strong enough to withstand several rinses. After all traces of fluoride are removed, the bags should be disposed of in a proper manner. Supposedly well-rinsed drums should never be used where traces of fluoride could present a hazard. The government's solid waste division should be consulted for the correct procedures regarding bag and drum disposal.

Water plant personnel should regularly receive safety training on all chemicals, including fluoride. Hazards and first aid measures should be reviewed and explained. Emergency spill procedures should be established and personnel trained in the execution of those procedures.

Always wear protective safety gear when handling fluoride chemicals. Protective clothing should be stored near the entrance to the area where the fluoride chemical is stored and used. This clothing should not be worn into other parts of the water plant to avoid spreading of the fluoride chemical.

The following is a list of protective clothing, equipment and procedures, which is the minimum recommended for each fluoride chemical.

##### **7.2.1 SODIUM FLUORIDE/SODIUM FLUOROSILICATE**

The greatest chance for overexposure to dry fluoride chemicals comes from the inhalation of dust generated when feeder hoppers are being filled. The maximum allowable concentration of fluoride dust in the area should be 0.2-0.3 mg/m<sup>3</sup> of fluoride dust in air.

- Wear protective clothing
  - Approved high efficiency dust respirator (chemical mask) with soft rubber

- face-to-mask seal and replaceable cartridges
  - Goggles
  - Gauntlet neoprene gloves (30 cm glove minimum length)
  - Heavy duty neoprene aprons
  - High top boots
- Don't tear or puncture bags when they are moved
- Use a knife to open the bags and make a clean cut
- Pour the sodium fluoride into the saturator gently, so as to raise as little dust as possible
- Empty opened bags completely
- Do not store partially filled bags of sodium fluoride for later use.
- Dispose of empty bags as required by government safety regulations
- Wash your hands immediately after handling sodium fluoride, the fluoridation equipment, or your protective clothing
- Never eat, drink, or smoke in areas where sodium fluoride is stored and used.

## 7.2.2 HYDROFLUOSILICIC ACID

Hydrofluosilicic acid requires special precautions. The 22% acid has a freezing point of approximately -16°C. The fumes from the acid are highly corrosive and will etch glass.

Although the acid is available in polyethylene drums, some suppliers continue to ship in lined steel drums that may suffer leakage problems.

- Wear protective clothing
  - Gauntlet neoprene gloves (30 cm glove minimum length)
  - Full 20 cm face shield and/or acid type safety goggles
  - Heavy duty acid type neoprene aprons
  - Safety shower/eye washer in easily accessible location (or 500 ml bottle of eyewash solution)
  - Boots
- Hydrofluosilicic acid containers should not be stored in the hot sun where they can build up hydrostatic pressure or in open areas where they are subject to winter freezing
- Store hydrofluosilicic acid in well-ventilated areas, away from switches, contacts, and control panels
- Keep the acid off clothes and skin and don't breathe in its fumes when handling the acid
- Use a transfer pump to move acid from one container to another
- Mop up any spilled acid immediately and wash the area with water
- Dispose of empty acid containers as required by government regulations
- Wash your hands after handling hydrofluosilicic acid, the fluoridation equipment, or your protective clothing. Do this immediately, before you do anything else.
- Never eat, drink, or smoke in areas where the acid is stored or used.
- Chemical respirators with cartridges for acid fumes should be worn if the concentration is sufficient to cause irritation to the nose
- Spill control pillows can be used to clean up small hydrofluosilicic acid spills. The liquid is absorbed and contained within the pillow by a highly efficient "foamed sand" type of absorbent, which is chemically inert and can absorb up to 10 times its weight. The pillows are commercially available in various sizes ranging from 1 to 4 litres.

### **7.3 TOXIC EXPOSURE**

While potable water with fluoride levels at the recommended concentration of 1.0 mg/l (1 ppm) has been exhaustively studied and firmly established as safe beyond question, the fluoride levels to which the water plant operator can be exposed are potentially much higher.

To prevent overexposure, the best safety measure is proper handling of fluoride chemicals. Proper handling implies adequate knowledge of the material, the practice of correct procedures, and the use of indicated safety equipment. There are times, however, that the operator may be overexposed to the fluoride chemicals especially the dusts. These overexposures, whether they occur in water or air, are called toxic exposures. The two kinds of toxic exposures are chronic and acute toxic exposure.

#### **7.3.1 CHRONIC TOXIC EXPOSURE**

Chronic toxic exposure occurs when exposure to large doses of fluoride exists over a number of years. This type of exposure could occur as a result of repeated dust inhalation when feeder hoppers are being filled. The body's assimilation capacity for fluoride is limited. Storage begins at about 1.5 mg/day. It is estimated that low poisoning may start at 0.2-0.35 mg/kg of body weight. For 80 kg that equals 15.9-27.8 mg.

The only toxic effect of low levels of fluoride (two to eight times that of the optimal level) over a long period of time is mottled enamel on the teeth. At higher levels of fluoride intake, osteosclerosis, calcification of ligaments and tendons, and/or vertebrae consolidation can occur. With chronic toxic exposure, there may be a general lack of appetite, slight nausea, some shortness of breath, constipation, pain in the regions of the liver, and anaemia.

#### **7.3.2 ACUTE TOXIC EXPOSURE**

Acute toxic exposure results from a single massive dose. Acute fluoride poisoning may result from ingestion, inhalation, or bodily contact with concentrated fluoride compounds. Knowledge is limited concerning acute fluoride poisoning caused by ingestion or inhalation because it is very rare. Accidental ingestion is quite unlikely, but could occur through contamination of food or drink either by mistaking the compound for sugar or salt or through carelessness in allowing areas where food is consumed to become contaminated by dust or spillage.

The symptoms of acute poisoning by inhalation of dust or vapour include sharp biting pains in the nose followed by nasal discharge or nosebleed and possibly coughing or respiratory distress. Acid spill or splash may cause a tingling or burning sensation of the skin. If the eyes are involved, severe eye irritation may result.

Ingested toxic dosages generally cause vomiting, stomach cramps, and diarrhea. If the poisoning involves ingestion of large amounts of fluorides, the vomitus may be white and the victim may experience weakness, disturbed colour vision, thirst, and have difficulty in speaking. Ingestion of 4-5 g/80 kg body weight may be fatal.

#### **7.3.3 FIRST AID FOR ACUTE TOXIC EXPOSURE**

Once fluoride poisoning is established, first aid treatment should be started while waiting for medical help. The recommended first aid for toxic fluoride dosages, in order of importance, is as follows:

##### **INGESTED FLUORIDE**

- Less than 5.0 mg of fluoride ion per kg

5mg fluoride as F is contained in 11mg NaF

8 mg Na<sub>2</sub>SiF<sub>6</sub> or

27 mg of a 23% H<sub>2</sub>SiF<sub>6</sub> solution

Ingesting 5 mg of fluoride / kg is equivalent to a 70 kg person consuming 0.8 grams of NaF or 0.6 grams of Na<sub>2</sub>SiF<sub>6</sub> or 1.9 grams of H<sub>2</sub>SiF<sub>6</sub>.

A can of evaporated milk should be available at all times to use for emergency treatment.

- If the chemical has been confined to the mouth, rinse mouth with large quantities of water
- Give calcium (milk) orally to relieve gastro-intestinal symptoms. Observe for a few hours
- Induced vomiting not necessary

- Over 5.0 mg of fluoride ion per kg

- Move the victim away from any contact with fluoride and keep him or her warm
- If the victim is conscious, induce vomiting by rubbing the back of the throat with a spoon or finger or use syrup of Ipecac. While vomiting, the patient should be placed face-down with the head lower than the body to prevent inhalation of vomitus. Vomiting should not be induced if an acidic form of fluoride is ingested.
- Give the victim a glass of milk or any other highly soluble calcium. (5% calcium gluconate or calcium lactate solution)
- Take the person to a hospital as soon as possible. If fluosilicic acid was ingested, notify the doctor at the hospital that the person is at risk for pulmonary oedema as late as 48 hours afterward.

## **NOSEBLEED**

- Move the victim from the exposed area
- Keep the victim quiet
- Place the victim in a sitting position, leaning forward if possible. If that is not possible, place the victim in a reclining position with the head and shoulders raised.
- Apply pressure directly by pressing the bleeding nostril toward the midline
- Apply cold compresses to the victim's nose and face
- If bleeding cannot be controlled by the preceding measures, insert a small, clean pad of gauze (not absorbent cotton) into one or both nostrils and apply pressure externally with thumb and index finger. A free end of the pad must extend outside the nostril so that the pad can be removed later.
- If bleeding continues, obtain medical assistance

## **ACID SPLASH**

- Wash away the chemical with large amounts of water as quickly as possible. Remove the victim's clothing from the areas involved and continue washing for a least 5 min.
- Where skin damage has occurred, cover the burn with a dressing bandage and seek medical attention

- If the eyes are involved, immediately begin to wash the eye, eyelid, and face. Hold the eyelid open and wash the eye for at least 5 min.
- After a thorough washing, cover the eye with a clean, dry protective dressing and bandage in place, then transport the victim to a doctor
- All instances of eye injury require medical attention. Even seemingly minor eye injuries can leave the eye vulnerable to infections that can lead to blindness.
- Keep in mind that hydrofluosilicic acid can be neutralized with sodium bicarbonate (baking soda). Thus, spills that can't be washed away can be neutralized.

## 7.4 EMERGENCY PROCEDURES FOR FLUORIDE OVERFEED

### 7.4.1 INTRODUCTION

When a community is fluoridating its drinking water, there is always a potential for overfeeding. Most overfeeds are of no serious consequence (but should be corrected). For example, if the optimal level of fluoride for a community is 1.0 ppm, and an overfeed resulted from 2.0 ppm in the drinking water for several years, mild fluorosis would appear in a few persons. Higher levels of fluoride for shorter periods can be accepted with no adverse effects. The danger of overfeed, while always present, should not be over-emphasized.

### 7.4.2 RECOMMENDED ACTIONS FOR FLUORIDE OVERFEED

| If the fluoride content (mg/l) is: | Then, perform the following recommended actions:   |
|------------------------------------|--|
| 0.5 above optimum to 2.0           | <ul style="list-style-type: none"> <li>• Leave the fluoridation system on</li> <li>• Determine what has malfunctioned and repair it</li> </ul>   |
| 2.0 to 4.0                         | <ul style="list-style-type: none"> <li>• Leave the fluoridation system on</li> <li>• Determine what has malfunctioned and repair it</li> <li>• Notify your supervisor and report the incident to the appropriate local authority</li> </ul>  |
| 4.0 to 10.0                        | <ul style="list-style-type: none"> <li>• Determine what has malfunctioned and immediately try to repair it</li> <li>• If the problem is not found and corrected quickly, turn off the fluoridation system</li> <li>• Notify your supervisor and report the incident to the appropriate local authority</li> <li>• Take water samples at several points in the distribution system and test the fluoride content (Save the part of the water samples not used)</li> <li>• Determine what has malfunctioned and repair it. Then, with supervisor's permission, restart the fluoridation system.</li> </ul> |
| 10.0 or higher                     | <ul style="list-style-type: none"> <li>• Turn off the fluoridation system immediately</li> <li>• Notify your supervisor and report the incident immediately to the appropriate local authority and follow their instructions</li> <li>• Take water samples at several points in the distribution system, and test the fluoride content. Save part of the sample for the lab to test.</li> <li>• Determine what has malfunctioned and repair it. Then, with supervisor's permission, restart the fluoridation system.</li> </ul>  |

Figure 2: Acid-feed installation.

Figure 3: Solution-feed installation.

Figure 4: Dry-feed installation with volumetric feeder.

Figure 5: Dry-feed installation with gravimetric feeder.