CHAPTER 6

MAINTENANCE AND TROUBLE-SHOOTING

6.1 INTRODUCTION

To realize the full benefits of fluoridation, it is very important that the optimal fluoride content be consistently maintained in the drinking water supply. To ensure constant fluoride feed, proper maintenance of the fluoridation equipment is essential. This includes maintaining not only the fluoride feeder, but also all the appurtenances, feed lines, and laboratory testing equipment. Experience has shown that the basic reason for low or erratic fluoride levels is due to poor operation and maintenance.

6.2 FLUORIDE FEEDERS

Like any other mechanical device, fluoride feeders must be kept clean and lubricated if they are expected to function efficiently. A regular program of maintenance will minimize costly breakdowns and ensure long life for the equipment. Electric motors usually come with a prescribed schedule for lubrication the right type, amount, and frequency of lubrication are all important. Gear boxes must be kept filled to the prescribed level with the proper lubricant, and all moving parts and unpainted metal surfaces should be kept clean and rust-free. If there are grease fittings, the proper grade, quantity, and frequency of greasing should be observed.

The best fluoride feeders will operate as intended only if the measuring mechanism is kept clean and operative. Thus, the mechanisms of both types should be regularly inspected for signs of wear or damage, and repairs or replacement should be made before the machine actually breaks down.

Dry feeders for sodium fluorosilicate must be lubricated regularly just like other dry chemical feeders to ensure long life. However, unlike many other dry feed chemicals, sodium fluorosilicate forms an acid with a pH of 3.5 when it comes in contact with water. The water may come from the dissolving tank or from humidity in the atmosphere. The acid formed is corrosive to the metallic parts of the feeder. Therefore, it is important to regularly clean and paint the surfaces of the dry feeder to limit corrosion. When painting any type of feed equipment, always remember to cover the serial number and model number with tape so that the feeder or pump will be identifiable. Occasionally the dissolving tank needs to be cleaned, as scale can form around the edges.

Many plants have faced a problem in the past in obtaining suitable sodium fluorosilicate. It has been noted that plants that have a roll-type dry feeder cannot use sodium fluorosilicate containing a free flowing agent because flow of the chemical through the rollers cannot be controlled. These plants need to be sure that their chemical does not contain the free flowing agent.

Most fluoride metering pumps are "fairly" maintenance free. Many small pumps now used in fluoridation are electronic, and do not even require lubrication. However, the majority of pumps still have gears bathed in oil, and do require maintenance. The most common failure in a chemical metering pump is cracking of the diaphragm. Most pumps have an acrylic or pvc head so that the diaphragm may be observed. If a diaphragm cracks in a pump using acid, the head needs to be removed as quickly as possible since the acid is highly corrosive to the internal parts of the pump. Diaphragms are inexpensive and replacements should be kept on hand.

Feed systems using fluorosilicic acid pose special problems because the acid fumes can corrode metal or etch glass. (Note: HF acid fumes are lighter than air, but SiF_6 fumes are heavier than air.) An acid feed system must be properly vented, especially if the acid storage is in the vicinity of any electrical contacts or glass meter faces. A simple venting system can be rigged by tapping two holes in the top of the storage tank (carboy) (see Chapter 4). One hole can be used to connect flexible tubing to serve as a vent to the outside while the other hole can be used for the metering pump intake. There will be a third hole if the storage tank (carboy) is filled with a transfer pump. It is very important that these holes be tightly sealed!

Fluoride feeders and related equipment, when purchased, usually are accompanied by an instruction booklet and/or parts list. The instruction booklet will contain information on maintenance and repairs, and the parts list will enable the operator to select replacement parts when needed. If booklets or lists have been lost, copies can usually be obtained through the manufacturer of the equipment or his representative. The equipment representative will also be happy to suggest a list of spare parts to be kept on hand. Having parts available can greatly minimize the length of shutdowns due to equipment failure. In the larger water plants, having an entire spare feeder available may prove to be prudent.

Leaks in and around the discharge line of a metering pump are an annoyance and can affect the quantity of the solution delivered and thus result in low fluoride levels. Leaks are corrosive, and can result in damage to the feeder, appurtenances, or surrounding equipment, if left unattended. Leaks of strong solutions result in the formation of crystalline deposits which, if allowed to build up, make subsequent cleaning difficult. A leak in the suction line of a metering pump will be immediately apparent, will adversely affect delivery, and can eventually lead to air-binding and cessation of feed.

Any time strong solutions are used, the possibility of precipitation build-up is present. In a solution feed system, precipitates in the feeder pumping chamber or on the check-valves will affect delivery rate or even stop the pump entirely. Deposits in the suction or feed lines can build up until flow stops, and a coating of insoluble matter on a saturator bed can prevent water from percolating through. If the deposits are the result of water hardness, softening the make-up water will eliminate the problem. If softening is impractical, frequent inspection and removal of the deposits is a necessity. Even when the water is soft, impurities in the chemical used and other mineral constituents in the water can build up to the point where small openings are clogged and the feed is impaired or stopped.

Tanks in which solutions are prepared invariably show precipitates of the insoluble impurities from the chemical used or of insoluble compounds formed by the reaction of the chemical with mineral constituents of the water. If a separate tank is used for solution preparation and the clear supernatant layer is transferred to a day tank, then problems will be minimized but not necessarily completely eliminated.

A regular schedule for cleaning a saturator should be established. The time interval between cleanings will depend on the amount of use and the accumulation of impurities in the saturator.

6.3 LABORATORY

The laboratory or fluoride testing area requires special cleanliness precautions. Dust on glassware can result in extreme analytical errors. Dirty pipettes or other measuring glassware can produce errors in volume measurements and hinder proper drainage, resulting in carry-over of solutions from one sample to the next. In colorimetric analyses, dirty glassware prevents accurate color determination whether the method is visual or photometric. Permanent standards for colorimetric test kits, since they are difficult to clean, should be kept covered when not in use. Reagent bottles, buffers, and standard solution should all be kept tightly closed when not in use. Evaporation ruins the reagents, and the acid fumes can damage nearby objects. Analytical instruments should always be covered when not in use, since fumes and dust can corrode electrical connections, cloud mirrors, and result in expensive repairs or replacement.

The use of phosphate-based detergents for cleaning glassware presents a hazard because of the potential interference of phosphates in colorimetric analysis. Since tap water contains fluoride, it is imperative that all glassware be thoroughly rinsed with distilled water.

6.4 PREVENTIVE MAINTENANCE

Breakdowns of your fluoridation system may be prevented by following a good maintenance program. In a preventive maintenance program each job such as cleaning the equipment or replacing worn parts is scheduled to be done periodically; then a job is done when its time comes even though the equipment may be working well. The instructions that came with the equipment will explain proper maintenance. That information can be used to make a simple plan for maintaining all the fluoridation equipment.

6.5 TROUBLE-SHOOTING

Incredible as it may seem, even under a good maintenance program, a fluoridation system can break down. When a system breaks down, children in the community are deprived of the benefits of fluoridation. Protect your community by watching for signs of trouble and correcting malfunctions early. Trouble in the system can show up as a change in the equipment, a change in the amount of chemical fed, and/or a change in the fluoride content of the fluoridated water.

If possible, inspect the equipment in the fluoridation system at least once a day. In the daily inspection, the equipment may be tested to ensure that it cuts on an off properly. At the same time look for signs that the equipment is not operating normally.

TABLE 6-1
RECOMMENDED FREQUENCY OF MAINTENANCE

EQUIPMENT	MAINTENANCE WORK	TIME
Metering Pump	1. Disassemble pump and replace worn parts.	1. Once a year.
	2. Change gear oil (except electronic).	2. After first 2 to 4 weeks, then every 6 months.
Saturator	1. Drain, disassemble, and clean.	1. Every 12 months (or more often with heavy use).
	2. Disassemble and clean precipitates from foot valve or suction strainer, discharge and injection lines, injection nozzle.	2. Every 6 months.
	3. Disassemble and replace worn parts of the siphon breaker.	3. Every 6 months.
Dry Feeders	1. Thoroughly clean.	1. Once per year.
	2. Check for worn gears, parts, etc.	2. Once per year
	3. Lubricate and change gear oil.	3. Once per year.
Anti-siphon	Disassemble and replace worn parts.	Once per year.
Injection Nozzle	Disassemble and clean.	Once per year.

A sign that fluoridation equipment is not operating normally may be that there is an unusual sound or a change in a normal sound; an unusual odor or a normal odor that is stronger than usual; more heat than normal given off by any part of the equipment; and/or unusual vibrations, leaks, drips, or puddles.

To recognize these signs of trouble, the operator must know what the equipment is like when it is operating normally. Once the operator knows this, he/she will probably be quick to notice a change in it. Whenever anything seems different no matter how small a change it may be pay attention. Don't think that it will go away. Look for the cause. It may be a sign that something is wrong with the equipment.

Examine the metering pump while the well pump is operation. Listen to the pump. Is the motor operating? Are the sounds normal? If there is an unusual sound, find out what is making it. Feel the pump, the motor casing (if not normally too hot to touch) and its mounting. Is anything warmer than normal? Is it vibrating more than normal? Look for leaks. Look around the body of the pump, at the suction and discharge lines, and on the floor beneath them, at the injection point, and at all connections.

If the system has a saturator, test its liquid level control (float switch, liquid level probe) while the well pump is operating. Push the float down. The solenoid valve should open and admit water. Lift the float. The solenoid valve should close and shut off the water. Lift the liquid level probe. The solenoid valve should open and admit water. Lower the liquid level probe. The solenoid valve should close and shut off the water. Some manufacturers have a 5 minute time delay in their liquid level controls. Test the metering pump. Turn off the well pump does the metering pump cut off as it should? Look for leaks in other parts of the fluoridation system.

The instructions that come with the fluoridation equipment may give information on troubleshooting, that is, finding out what has gone wrong. Some manufacturers have excellent troubleshooting charts, but they may not cover an entire fluoridation system.

The problems commonly encountered in the operation of a fluoridation system are related to low, high, or variable fluoride readings. Although slight over- or under- feeding fluoride for short periods actually is of no serious consequence, such variations should be investigated, since they may be indications of potential problems of a more serious nature.

When the fluoride concentration determined by analysis is consistently lower than that determined
by calculation, a number of problems may be indicated. If the calculations are correct and are based on accurate weight and flow figures, the problems may be interference in the laboratory test procedure. If alum is used for flocculation, traces of aluminum in the finished water can interfere with colorimetric analysis by influencing the readings negatively. A high iron content can also cause low readings if the SPADNS method is used. In rare cases, chloride and alkalinity can also interfere, but their concentrations have to be extremely high.

A common cause of low readings is underdosing due to inadequate chemical depth in a saturator or incomplete mixing in a dissolving tank. Deposits of undissolved chemical in the dissolving tank of a dry feeder indicate incomplete mixing. This can be due to inadequate baffling or inadequate makeup-water flow rate. As the fluoride is dissolved, a high reading may result. Also, adding 45 kilograms of sodium fluoride to a saturator at one time will result in a temporary higher fluoride concentration. Thus, it is better to add 22 kilograms at a time.

Low chemical purity is another possible cause of low fluoride readings. Fluorosilicic acid has the most variable purity and can be anywhere from 20 to 30 percent pure. The manufacturer usually specifies the purity of a given batch, but if there is some doubt, the acid should be analyzed according to directions given in the AWWA Standards. Sodium fluoride and sodium fluorosilicate usually exhibit less variation in purity, but occasionally a relatively impure lot is produced.

If the fluoride level is low in a sample taken from the distribution system, it may be advisable to check for unfluoridated water entering at some point in the distribution system and diluting the water fluoridated at the plant.

If laboratory testing indicates a fluoride concentration consistently higher than that determined by calculation, several problems may be indicated.

Polyphosphates can cause analytical error in the positive direction when using the SPADNS method. This type of error can be checked by using the electrode method or comparing results with the local or state health department. Failure to eliminate chlorine from the water sample can also lead to high results in colorimetric analysis.

Failure to take into account the natural fluoride content of the raw water can result in adding more fluoride than is needed; surface supplies, which can show considerable variability, should be analyzed daily so that the correct dosage can be calculated. If the water supply comes from wells, the variability is much less, but in the case of a higher-than-calculated fluoride concentration, the possibility of a contribution from a high-fluoride well should be investigated.

The most difficult type of problem to solve is that of variable fluoride concentration when calculations show that the fluoride feed rate is of the required proportion. One possibility, however, that can be checked is the fluoride feeder. Verification of the delivery rate with weight measurements at short intervals will reveal whether the feeder delivery rate is constant.

Almost all of the factors that can produce consistently low or high fluoride analyses can also produce variable errors if the analytical interference, chemical purity, raw-water fluoride, or completeness of chemical solution is variable. In the last case, undissolved sodium fluorosilicate can eventually go into solution after a quantity of undissolved material accumulates at some point, and a solution feeder can begin drawing from a concentrated stratum after feeding from a dilute stratum in an improperly mixed solution tank.

One of the causes of varying fluoride content in a treated water system is the intermittent intrusion of unfluoridated water into the system. This situation usually occurs when fluoridation measures are instituted and no attempt has been made to fluoridate the reservoir separately. When no water is being pumped or the pumping rate is less than the demand, water flows into the system from the reservoir and, since this water has not yet been fluoridated, low fluoride readings will result, particularly at the sampling points nearest the reservoir. Eventually, with flow pattern reversals as the pumps operate intermittently, the reservoir contents will become displaced by fluoridated water. However, there have been cases involving large reservoirs, located at the end of a water system,
where it has taken years before there was a complete turnover of the reservoir contents. The obvious solution to this type of problem is to fluoridate the reservoir separately at the time fluoridation of the system begins, if possible.

A similar situation occurs when an elevated tank or other storage facility merely rides on the system, and its contents rarely enter the system or at best there is only a slight intermixing. Sampling points near the tank will have varying fluoride concentrations normal during pumping and low when water is being drawn from the tank. The solution is to allow the tank contents to drain into the system before fluoridation begins and then not refill the tank until the entire system is up to the optimal fluoride level.

Cyclic fluoride levels can result when the feeder is operated intermittently, such as when capacity is reduced by the use of a cycle timer and when there is insufficient storage capacity between the feeder and the consumers. Detention time in mains or a storage facility between the feed point and the first consumer are important factors in providing homogeneous fluoridated water.

There are undoubtedly many other possible causes for fluoride levels below optimum, but it is certain that fluoride does not disappear in the pipelines, nor is it likely that fluoride will concentrate at points or become leached out of incrustations in the mains. Unlike chlorine, fluoride does not have the ability to dissipate and, even though trace amounts are incorporated into tubercles in pipelines, the extreme insolubility of these formations prevents subsequent dissolution. When there is an unexplained difference between the calculated and observed fluoride concentration, the calculations are usually at fault. If calculations prove to be accurate and none of the previous possibilities apply or can be eliminated, common sense and a knowledge of the individual system should enable the operator to locate and correct the cause of the trouble.