ION ScaleBuster® and CORROSION

Corrosion occurs because metals tend to oxidize when they come in contact with water, resulting in the formation of stable solids.

What problems does corrosion cause?

Corrosion can cause higher costs for a water system due to problems with:

- decreased pumping capacity, caused by narrowed pipe diameters resulting from corrosion deposits;
- decreased water production, caused by corrosion holes in the system, which reduce water pressure and increase the amount of finished water required to deliver a gallon of water to the point of consumption;
- water damage to the system, caused by corrosion-related leaks;
- high replacement frequency of water heaters, radiators, valves, pipes, and meters because of corrosion damage; and
- customer complaints of water color, staining, and taste problems.

How is corrosion diagnosed and evaluated?

The following events and measurements can indicate potential corrosion problems in a water system:

Consumer complaints: Many times a consumer complaint about the taste or odor of water is the first indication of a corrosion problem. Investigators need to examine the construction materials used in the water distribution system and in the plumbing of the complainants' areas.

Corrosion indices: Corrosion caused by an inappropriate layer of calcium carbonate deposition in the system can be estimated using indices derived from common water quality measures. The Langelier Saturation Index (LSI) is the most commonly used measure and is equal to the water pH minus the saturation pH (LSI = pH water – pH saturation). The saturation pH refers to the pH at the water's calcium carbonate saturation point (i.e., the point where calcium carbonate is neither deposited nor dissolved). The saturation pH is dependent upon several factors, such as the water's calcium ion concentration, alkalinity, temperature, pH, and presence of other dissolved solids, such as chlorides and sulfates. A negative LSI value indicates potential corrosion problems.

Sampling and chemical analysis: The potential for corrosion can also be assessed by conducting a chemical sampling program. Water with a low pH (less than 6.0) tends to be more corrosive. Higher water temperature and total dissolved solids also can indicate corrosivity.

Pipe examination: The presence of protective pipe scale (coating) and the condition of pipes' inner surfaces can be assessed by simple observation. Chemical examinations can determine the composition of pipe scale, such as the proportion of calcium carbonate, which shields pipes from dissolved oxygen and thus reduces corrosion.

How can system corrosion be reduced?

Corrosion in a system can be reduced by changing the water's characteristics, such as adjusting pH and alkalinity; softening the water with lime; and changing the level of dissolved oxygen (although this is not a common method of control). Any corrosion adjustment program should include monitoring. This allows for dosage modification, as water characteristics change over time.

pH adjustment: Operators can promote the formation of a protective calcium carbonate coating (scale) on the metal surface of plumbing by adjusting pH, alkalinity, and calcium levels. Calcium carbonate scaling occurs when water is oversaturated with calcium carbonate. (Below the saturation point, calcium carbonate will redissolve; at the saturation point, calcium carbonate is neither precipitated nor dissolved. The saturation point of any particular water source depends on the concentration of calcium ions, alkalinity, temperature, and pH, and the presence of other dissolved materials, such as phosphates, sulfates, and some trace metals.

It is important to note that pH levels well suited for corrosion control may not be optimal for other water treatment processes, such as coagulation and disinfection. To avoid this conflict, the pH level should be adjusted for corrosion control immediately prior to water distribution, and after the other water treatment requirements have been satisfied.

Lime softening: Lime softening (which, when soda ash is required in addition to lime, is sometimes known as lime-soda softening) affects lead's solubility by changing the water's pH and carbonate levels. Hydroxide ions are then present, and they decrease metal solubility by promoting the formation of solid basic carbonates that "passivate", or protect, the surface of the pipe.

Using lime softening to adjust pH and alkalinity is an effective method for controlling lead corrosion. However, optimum water quality for corrosion control may not coincide with optimum reduction of water hardness. Therefore, to achieve sound, comprehensive water treatment, an

operator must balance water hardness, carbonate levels, pH and alkalinity, as well as the potential for corrosion.

Dissolved oxygen levels: The presence of excessive dissolved oxygen increases water's corrosive activity. The optimal level of dissolved oxygen for corrosion control is 0.5 to 2.0 parts per million. However, removing oxygen from water is not practical because of the expense. Therefore, the most reasonable strategy to minimize the presence of oxygen is to:
- exclude the aeration process in the treatment of groundwater,
- increase lime softening,
- extend the detention periods for treated water in reservoirs, and
- use the correct size water pumps in the treatment plant to minimize the introduction of air during pumping.

What about the use of corrosion inhibitors?

Corrosion inhibitors cause protective coatings to form on pipes. Although they reduce corrosion, they may not totally arrest it. There are several commercially available corrosion inhibitors that can be applied with normal chemical feed systems. Among the most commonly used for potable water supplies are inorganic phosphates, sodium silicates, and mixtures of phosphates and silicates.

Inorganic phosphates: Inorganic phosphate corrosion inhibitors include polyphosphates, orthophosphates, glassy phosphates, and bimetallic phosphates. Zinc, added in conjunction with polyphosphates, orthophosphates, or glassy phosphates, may help to inhibit corrosion in some cases.

Silicates: The effectiveness of sodium silicates depends on both pH and carbonate concentrations. Sodium silicates are particularly effective for systems with high water velocities, low hardness, low alkalinity, and pH of less than 8.4. Typical coating maintenance doses of sodium silicate range from 2 to 12 milligrams per liter. They offer advantages in hot-water systems because of their chemical stability, unlike many phosphates.

Is cathodic protection an option?

Because the corrosion process is the result of an anodic and cathodic process, it can be controlled either by anodic or cathodic reactions. For both anodic and cathodic reactions to take place, electrons and ions must be transferred.

There are two basic methods of applying cathodic protection. One method uses inert electrodes, such as high-silicon cast iron or graphite, which are powered by an external source of direct current.

The second method uses a **sacrificial anode.** Magnesium or zinc anodes produce a galvanic action with iron, so that the anodes are sacrificed (or suffer corrosion), while the iron structure they are connected to is protected.

Why the Ion ScaleBuster® conditioner?

The **ScaleBuster**® device is considered a "slick" design among sacrificial anode devices because its non-stick polyperfluoroethylene (PTFE) treatment surfaces remain remarkably free of occluding build-up debris that can strongly diminish treatment performance. Its treatment surfaces do not collect magnetized rust particles or other conveyed sediments - including any scale solids that the unit induces to form. In not requiring electrical input, the unit can ignore power outages, and avoids possible corrosion factors from insufficiently shielded AC current inputs or poorly rectified DC sources energizing electromagnet units. Stray currents if allowed to spread out onto adjoining pipelines can sponsor electrolytic corrosion and additionally remove scale nucleation sites normally critical for generating essential scale particulates.

One common oversight for assuring successful conditioner application is failing to retain carbonate scale nucleation sites in a unit's immediate downstream plumbing. For the supersaturated stream from the conditioner to grow carbonate particulates in the limited 2 to 3 seconds that the flow remains supersaturated, carbonate scale surfaces need to be present to foster immediate rapid particle production. Even when plumbing is grounded, excess stray AC voltages can corrosively scour nucleate sites off critical pipeline areas to yield an adverse non-treatment result.

Favourably again, the **ScaleBuster**® includes an internal zinc anode block that provides a stream of negative charges along all electrically attached plumbing so far as such pipeline continues to be of a <u>mono-metallic</u> composition; that is, for example, a stainless steel insert could shield off the zinc protection for extensions of iron pipe. In any event, the cathodic protection as afforded by the zinc anode strongly assists the conditioner to create the needed particle formation.

Properly installed, a water conditioner, such as the advantageous **ScaleBuster**® can reduce scale and corrosion by three basic mechanisms:

1. Calcium carbonate scale formation on submerged surfaces is managed by the conditioner treatment pre-emptively forcing carbonate scale out of the water in suspended particulate form that leaves the liquid phase of the water much less saturated with scale-forming solutes.
2. Calcium carbonate precipitates which typically concentrate organic nutrients (TOC) towards stimulating biofouling corrosion are drawn away from pipeline contact and into

the suspended scale particles where biological activities can have little consequence upon pipe surfaces. (Up to 80% of water TOC can be absorbed out of the water leaving a cleaner water phase to in contact with pipeline walls).

3. The internal zinc anode block in a **ScaleBuster®** unit provides local cathodic corrosion protection even as it promotes its basic anti-scaling efficiency.

Typical water quality complaints which might be due to corrosion

Customer Complaint	Possible Cause
Red water or reddish-brown staining of fixtures and laundry	Corrosion of iron pipes or presence of natural iron in raw water
Bluish/greenish stains on fixtures	Corrosion of copper lines
Black water	Sulfide corrosion of copper or iron lines or precipitations of natural manganese
Foul taste and/or odors	By-products from microbial activity
Loss of pressure	Excessive scaling, tubercle (buildup from pitting corrosion), leak in system from pitting or other type of corrosion
Lack of hot water	Buildup of mineral deposits in hot water system (can be reduced by setting thermostats to under 60ºC/140ºF)
Short service life of household plumbing	Rapid deterioration of pipes from pitting or other types of corrosion

Source: U.S. Environmental Protection Agency