Corrosion:
Causes, Control and Opportunities

By Greg Reyneke, CWS-VI

Nature is constantly striving to reach balance and equilibrium. Corrosion is the natural deterioration of materials by chemical and physical interaction with their external environment. Man creates, and nature destroys; this is the essence of corrosion.

Symptoms of corrosion

Corrosion symptoms will vary, but usually include:

- ***Color in water.*** Look for yellow, orange, green or blue as clues of metallic corrosion.
- ***Color on surfaces.*** Toilet tanks, toilet bowls, bathtubs, and shower grout are good places to find evidence of metallic corrosion.
- ***Tastes and odors.*** Corroded iron, copper and brass will cause that water to taste bitter or metallic, and often produce unpleasant odors.
- ***Sediment and particulate.*** Rust particles will tend to accumulate as a reddish-brown sediment.
- ***Leaks in tubing/piping, appliances or fixtures.*** Dripping water or crustaceous deposits on the outside of piping are sure signs of bigger issues within.

Causes and accelerators

As a natural process, many factors contribute to corrosion, but the most notable are:

- ***High water-flow rate.*** This is, unfortunately, more common than many people realize. In today's economy, engineers and designers tend to undersize piping and recirculation systems. When flow velocity becomes excessive, pitting is the inevitable result.
- ***High conductivity/TDS.*** As conductivity increases beyond 1,000 micro-siemens (approximately 500 ppm TDS), the potential for corrosion increases.
- ***Low pH.*** Strive to maintain a water pH above 7.0 and below 8.4.
- ***High water temperature.*** Be aware that chemical and

electrochemical reactions become more active as water temperature increases. Warm water is also more likely to liberate dissolved CO_2, which contributes to additional issues.

- ***Suspended solids.*** Suspended solids can act like sandpaper on the inside of piping, faucets and fixtures, especially at high velocities.
- ***Dissimilar metals in contact.*** Galvanic action is probably one of the most significant contributors to metallic corrosion of water storage and delivery systems. Avoid direct connection of dissimilar metals and, when doing so, maintain a differential of 0.15V or less on the *Anodic Index*.
- ***Chlorine, chloramines and chlorides.*** Common disinfectants like chlorine and chloramines have a devastating effect on the integrity of metallic components in plumbing systems and even on rubber materials. Chlorides are the Achilles heel of stainless steel and contribute to conductivity problems. Be careful when deploying anion resin-based systems, as they will contribute additional chlorides to the water.
- ***Biofilm accumulation.*** Biofilm grows in all water systems. Biofilm accumulation will contribute to corrosion through the creation of anodic cells, as well as the chemical reaction of metabolic byproducts. Keep water treatment systems properly maintained and sanitized, and practice prudent installation techniques to minimize bacterial contamination and growth.

Anodic Index

Metal	Index (V)
Gold, solid and plated; gold-platinum alloy	0.00
Rhodium-plated on silver-plated copper	0.05
Silver, solid or plated; monel* metal; high nickel-copper alloys	0.15
Nickel, solid or plated; titanium and alloys; monel	0.30
Copper, solid or plated; low brasses or bronzes; silver solder; German silvery high copper-nickel alloys; nickel-chromium alloys	0.35
Brass and bronzes	0.40
High brasses and bronzes	0.45
18% chromium-type, corrosion-resistant steels	0.50
Chromium plated; tin plated; 12% chromium-type, corrosion-resistant steels	0.60
Tin-plate; tin-lead solder	0.65
Lead, solid or plated; high lead alloys	0.70
2000 series wrought aluminum	0.75
Iron, wrought, gray or malleable; plain carbon and low alloy steels	0.85
Aluminum; wrought alloys other than 2000 series aluminum; cast alloys of the silicon type	0.90
Aluminum; cast alloys other than silicon type; cadmium, plated and chromate	0.95
Hot-dip-zinc plate; galvanized steel	1.20
Zinc, wrought; zinc-base die-casting alloys; zinc plated	1.25
Magnesium and magnesium-base alloys, cast or wrought	1.75
Beryllium	1.85

* An alloy mainly of nickel and copper, that is very resistant to corrosion

Corrosion-created opportunities

As a water treatment expert, corrosion creates many opportunities for you to help your customers.

Periodic maintenance service

All water improvement systems should be periodically checked and maintained. Every location is different, with varying water-usage patterns and expectations of water quality. The annual model is clearly deficient, so the progressive dealer schedules service based upon the aggregate amount of hardness and other inorganics processed by the system. Many industry experts agree that a system should be serviced after processing approximately 1,000,000 grains of hardness, or at least every 12 months, whichever is sooner. In addition to standard testing and evaluation performed to ensure system functionality, you can also inspect the appliances, faucets and fixtures for evidence of corrosion, and provide clients with advice on how to properly address the problem.

A proper periodic maintenance visit could include the following diagnostic steps before making appropriate recommendations to the client:

- Influent water chemistry panel. Determine hardness, iron, pH, TDS, alkalinity, chlorine, copper
- Effluent water chemistry panel. Determine hardness, iron, pH, TDS, alkalinity, chlorine, copper
- Comprehensive mechanical performance evaluation. Cycle the system and ensure that each step functions as it should.
- Media performance and attrition calculations. Determine the attrition rate of the specific resin and adjust system capacity, or augment/replace resin as necessary to ensure maximum efficiency and peak performance.
- Cleaning power. Use a soap test to confirm that there are no chemical interference factors to preclude the water from producing the level of water that the client desires.
- Symptoms of corrosion. Look for staining, pitting, leaks, metallic sediments, colors, odors and other tell-tale signs of corrosion.

Softener/POE disinfection service

All water improvement devices are susceptible to biofilm growth. As a significant contributor to corrosion, diminished water quality and potential health risks, we can't underestimate the impact of biofilm growth on a plumbing system. Once colonized, it is very difficult to remove without physical abrasion or even replacement of piping, tubing and components. A number of disinfection protocols have been created by various industry groups. My personal favorite is the SP-5000 protocol, which addresses biofilm growth comprehensively and cost-effectively.

New equipment sales and upgrades to old equipment

Water improvement systems that incorporate automatic disinfection mechanisms will soon become the norm in our in-

dustry. Many strategies currently exist for controlling biofilm growth, such as silver-impregnated media, disinfectant coatings, automatic injection of disinfectants, ultraviolet sterilization, and a host of other current and emerging technologies. Each technology has its own relative strengths and weaknesses and should be evaluated to determine if it fits within the holistic of your business model and goals for properly servicing your customer base.

As frustrating as corrosion can be, it is just another opportunity for the savvy dealer to build a stronger relationship with their clients, and provide them with better water and quality of life.

About the author

♦ *Greg Reyneke, CWS-VI, is currently General Manager at Intermountain Soft Water in Lindon, UT and serves on the WC&P Technical Review Committee. He also serves on the advisory board of the Smart Dealer Network, a trade association dedicated to helping independent water treatment dealers succeed in today's changing world and reach their full potential.*