

Controlling Aluminum Corrosion

Why should I be interested in aluminum corrosion?

Many water systems contain the metal aluminum. Not just industrial applications such as injection molding, high purity water applications in pharmaceuticals and chemical manufacturing, but also it is widely used in the hydronic heating industry for production of high efficiency boilers and radiators. When aluminum corrodes it tends to do so in very small, localized areas resulting in pits which quickly result in metal perforation and equipment failure. Failure of boilers and radiators is disruptive and costly and poses major problems for installers and users.

How does aluminum corrode? I thought aluminum didn't corrode.

Aluminum is resistant to corrosion because of the presence of a protective surface oxide film. The corrosion performance of any aluminum-based alloy is based upon the stability of this film. Aluminum forms a stable oxide layer on the surface over the pH range of 4.0 to 9.0. A disruption in the film results in accelerated pitting. Corrosion resistance in high purity water and neutral, naturally soft water is excellent. Hard waters with high alkalinity and artificially softened waters tend to increase pitting.

I thought all I had to do was keep the system pH at 8.0.

It is desirable to maintain the pH between 7.0 and 8.5. Aluminum corrosion accelerates in both low (<6.0) pH and high (>9.0) environments. Increasing levels of aggressive ions (chloride, sulphate, etc.) present in the water also undermine the stability of the surface film.

What about my treatment program which buffers to a pH above 9.0?

Controlling programs at a pH higher than 8.5 should be avoided if there is aluminum present in the system. Aluminum protection is a key objective and the pH should be maintained within the recommended range.

However, studies have shown that surface deposits can be an even greater factor than pH in destroying the integrity of the protective oxide layer.

Surface deposits - What type of deposits?

Dissolved copper, iron, and suspended solids, which deposit on the aluminum surface, destroy the film. Dissolved copper is a major concern. It can actually "plate out" on the aluminum and create a micro-galvanic corrosion cell.

How much copper is acceptable in the recirculating water and what can I do about it?

Aluminum is not compatible with copper and 0.1 mg/l of copper in the untreated system water is generally accepted as the threshold concentration. Azole should be present in treatment chemicals to sequester the copper in solution and protect any yellow metal (copper, brass) components in the system.

What are the recommended best practices for systems with aluminum?

- Maintain a pH between 7.0 and 8.5.
- If copper or copper-bearing alloys such as brass are present, ensure that a suitable treatment chemical, such as Sentinel X100, is being used that contains azole.
- Avoid the use of artificially softened water unless it is treated with an appropriate corrosion inhibitor such as Sentinel X100 at the recommended dose.
- Keep the system clean. For heating systems ensure that there are no points of leakage that are resulting in excessive water makeup to the system. Also ensure that a suitable treatment such as Sentinel X100 is being used.

Typical Corrosion Rates for Aluminum

<1 mpy	Typical for clean systems with no copper
1 to 5 mpy	Moderate attack
>5 mpy	Severe attack
