EnviroAqua CONSULTANTS INC.

Water Talk

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Aluminum Protection

One challenge that water treaters are increasingly facing is a growing trend to replace old water heaters with new ones which contain aluminum. New construction systems are also moving towards aluminum water heaters. The use of aluminum is not new. Aluminum has always been a common material used to make the molds found in plastic injection mold systems and in blow mold systems. This increasing trend to use aluminum, especially in mixed metal systems has lead to numerous cases of system failures due to poor water treatment practices.

Typical Treatment Challenges

While the treatment challenges encountered in hot loops and mold cooling loops will be very similar, there are some differences. Building heating hot water systems will tend to be true closed loops, requiring less frequent treatment additions due to less water loss. Injection molding and blow molding systems can sometimes experience frequent, or near continuous water loss due to mold change-out evolutions, resulting in the need for frequent chemical additions. Plastic injection mold systems can sometimes be open to the atmosphere, with vented expansion tanks. This open loop configuration can compound the microbio control

issues. Common to all these systems, whether they be closed heating loops found in buildings, or semi-open cooling loops found in mold cooling applications, is the fact that they contain a mixed bag of metals. While copper, brass and mild steel are common materials of construction found in many heating hot water loops and mold cooling systems, adding aluminum to the mix, really complicates the water treatment job.

The problem with aluminum…

Aluminum is a troublesome metal to chemically protect, because it is amphoteric. This means that it is very reactive at both ends of the pH spectrum. Aluminum has a tendency to succumb to pitting attack at high pH. This tendency to pit, is the cause of many problems, especially in systems with mixed metallurgies. All of these systems contain mild steel, aluminum and copper/copper alloys. Each of these metals require slightly different treatment methods to ensure protection. In the case of aluminum and mild steel, the treatment methods are actually in conflict with each other. Mild steel corrosion protection is based upon having a high pH, while aluminum needs a much lower pH (8.0 to 8.5) to prevent pitting attack. To prevent the aluminum pitting, water treaters will typically treat the system with a traditional closed loop formulation, which raises the pH, then add sulfamic acid to lower the system pH back down to safe levels. This technique can result in high corrosion rates on the mild steel components, due to the lower than optimum pH. Additionally, the treatment formula being used may not adequately prevent copper corrosion, which can compound the aluminum corrosion rates. High corrosion rates in systems with molds can be especially troublesome due to the extremely small diameter flow channels in the molds that carry the cooling flow. Corrosion products can block these flow channels, resulting in loss of cooling flow, leading to higher costs due to defects, and longer cycle times.

Injection Molding & Blow Molding

While most water treaters are familiar with the heating hot water closed loop systems in buildings, many have never seen a plastic injection molding system. By examining this type of system we can see that they present some significant water treatment challenges. Injection molding systems are extremely cooling intensive, good heat transfer is critical to quality and reliability control. Cooling water quality also has a tremendous effect on cycle time and the number of molding rejects. Additionally, some molds are extremely costly (up to $1,000,000), thus water treatment is critical to a plants success. These customers are primarily concerned with the mold equipment longevity, the heat transfer efficiency, the electrical costs, and process related defects. As water treaters, we can help to manage the water quality to ensure extended equipment life, to ensure heat transfer optimization, to reduce water treatment related defects and to provide our consultative expertise, assisting in the optimum use of chillers and heat exchange equipment to minimize electrical costs. So how do these systems work? First, plastic resin beads are loaded into a hopper. These plastic beads are heated to a liquid, then mechanically forced into a mold by the hydraulic system. The cooling water is then applied to the other side of the mold causing the plastic to cool. Efficient cooling allows the plastic to be cooled and released from the mold quickly, and defect free. Like injection molding, blow molding requires extensive cooling to be efficient. Blow molding systems start with a plastic pre-form. These performs are premade in injection molding systems.

The perform is placed into the mold and hot air is blown into the perform. This causes the preform to expand into the mold shape. Chilled water then cools the mold, and the finished bottle is released from the mold.

Injection Molding & Blow Molding

While this may sound simple, the systems that accomplish this are fairy complex. They contain cooling towers, chillers, heat exchangers, injection molding machines, molds, hoses and water

connections, flow tubes, oil cooler heat exchangers and mold heaters. Of particular concern is the mold. These are usually made from tool steel or aluminum, but can also be made from beryllium or other metals or alloys. Molds are usually custom designed for a particular product (think of the wide variety of plastic bottle shapes found in grocery stores). Flow rates in the mold flow channels can be as low as 2 fps. These flow channels can also contain flow directional baffles which can be made of differing metals from the mold metallurgy. It is not uncommon to see brass baffles with molds made from tool steel. These mixed metals can form significant corrosion sites, where the least noble metal will fail first (from galvanic attack).

Water Treatment Chemistry

One of the primary concerns is to closely maintain the closed loop system pH at 8.3 to 8.5. This will help to minimize the possibility of aluminum pitting. Aluminum protection can also be enhanced by closely controlling copper corrosion. As little as 20 ppb of total copper can cause aluminum corrosion. The water treatment program should utilize a high level of azole to promote the maximum copper protection possible. To protect against mild steel corrosion resulting from the lower pH levels needed for aluminum protection, a good steel protection program like molybdates should be incorporated. Many programs will utilize a moly-nitrite blend to reduce the mild steel corrosion rates. While Silica is a good choice for aluminum protection, there are solubility issues, especially at the moderate pH needed to prevent pitting. Side stream filtration of the closed loop systems (2 to 5 micron) should be utilized to keep deposit forming corrosion products out of the system. This will also help to minimize plugging of the small flow channels in the molds.

Microbiological control should be accomplished through the use of Gluteraldehyde. 7420 and 7421 are especially suited for this purpose.

EnviroAqua formula EA-555

EnviroAqua R&D has developed and tested a new formula which is designed to meet all of the treatment challenges found in these complex systems. EnviroAqua formula EA-555 consists of a blend of sodium molybdate, sodium nitrite and benzotriazole for corrosion inhibition, along with pH buffering agents designed for closed water systems that contain aluminum. It comes in a concentrated, stable liquid form for ease of application. EA-555 is formulated to provide maximum surface protection for ferrous and nonferrous metals in closed and chilled water systems, especially those systems where aluminum is present, and pH concerns limit acceptable alkalinity. Rubber and non-metallic materials are not adversely affected by EA-555.

EA-555 has a recommended feed rate of 3000 ppm, and will result in treatment levels of 300 ppm as $NaNO_2$, 100 ppm as Mo, and 30 ppm as BZT.

EA-555 has been extensively tested in the EnviroAqua pilot closed loop system. Coupon analysis of the treatment has shown copper corrosion rates at 0.02 MPY, mild steel at 0.2 MPY and aluminum at 0.3 MPY, with no pitting attack. All of these are excellent results.

While EA-555 is buffered to maintain the system pH between 8.3 to 8.5, system waters may vary. Therefore, after treating a system with EA-555, the system pH should be tested to ensure that it is between 8.3 and 8.5. Adjust with sulfamic acid if necessary. EA-555 comes in 45 pound pails, and 280 and 540 pound drums (30 gal, 55 gal).