Water Recycling and Reuse

TT-037-0709

Recycling is generally a term we use when we recycle aluminum cans, glass bottles and newspaper and not really a term we think of when applied to water. Water recycling is reusing treated wastewater for beneficial purposes such as agricultural and landscape irrigation, industrial processes, toilet flushing and even cooling tower make-up. The most common type of recycled water is water that has been reclaimed from treated municipal wastewater or sewage. Instead of the municipality discharging the treated wastewater to a waterway, this water is returned to the customers who can use it for non-potable purposes. By using recycled water, the demand for fresh potable water is reduced accordingly. In certain parts of the United States and even the world, this can have a major impact on efforts to provide fresh water for the local population. Areas that have a population boom, poor infrastructure and drought conditions are turning to recycled water for relief of pressure on the heavy potable water demand. Many of the major metropolitan areas across the country, from Florida to California, currently have set up water recycle programs. The US Environmental Protection Agency regulates many aspects of wastewater treatment and drinking water quality. Most states have established criteria or guidelines for the beneficial use of recycled water. In 1992 the EPA developed a technical document entitled "Guidelines for Water Reuse" which contains a summary of state requirements and guidelines for the treatment and uses of recycled water. The States and Federal government have provided a framework to ensure the safety of many of the water recycling programs that have been developed.

The recycled water that we are concerned about is the treated wastewater or sewage that would normally be discharged to a lake, stream, or waterway. This water is not the raw sewage that first reaches the municipality's wastewater treatment plant but the water that has been fully treated for discharge to the environment. This water has gone through Primary Treatment and Secondary Treatment, including Biological Oxidation and Disinfection. The water quality will change somewhat from what the initial municipal water quality was before primary use. The recycled water is different in many respects from the city water currently used as makeup and these differences may create potential problems that need to be addressed in planning a chemical treatment program for cooling water systems. Evaporative cooling systems, which don't require water treated to potable standards, are good customers for recycled water. Recycled water for cooling tower use is a drought-proof water supply that not only saves large amounts of potable/fresh water, but also is generally less expensive to purchase. Recycled water is sent to the customer using its own piping system completely separate from the potable piping system. This may mean some initial extra cost for setting up the delivery system.

Cooling systems using fresh potable make-up water with lower dissolved impurities can be operated at higher cycles of concentration. Because recycled water is typically higher in dissolved solids than fresh potable water, converting to recycled water will require operational changes which may include reducing cycles of concentrations, adding pH control to reduce scaling tendencies and using a high stress chemical treatment program.

Scale Potential

In most cases recycled water will have higher levels of dissolved impurities, including conductivity/TDS, chlorides, sulfates, hardness/calcium and magnesium, silica, iron, copper, alkalinity, phosphate and Biological Oxygen Demand (BOD).

It is important to understand that in a cooling system one is increasing the temperature of the tower water, therefore decreasing the ability of that water to hold impurities in solution. The higher the water temperature and the higher the level of scale-forming impurities, the greater the chance will be for scale formation on the heat exchange surfaces. Impurities that are of major concern for scale control are: calcium and magnesium hardness, phosphate, alkalinities, sulfate and silica. If these impurities are oversaturated they will form the following scales; calcium carbonate, calcium phosphate, calcium sulfate, magnesium silicate and silicate. These scales will rob the heat exchange capacity of the cooling system resulting in excess energy use. Having the cooling system scale, defeats the purpose of saving water by using the recycled water. The excess energy use increases the carbon foot print of the facility.

Corrosion Potential

The use of recycled water may also increase the corrosion potential over regular city make-up. Recycled water will generally have higher levels of chlorides and sulfates, which will affect the corrosion protection of mild steels and stainless steels. An increase in the ammonia level will have an impact on the protection of copper alloys. It is important to understand what the impact of these impurities will have on the different cooling system metallurgies.

Microbiological Potential

The use of recycled water may also have a greater impact on the fouling potential in the cooling system. Recycled water with high levels of phosphate, ammonia and BOD will result in microbiological control issues. An increase in biomass will have a major impact on both scale and corrosion control in a cooling water system. Biofilm growth on heat exchange equipment will cause a significant waste of energy just like scale formation, but even worse. Biofilms may also cause severe localized corrosion to metal surfaces. Stainless steels may be significantly impacted by the biomass accumulation, resulting in localized corrosion.

Before a facility decides to switch to recycled water all aspects should be reviewed in detail. The facility should look at the following:

1. The cost of recycled water compared to city/potable water. In general the cost of recycled water will be 30% to 50% less expensive.
2. What additions are required to the infrastructure to use the recycled water including new piping and pumping equipment?
3. What is the current system metallurgy? i.e.: Galvanized cooling tower or stainless steel cooling tower, copper heat exchanger or galvanized evaporative condenser tube bundle, black iron piping or plastic piping?
4. What are the system water volume, water temperature, flow rates and hours of operation?
5. What is the recycled water quality and therefore what problems may be incurred by using it as the source of make-up to the cooling system?
6. Based on water quality what is the best chemical treatment approach to achieve the goals of scale, corrosion and microbiological control?
7. Establish the desired cycles of concentration to minimize water and chemical use, without compromising system performance.
8. Upgrade to a reliable chemical feed and control system that monitors all critical parameters.

The use of recycled water for cooling towers will generally require a more sophisticated chemical treatment program. Cooling water treatment products containing modern organophosphonates, polymers and co-polymers are generally used to provide maximum control of scale forming impurities. All-organic corrosion inhibitors provide multi-metal protection for corrosion control. Chlorine dioxide or other oxidizing biocides using ORP control and feed are generally used for microbiological control. In many cases the use of filtration will be a major benefit in keeping the cooling system clean along with reducing the chemical treatment consumption.

International Chemtex Corporation utilizes advanced water modeling computer program to help determine the maximum cycles of concentration that maybe employed along with the successful chemical treatment product. The "PREDICT" Program takes into consideration the water quality and cooling system parameters and determines what chemical product will treat the system water at a given cycle of concentration. This program provides the capability of showing "what if situations" including changing water quality conditions, water temperatures, and chemical treatment product. It will show when and under what conditions a specific chemical treatment will succeed or fail.

The "PREDICT" program is an extremely valuable tool in making sure the cooling system is operating at maximum efficiency.

The use of recycled water for cooling systems, landscape irrigation and even toilet flushing will aid a facility in acquiring points towards its Green Building Certification or LEED Certification. Reducing building water consumption is part of the US Green Building Council's requirements.

The two general purposes of cooling water treatment are:

1. To protect and maintain the cooling system equipment for long term uninterrupted service.
2. To maintain design heat transfer capability, reducing the facility carbon footprint.

These goals are readily achievable when using recycled water for cooling system make-up. It is just a matter of paying attention to detail, applying the correct chemical treatment program and monitoring the program for proper operation.