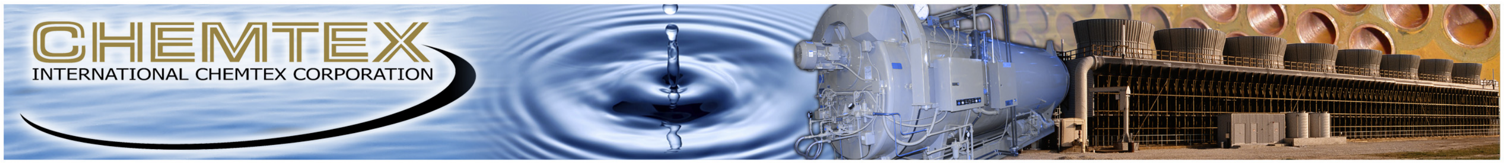

WATER TREATMENT NEWS

Does Your Chemical Program Fit Your Cooling System?

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When an engineer designs a new cooling system, he must consider a number of factors to make certain the system will function properly. Things such as tonnage requirements, refrigerant selection, space constraints and numerous other considerations must be made to assure that the chiller is able to meet the facility's cooling requirements. Then, the tower must be sized correctly to allow the chiller to operate to capacity. All the components have to "fit" in order for the system to do the job.

Just as all the mechanical components of the cooling system need to be compatible, it is of equal or in some ways even greater importance that the water treatment chemical program be designed to meet the specific requirements of the system. If the treatment program doesn't "fit," system efficiency, reliability and/or safety will be compromised. And compromising *any* of these may result in increased operating costs.

So how do you know if your chemical program is a good fit for your cooling system? To some, the answer may seem obvious: "My system is clean – the program fits." In reality, however, this is not necessarily the case.

To be sure, the performance of the program in keeping the system clean – free of scale and deposition - is important; perhaps *the* most important function of the chemical program. But keeping the system free from scale is not the sole factor in determining whether a chemical program is a good fit for a cooling system. Even an old, outdated cooling water sludge conditioner can keep a chiller scale-free if excessive blowdown is employed. Excessive blowdown wastes water and chemicals and increases operational costs. A program that relies on excessive blowdown to keep a system clean is not a good fit for the system.

A cooling water treatment program must meet three criteria to be successful. To be a good fit for any cooling system, the water treatment program must:

1. Prevent scale and deposition in the condenser or heat exchanger, tower and piping.
2. Provide corrosion protection to all system metal surfaces.
3. Provide microbiological growth control throughout the system.

First, scale control. Scale results when the calcium and magnesium salts (hardness) dissolved in system makeup water precipitate and form sludge deposits on cooling system heat exchange surfaces. Two factors cause this precipitation: the increase in tower water temperature as it passes through the condenser, and concentration of the hardness salts due to evaporation of system water from the tower. The sludge hardens into scale on the heat exchange surface, where it acts as an insulator, decreasing the ability of the condenser to remove heat from the refrigerant. This causes the chiller to work harder to provide cooling, increasing the chiller's electrical use.

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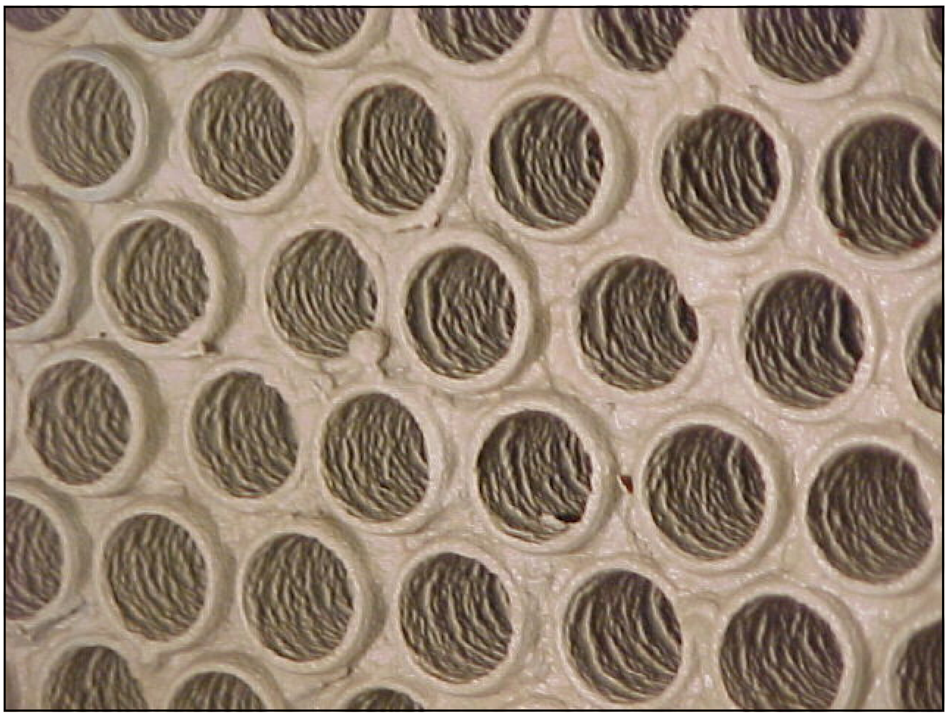
Even a thin layer of scale can increase a chiller's electrical use significantly: a uniform layer of scale $^{1}/_{32}$" thick on the condenser tubes of a 500 ton centrifugal chiller would increase the chiller's electrical costs by approximately $18,000 per year, based on 180 days of operation and a cost of electricity of $0.07/kwh. This is likely more than the entire annual water treatment chemical cost.



Severe scaling on condenser tubes and tube sheet. Scale this heavy would increase chiller's electrical consumption by 30-35%, or even shut the chiller down.

A good cooling water scale inhibitor functions by maintaining the cooling water hardness salts in solution. If no hardness precipitates, no scale will form. The component in the scale inhibitor that performs this function is typically a phosphonate – an organic phosphorous compound that forms a soluble complex with cooling water calcium and magnesium, preventing them from precipitating. New advanced phosphonate technology enables modern inhibitors to provide complete scale control under the most severe temperature and water chemistry environments. A good scale inhibitor also contains polymers that extend the phosphonate's ability to maintain system cleanliness.

Cooling system make-up waters in some parts of the country contain elevated silica (SiO_2) levels. A silica content of 30 parts per million (ppm) or higher in tower make-up can cause or contribute to deposition or scale problems. If silica concentrations exceed 100 ppm in the tower water, the occurrence of silica-bearing scale deposits becomes a very real possibility. In some western states, silica concentrations in tower make-up water supplies can reach 100 ppm. In these cases, silica may be the primary scale concern.

Silica, as most people know, is the main ingredient in glass. Scales that contain any significant amount of silica are very hard – almost glass-like – in their consistency. In addition, they are very insulating, and, to make matters worse, are extremely difficult to remove, even through off-line cleaning.

In systems where silica deposition is a possibility, extra care should be taken to prevent calcium and magnesium deposition, as precipitation of these minerals can result in the simultaneous precipitation of silica. Strong consideration should also be given to using a scale inhibitor that contains a silica-specific polymer.

The next water-related problem that needs to be addressed in a cooling system is corrosion. Wikipedia defines corrosion as "……the disintegration of an engineered material into its constituent atoms due to chemical reactions with its surroundings." As this definition suggests, corrosion can result in damage to, or even the destruction of, a cooling system.

If scale control is the most important function of a cooling water treatment program, corrosion control is, in many cases, a close second. Depending on cooling water uses and make-up water chemistry, corrosion could be the *primary* concern in a given system. In systems with low hardness, low alkalinity make-up water, this is often the case.

Typically, the same product used for cooling system scale control also contains the components needed to control corrosion. Most cooling water scale and corrosion inhibitors prevent corrosion by establishing a film on ferric metal (mild steel) surfaces. This film acts as a barrier that prevents the cooling water from directly contacting the metal surface. By isolating system metals from their environment (the cooling water), corrosion is prevented, or at least controlled.

Historically, scale and corrosion inhibitors used metallic ions such as chromate to establish the film on cooling system metal surfaces. When the use of chromate was banned due to its carcinogenicity, the water treatment industry began using molybdate as a replacement. With adequate control over cooling water chemistry and product dosage, molybdate provides good corrosion control to system piping, tower steel and galvanized components and condenser end bells and tube sheets.

Some water treatment companies have developed the use of new phosphonate technology to produce scale and corrosion inhibitors that are metal-free. Some of these "all-organic" inhibitors have been shown to provide excellent corrosion control, even in highly corrosive cooling water environments.

To complete the corrosion protection package, a good cooling inhibitor must contain a component that protects copper and other yellow metals. Most water treatment companies use an azole such as tolyltriazole or benzotriazole for this purpose. In addition to providing yellow metal protection, the azole in a well-designed cooling water inhibitor works synergistically with the metallic or organic inhibitor to enhance the ferric metal corrosion inhibition.

The third key function of the cooling water treatment program is microbiological growth control. A cooling water system provides a favorable environment for the growth of many types of micro-organisms. Water temperatures in most systems, typically within the 80 – 120° F range, are ideal for rapid growth of many types of microbes, which enter the system in the make-up water and on airborne dust, dirt and other debris drawn in through the tower. Deposits of this airborne debris in the system provide both habitat and nutrients for bacteria, and sunlight falling on exposed areas of the system provides the energy for algae to become established and grow.

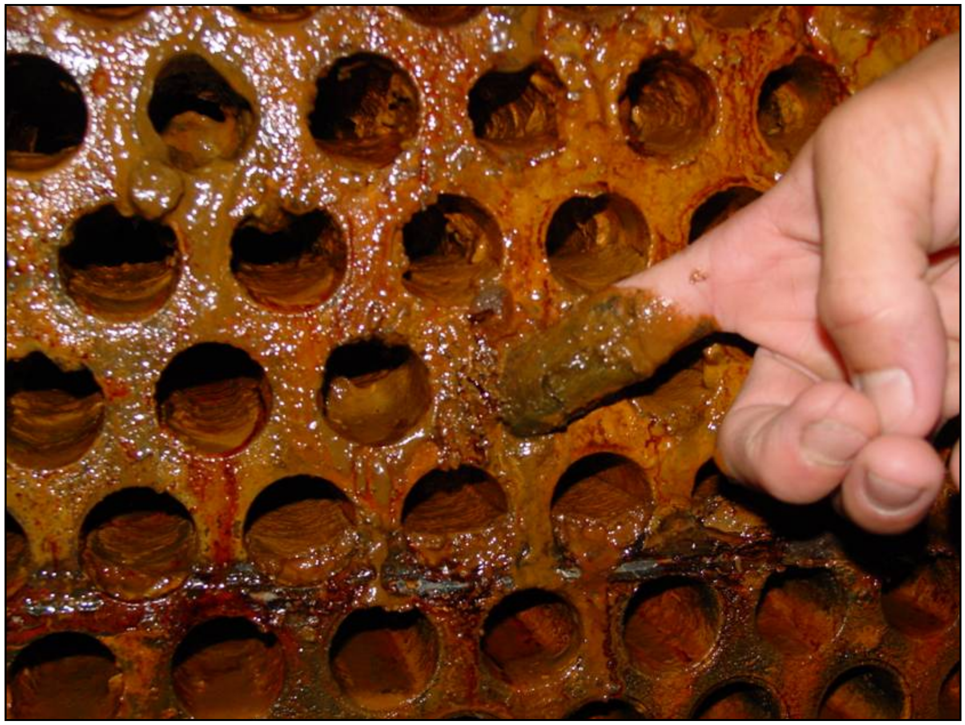
Left unchecked, the population of these microbes in a cooling tower system can literally explode. And that explosion can lead to real problems. Planktonic, or free-swimming, bacteria attach to system metal surfaces, where they begin to multiply rapidly and form masses called biofilm. The biofilm consists of the microbes themselves and their waste products, all of which forms a gooey, sticky mass sometimes referred to as "slime."

Bacterial biofilms typically form within the condenser or heat exchanger, as this is where the warmest, most favorable conditions for bacterial growth exist. And, since bacteria reproduce in minutes, the biofilm can develop and grow quickly. As the biofilm mass grows, it coats the tubes of the condenser or heat exchanger, where it causes what can be a severe decrease in heat transfer, with a corresponding increase in electrical costs.

Biofilm is 4-5 times as insulating as calcium carbonate scale; the same 500 ton chiller referred to earlier in this article would experience an increase in electrical costs approaching $100,000 per year with a biofilm coating of $^{1}/_{32}$" on the condenser tubes!

Bacteria cause other cooling system problems as well. Bacterial biofilms can foul piping and process equipment, often necessitating shutdown for cleaning. Biofilm deposits promote under-deposit corrosion that can severely damage or even destroy piping and related equipment. Sulfate reducing bacteria cause a pitting type of corrosive attack that can penetrate a cooling tower basin or distribution pan in a matter of weeks, causing what can amount to tens of thousands of dollars in damage. And most people are well aware that Legionella bacteria in a cooling tower system can cause Legionnaires Disease, a sometimes deadly form of pneumonia.

A wide array of biocides and biodispersants is available to control microbiological growth and prevent the related problems. Oxidizing and non-oxidizing biocides are both generally effective at controlling microbial growth, provided they are applied correctly. A microbiocide program consisting of an oxidizer and a non-oxidizer applied alternately can be very effective at maintaining control.



Heavy biofilm fouling of condenser tubes. Biofilm is more resistant to heat transfer than scale and promotes under-deposit corrosion.

For *any* microbiocide program to provide good microbial control, the water volume of the system must be determined accurately, and the biocides fed at dosages sufficient to maintain lethal concentrations for the required exposure time. The very best biocide program will not control microbial growth if it is not maintained in the system at the required dosage for a length of time necessary for a complete kill. If the system volume is not known, a knowledgeable water treatment professional can provide the means of accurately measuring system volume.

Scale prevention, corrosion inhibition and microbial growth control. To be a good fit for your system, your cooling water treatment program must do all three effectively and economically. A well-qualified water treatment professional understands the needs of his or her customers' cooling water systems, and designs a water treatment program that meets those needs – one that "fits." Does your water treatment program fit your cooling system?

Does your chemical program fit your system?

Ask your Chemtex Representative to check it out!