THE BASICS OF COOLING TOWER WATER TREATMENT

The purpose of a cooling tower is to remove the heat generated by an HVAC system (cooling of compressor refrigerant and heat generated by the compressor itself). Cooling is accomplished through the latent heat of vaporization. For each pound (.121 gallons) of water that a cooling tower evaporates it removes about 1,000 BTU's from the liquid that remains. As evaporation increases more heat is removed. Water vapor evaporates, leaving dissolved or suspended solids in the re-circulating cooling water. As evaporation increases, the re-circulating water becomes more concentrated with solids. A variety of microorganisms, gases, nutrients and dust are scrubbed from the atmosphere during the evaporation process adding additional contaminants to the re-circulating water.

Cycles of Concentration
The term “Cycles of Concentration” refers to the concentration of solids in the re-circulating water as compared to the makeup water. Cycles of Concentration can refer to a variety of components, but the industry accepted standard for measuring "Cycles" is a comparison of the chloride content in the sump water versus the makeup water.

Cooling Tower Water Treatment
Water Treatment becomes critical as the “contaminated” water re-circulates through the chiller tubes. Biological contaminants and certain inorganic substances are “drawn” to the heat transfer surfaces. Left unchecked they coat and insulate the heat transfer surfaces, inhibiting the effective transfer of heat, corroding chiller surfaces, and eventually reducing flow through the chiller. Scale, Biofilm, Corrosion & Bacteria are the four most common concerns associated with operation of evaporative cooling systems.

Scale
When makeup water contains high concentrations of inorganic salts, mineral scale can form insulating deposits on heat exchange equipment. When deposition of these salts is heavy, heat transfer and water flow may be severely restricted. The resulting rise in condensing temperature will cause a reduction in refrigeration capacity and an increase in energy consumption. Calcium is particularly problematic as it precipitates from solution at warmer temperatures and in the presence of carbonate alkalinity will readily convert to calcium carbonate scale. Acids and organic polymers are commonly used to prevent and remove scale deposits. The use of acids must be carefully managed as acidic conditions can result in corrosion and the premature degradation of equipment.

Biofilm
The cooling water system creates a number of ecological niches for colonization by microorganisms. Biological deposits on metal surfaces are powerful heat insulators. Bio-films have 6 times more insulating capacity than scale and can also contribute to corrosion. Biofilms vary in composition; some are more resistant than others to traditional chemical biocidal programs such as chlorine or bromine. Ozone Gas and
Chlorine Dioxide Gas have proven to be most effective in the eradication of both biofilms and bacteria in cooling water.

**Corrosion**
Corrosion results primarily from the use of corrosive or acidic chemical additives, acid producing microorganisms residing in biofilms, and "White Rust" (see below). Often the chemicals used to control bacteria, scaling and biofilm, contribute to chemically induced corrosion. A properly administered water treatment program should not Microbiologically Influenced Corrosion (MIC) is a result of destructive microorganisms that produce sulfuric acid, hydrogen sulfide, or other corrosive materials that can corrode metal. Once established, MIC can be difficult to eliminate. Preventing the occurrence of MIC is an important consideration in any water treatment program.

**Bacteria**
Deadly Legionella bacteria has been a recurring problem in cooling towers and evaporative condensers for decades. Warm water temperatures and the presence of other biological matter and organic debris promote the growth of Legionella bacteria. Many protocols call for alternating biocides to insure that bacteria present in the system do not become resistant to any one compound. Legionella can be difficult to kill because the bacteria can tolerate relatively high levels of chlorine or bromine, the two most commonly used chemicals in cooling tower water treatment. Ozone and Chlorine Dioxide gasses are both highly effective treatments for Legionella, but are not widely used due to the cost and technical expertise required to properly administer the program and maintain the equipment required to generate the gasses onsite. Programs in which the gas is generated on demand based on sump water quality are most effective, and have less downstream environmental implications than chlorine or bromine based programs.

**White Rust**
White Rust is a serious problem primarily found in newer galvanized steel cooling towers and related components. The problems stems from improper start-up procedures, or failure to properly passivate a new cooling tower. The condition is aggravated by high alkalinity (high pH) and softened water. The three largest cooling tower manufacturers in the US each offer a specific passivation protocol. The protocols vary slightly, but each calls for the use of inorganic phosphates, initial pH control between 6.5-8.0 and control of the heat load during the passivation phase.