“Green” - Low Environmental Impact Cooling Water Management

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Reducing the impact on the environment from evaporative cooling water system operation should be a goal for every system owner/operator. However, as water treatment chemistry is a specialized field dealing in often proprietary technology, there is little reliable information with which the owner/operator can evaluate the various means to safely reduce the environmental impact from operation of their cooling water system. The following information on reducing the environmental impact from operation of evaporative cooling water systems is based upon work in both the environmental and water treatment fields since 1973. Basic technology is discussed along with a new technology developed specifically to reduce environmental impact and comments are provided on several misconceptions concerning water treatment chemistry, environmental impact, and the use of non chemical device (NCD) water treatment gadgets as a “green” technology.

Blowdown - Intentional Water Loss from Cooling Systems

Evaporative cooling water systems (**systems**) reject 75 to 80% of their heat load by evaporation of water. As the water evaporates, removing heat from the system, the dissolved solids present in **makeup** water, added to replace the evaporated water, become more concentrated, at some point exceeding the solubility limit(s) of the materials present (usually calcium carbonate) which results in precipitation and formation of undesirable scale. **Blowdown** is water intentionally drained from the system to restrict the buildup of dissolved solids to levels below the precipitation point. **Cycles** is the term used to denote the concentration of dissolved solids in the system water as compared to the makeup water, thus two cycles indicates that the dissolved solids in the system water are twice the level in the makeup water.

Blowdown constitutes the major environmental impact from system operation as it is "wasted" water, water run to sewer that must be replaced with fresh water. For instance, a 1000 ton rated cooling tower running at two (2) cycles will evaporate 25,000 gpd with a blowdown of 25,000 gpd. If the cycles are increased to four (4), the blowdown would be reduced to 12,000 gpd.

Evaporation = 25.0 gpd/ton cooling Blowdown = Evaporation/Cycles - 1

Since increasing cycles generally results in solubility limits being exceeded, acid or a scale inhibitor must be added to the water to prevent scale formation. In practice, acid is not recommended due to health/safety and control issues, while use of scale inhibiting products generally limits the system to a maximum of six (6) cycles, in the absence of bypass filtration. Using the 1000 ton system example, operation at six (6) cycles would reduce the blowdown to just 5,000 gpd. **Operation at more than six (6) cycles can seldom be justified on either environmental or cost reasons, and normally presents severe technical challenges.**

Chemical Scale Inhibitor Use

A common misconception is that it is "bad" for the environment to be adding "chemicals" to cooling water. Fortunately, this is incorrect as the truth of the matter is that the effective, commonly used scale inhibitor compounds have very low toxicities and are completely biodegraded when discharged into the environment. Thus use of scale inhibitor products in cooling towers does not adversely impact the environment. In fact, when used to increase cycles, scale inhibitor chemical use reduces the environmental impact of system operation by lowering the amount of fresh water used and blowdown discharged.

A second environmental benefit, often very substantial, is that by keeping the heat exchange surfaces in the system free of scale, energy use, and resultant environmental pollution from energy production, is reduced. For instance, a scale thickness of just 0.08 inches can increase energy usage in a chiller condenser by as much as 12%, a waste that can be totally prevented by proper use of scale inhibitor chemicals.

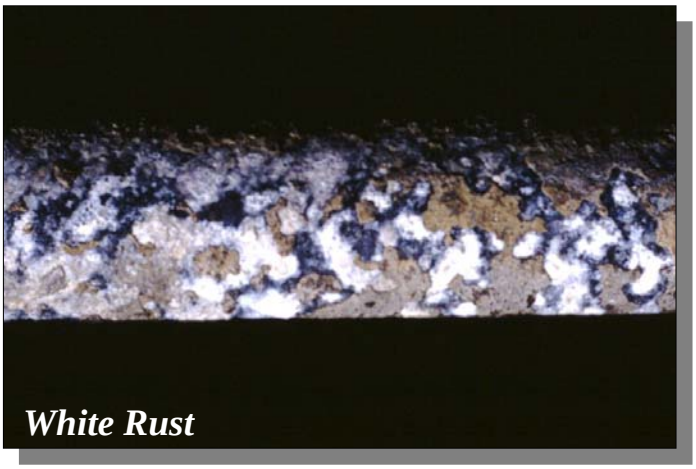
Biological Control – Biocide Dangers

Warm cooling water is an excellent place to grow microorganisms, including pathogens such as legionella. This growth causes severe system problems related to risk of Legionnaires' Disease, system plugging, accelerated corrosion, and reduced heat exchanger efficiency. Typically, microorganism growth in systems is controlled by routine addition of toxic chemicals, **biocides**, to the system, which kill the microorganisms. Annually, we use millions of pounds of toxic biocides in systems, creating a potential for transportation and usage spills, in hundreds of thousands of systems located in our towns and neighborhoods. Following addition to systems, the biocides are subsequently discharged in the blowdown to the public sewers, thus reaching our streams and lakes. The use of biocides in systems thus constitutes the major environmental impact from cooling system operation due to potential damage from accidental spills and routine discharge of toxics in blowdown. Toxic biocide use is also a substantial health/safety issue for all the workers involved in the handling/use of such products.

Many biological control technologies are presently marketed as "green". These methods, such as copper-silver ionization, ozone, and the various NCD gadgets; either have a substantial environmental impact themselves (copper and silver ions discharged in the blowdown!), present major health and safety problems (ozone requires high voltage electrical generation and ozone is toxic), or just do not work (do any of the NCD gadgets have a USEPA registration number?).

The best means to eliminate the impact of biocide use in cooling systems is the patent pending **"ElectroBrom tm"** biocide system by ProChemTech**,** which generates a non-hazardous aqueous solution of electrolytic bromine on-site from a non-toxic table salt and sodium bromide solution via electrolysis. After addition to the cooling system, the generated electrolytic bromine reverts back to the starting non-toxic bromide ion (present in sea water at 65 mg/l) in a short time, thus eliminating discharge of toxics in the blowdown. This economical technology thus eliminates both the environmental impact from controlling biological growth in systems and worker health/safety issues from handling of toxic biocides. Units are available for systems from small HVAC installations to power plants.

Corrosion Control


White Rust

Most cooling water systems have substantial amounts of metal, such as copper and zinc, used in their construction. Uncontrolled corrosion of these metals will not only destroy the cooling water system over time, but will also have an adverse effect on the environment by discharge of these metals via system blowdown. While some corrosion inhibitors, such as molybdate and phosphate, can have an adverse environmental impact, controlling corrosion within systems is a decided benefit to the overall ecosystem due to reduced metals discharge to the environment and avoidance of the environmental impact resulting from premature replacement of corrosion damaged systems.

If proper care is taken during selection of corrosion control chemistry to account for the environmental impact of the specific products selected, water management programs can be easily designed which have no adverse environmental impact. Given the vast number of products available to the water treatment chemist today, such a program can be designed which will keep corrosion rates below 2 mil/yr steel and 0.1 mil/yr yellow metals.

Scale and corrosion inhibitor dosage to systems should be carefully controlled to prevent any adverse environmental effects from over or under dosing, provide for optimum performance, and control the program cost. The best means to control dosage is generally referred to as proportional control, which is simply the process where the amount of makeup water added to the system is metered and the inhibitor products are fed in direct proportion using chemical pumps drawing directly from product shipping containers.

"Green" Gadgets

In the past fifty years a substantial number of NCD gadgets for treatment of cooling water have been marketed. These gadgets claim to control scale, corrosion, deposition, and biological growth in systems by a variety of processes described as magnetic, electrostatic, hydrodynamic, pulsed power, electromagnetic induction, ionization, and zeta potential; among others. Numerous studies by various government agencies and industrial firms over the years have shown all of these gadgets to be of no practical use in water treatment. Review of recent marketing literature by firms such as Clearwater LLC, the "Dolphin" unit, and TLC Envirotech, Inc., show that such gadgets are now being marketed as a "green" technology since they use no chemicals.

Careful review of gadget literature shows that their operation is not based upon any accepted scientific principals with the only evidence offered to substantiate acceptable performance is in the form of testimonials. In every case where a testimonial has been subjected to scientific investigation, the performance reported was found to be due to cause(s) other than the gadget. For example, in many cases scientific investigation has shown that the cooling system cycles had been reduced by a substantial amount following installation of the gadget. Operating at lower cycles often reduces dissolved solids to the point where precipitation will not occur, thus "controlling" previous scale formation and sometimes removing any existing scale. Of course, operating at lower cycles increases blowdown to the sewer and fresh makeup water requirements, hardly a "green" treatment technology.

Another observation often made in systems reporting successful operation with gadgets is that they are excessively cycled to the point where bulk precipitation of calcium carbonate is taking place in the system water. While this will often protect high flow heat exchanger surfaces from formation of scale, reduce planktonic microbiological activity, and will produce a very clear water due to flocculation precipitation: the scale solids will build up somewhere in the system and at some point require removal. This phenomenon is a known chemistry and has been used in both potable and boiler water treatment for over one hundred years. It is difficult to control in cooling system applications and will not work in high heat flux industrial applications, which are the reasons it is not used for system treatment by reputable water management firms.

Considering on a rational basis the potential for adverse environmental impact from premature failure and replacement of systems from corrosion, excessive blowdown, and excessive energy use due to scale/deposition; replacement of proven “green” water management practices with a NCD gadget cannot be considered "green" technology. In reality, use of NCD gadgets results in increased environmental impact due to increased water usage, increased blowdown discharge, increased corrosion and discharge of metals, and additional pollution due to increased energy usage caused by scale formation on heat exchange surfaces. All things considered, “green” is only good when it works.

It should also be noted that any gadget being marketed as capable of providing biological control within a system must be, under law, registered with the USEPA as a pesticide. To date, no gadgets have obtained such registration.

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