Shades of Green for GSA

Management of Cooling Towers for Minimal Environmental Footprint

TAB1110

Cooling Tower Installation

In the August 2010 issue of GreenSource magazine, the Administrator of the GSA, Martha Johnson, stated that the GSA has a new goal, elimination of its environmental footprint. The environmental footprint of many GSA facilities includes cooling towers, which consume large amounts of water, produce blowdown wastewater, and use toxic chemical biocides. In fact, cooling tower systems used for comfort cooling are usually the largest single water use in commercial and government buildings, accounting for up to 40% of total facility water use.

ProChemTech International, Inc. has developed several patent pending, and patented, technologies to help GSA building contractors **reduce the environmental footprint of their managed facilities as to operation of cooling towers.** GSA management has informed us that these technologies must be marketed directly to the GSA building contractors. Accordingly, we have prepared the following discussion of these technologies to provide GSA contractors with several options to reduce the environmental footprint of managed buildings.

Blowdown - Intentional Water Loss from Cooling Systems

Evaporative cooling tower 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 of concentration (COC)** is the term used to denote the dissolved solids concentration in the system water as compared to the makeup water, thus at two (2) COC, the dissolved solids in the system water are twice the level in the makeup water.

After evaporation, **blowdown constitutes the major water loss from cooling tower system operation as it is "wasted" water, water run to sewer that must be replaced with fresh water.** For instance, a 1000 ton thermal load cooling tower running at two (2) COC will evaporate 26,600 gpd with a blowdown of 26,600 gpd.

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Evaporation = 26.6 gpd/ton cooling load Blowdown = Evaporation/COC - 1

With solubility limits being quickly exceeded when COC are increased, either a high blowdown rate must be utilized to prevent scale formation by keeping the COC at a low value or various management techniques must be utilized to prevent scale formation at higher COC.

Acid Adjust for Higher COC

Historically, addition of acid has been practiced to increase solubility limits and permit increased COC to be obtained to reduce blowdown water use. **While effective, this method suffers from a large environmental footprint due to manufacture, shipping, storing, handling, and feeding concentrated mineral acids.** Another problem is the potential for severe system corrosion damage should control of the acid feed be lost.

Chemical Scale Inhibitors for Higher COC

Several chemicals, typically phosphonates and polyacrylates, are very good cooling water scale inhibitors. They are usually supplied as multi-component products to take advantage of the improved performance provided by multiple actives in place of just a single compound. The amount dosed, product ratios, and specific actives used determine product performance. The industry standard scale inhibitor generally allows 3 COC with the typical hard makeup water supplied to most facilities.

Starting Green

ProChemTech has developed patent pending scale inhibitor products (HighCycle tm), which will permit operation at a full 2 COC over the industry standard scale inhibitor. A simple switch in the scale inhibitor used can provide a substantial reduction in water use and sewer discharge. **Using a 1000 ton thermal load as an example and going from 3 to 5 COC, we see an annual reduction in water use of 2,422,505 gallons per year, with an equal drop in blowdown wastewater discharged to sewer, giving a substantial reduction of the facility environmental footprint.**

Automatically A Little Greener

Chemical inhibitor use can be decreased, thus reducing the facility environmental footprint, by use of automatic dosage control. Currently the patented ProChemTech/Advantage BlueTrak tm unit[i] is one of only two such controls available. Operation at a higher COC than the scale inhibitor is capable of treating will result in scale formation. Accordingly, good equipment for control of COC via blowdown based on conductivity is also a requirement for successful system operation using chemical scale inhibitors to operate at high COC. **Note that scale formation in chiller condensers substantially increases the energy use and thus the facility environmental footprint.**

Combined Blowdown and BlueTrak Controller

A Green Biocide

One drawback to use of cooling towers is that they present a biological control problem as warm water, with dissolved and suspended solids present, is an excellent medium for growth of microorganisms. The uncontrolled growth of microorganisms in cooling water causes severe problems related to increased risk of Legionnaires disease, plugging due to physical blockage of cooling water passages, accelerated corrosion under biological masses, and reduced heat exchanger efficiency due to biofouling of surfaces.

Current cooling water biological control technology depends upon various toxic, hazardous chemicals such as chlorine, ozone, chlorine dioxide, dithiocarbamate, isothiazolin, hydantoin, and glutaraldehyde; commonly termed “biocides". While these biocides are often quite effective, they constitute a huge environmental footprint due to use in over 300,000 cooling towers at an estimated 40 million pounds per year. These toxic biocides are found basically everywhere as cooling towers are found throughout our country; in neighborhoods, towns, and cities. In addition to typical industrial installations; cooling towers are commonly found at hospitals, hotels, grocery stores, office buildings, warehouses, apartment buildings, schools, colleges, and retirement homes; basically, anywhere air conditioning or process cooling is needed.

MiniBrom tm Electrolytic Bromine Unit on Hospital Cooling Tower

ProChemTech has a patented electrolytic bromine delivery system[ii] which is based on on-site electrolysis of a totally harmless mixed aqueous sodium bromide and chloride solution. **No hazardous materials are manufactured, shipped, stored, handled, dosed, or discharged to the environmental, giving this bromine delivery system a lower environmental footprint than any current biological control technology.**

A capital cost is incurred as an electrolytic bromine generator must be purchased.

A Higher COC Green

Increasing COC beyond the level which can be obtained using chemical scale inhibitors requires that the makeup water be softened and treated according to a ProChemTech patented technology. This technology, SofTek tm, is operated at 8 to 10 COC, which reduces the makeup and blowdown requirements by another substantial amount. Using a 1000 ton thermal load as an example and going from 5 to 10 COC, we see an annual reduction in water use of 1,346,120 gallons per year, with an equal drop in blowdown wastewater discharged to sewer. As compared to our baseline 3 COC standard technology water management program, a reduction of 3,768,625 gallons per year is obtained.

ProChemTech manufactured water softener

As with the electrolytic bromine generator, a capital cost is incurred due to purchase of a makeup water softener.

A Greener Biological Control

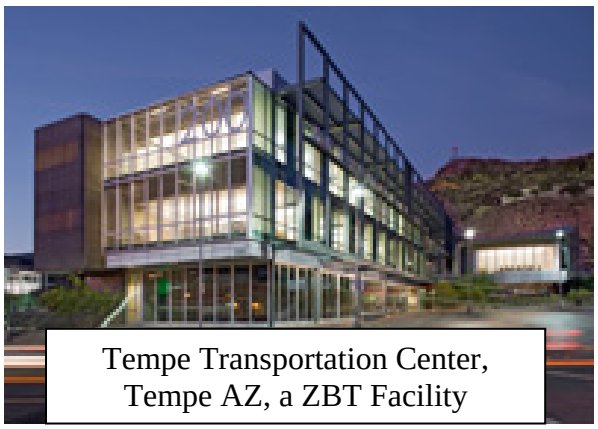
SSBrom Power Supply and Sidestream Electrolysis Cell

Once a cooling tower system is converted to softened makeup and COC increased to the point where the cooling water conductivity exceeds 4,000 mmhos, another, greener, method of biological control can be utilized, sidestream electrolytic bromine generation. This technology, SSBrom tm, utilizes the bromides and chlorides naturally present in the cooling water to generate electrolytic bromine in a sidestream of the cooling water. No chemical feed is needed, only electrical power to operate the electrolytic cell.

Again, a capital cost is incurred for purchase of the SSBrom unit.

Ultimate Green – Zero Blowdown Technology

Zero blowdown operation can be obtained by increasing the COC to the point where **windage,** liquid water carried out of the cooling tower by the passage of air through the unit, equals the blowdown at that COC. **When windage equals blowdown, the cooling tower is operating with zero blowdown.** Typically, we see that zero blowdown occurs between 12 and 25 COC, dependent upon cooling tower design, state of maintenance, and flow rate (load). An additional problem, deposition from airborne debris and products of corrosion, must be addressed for reliable zero blowdown operation. We have found that use of a multimedia filter, or cartridge filter in smaller cooling systems, combined with the SofTek chemistry developed for soft water makeup operation, is effective in controlling deposition in a zero blowdown cooling tower system. ProChemTech has commercialized this combined technology as our Zero Blowdown Technology - ZBT tm[iii] water management program.



Tempe Transportation Center, Tempe AZ, a ZBT Facility

Zero blowdown operation of cooling towers is only recommended when the environmental footprint has to be reduced to the minimum. Using our 1000 ton thermal load as an example and going from 10 COC to ZBT, we see an annual reduction in water use of 1,076,750 gallons per year, with an equal drop in blowdown wastewater discharged to sewer. As compared to our baseline standard 3 COC technology water management program, a reduction of 4,845,375 gallons per year is obtained.

Energy - Environmental Green

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 COC, scale inhibitor chemical use reduces the environmental footprint of system operation by lowering the amount of fresh water used and blowdown discharged.**

An often over looked environmental footprint from operation of evaporative cooling tower systems is energy use and the affect of scale on energy use. 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. Operating with the proper scale inhibitor at the COC for that product will control scale. As both SofTek and ZBT use softened makeup water where the major scale formers, calcium and magnesium, are removed, cooling towers operated on such programs are scale free.

Green is Good, But Only When It Works!

Currently a substantial number of non-chemical device (NCD) gadgets for treatment of cooling water are claimed to be capable of reducing water use via operation at increased COC. These gadgets operate 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 objective studies by various government agencies[ivvvivii] 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; VTRX; and Evapco, the “Pulse-Pure” unit, show that such gadgets are now being marketed heavily as “green” water use reduction technologies.

Careful review of gadget literature shows that operation is not based upon any accepted scientific principals while 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 cooling system COC had been reduced by a substantial amount following installation of the gadget. Operating at lower COC 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, operation at lower COC increases blowdown to the sewer and fresh makeup water requirements, hardly a water use reduction technology.

Another observation often made in systems reporting “successful” operation with gadgets is that they are running very high COC, 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 by reputable water management firms.

Scale from NCD Treated Cooling Tower

Considering the potential for adverse impacts from premature failure and replacement of systems from corrosion, excessive blowdown, and excessive energy use due to scale/deposition; replacement of proven water management practices with a gadget cannot be considered a viable green water use reduction technology. In reality, use of many gadgets results in increased water usage due to operation at lower COC than can be obtained by proven water management practices.

Shades of Green - Summary

What we have presented is a series of progressive actions that can reduce the environmental footprint from operation of evaporative cooling towers at GSA facilities as follows:

Activity	Capital Costs	Benefit
Change scale inhibitor to HighCycle product	none	substantial decrease in water and sewer use
Automate blowdown and scale inhibitor control	Advantage BlueTrak controller	less inhibitor use, better COC control
Replace chemical biocides with electrolytic bromine	MiniBrom or ElectroBrom unit	toxic chemical biocides replaced by salt solution
Change to softened water as makeup	Water softener	further substantial decrease in water and sewer use
Replace chemical biocides with sidestream electrolytic bromine	SSBrom (note: only works with softened makeup water)	eliminate toxic biocides, no chemical feed
Go to Zero Blowdown Technology	Water softener, sidestream filters	eliminates all cooling tower blowdown, minimum water use option

ProChemTech International, Inc.

"Innovation in Water Management"

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[i] Patented, USPTO 7,932,091
[ii] Patent, USPTO 7,927,470
[iii] Patented, USPTO 7,595,000
[iv] Demonstration and Evaluation of Magnetic Descalers, US Army Corps of Engineers, Report ERDC/CERL TR-01-63
[v] Biological Control in Cooling Water Systems Using Non-chemical Treatment Devices, ASHRAE Research Project 1361
[vi] Legionella and Non-chemical Water Treatment Devices, Stout, Duda, and Vidic, University of Pittsburgh and Special Pathogens Laboratory, AWT Conference Paper, 2010
[vii] Non-chemical Devices: Thirty Years of Myth Busting, Keister, International Water Conference paper IWC-04-22, 2004