Ozone as a Green Option for Cooling Tower Water Treatment and Water Conservation

In these times of new "Green" ideas coming out of every outlet and alleyway, it is important to know which technologies work and which are smoke and mirrors; which ones are said to be "Green" and which ones are truly beneficial alternatives to traditional chemical treatment programs. There is a lot of mystery and hype out there, but there are also some very good alternatives that have extended track records. The proof is always at hand – the system must actually be chemical free, must reduce water and energy usage, and must have functioned in this manner for more than three years.

The biggest key will always be the track record – how successful has the technology been and for how long. It is also very important that the provider of the technology has a background and understanding of water and water treatment so that he can provide the technical expertise necessary to back up the technology – the best equipment or program in the world will provide zero benefit to the customer if it has no backing. This technical expertise also includes engineering support. If a company cannot help the customer properly install a system and maintain it in working order (or at least train the facility personnel how to maintain it), the system will be of no benefit to the end user.

Methods used to treat water in a "Green" fashion range from metal ions, to magnetic fields, to Electro-Magnetic, to Elector-Static, to Ozone and UV disinfection. There are even "Green" chemical programs. Facts are, to be truly "Green" a program should not include any chemicals (even metal ions), should conserve energy, and should reduce water consumption. Of all of the mentioned treatment alternatives, only Ozone fills all of these categories. Most use some kind of chemical in the program. Whether it is copper/silver ions, zinc, iodine, perchlo-acetic acid, or others, there is some additive being used that will negatively affect the environment into which it is discharged. Even "low impact" chemicals designed to biodegrade will have limited affect treating the tower and some impact when discharged.

While there is a lot of bad technology out there – and a few outright frauds – I believe the best way to help the industry is to provide information on a technology that has a proven track record and one that I am very familiar with. This would be Corona Discharge Ozone Generation Equipment – in particular the USGBC "Green Spec" listed Clean Streams™ system. Corona Discharge is the key to effectively and efficiently producing Ozone on site. UV disinfection initially is less expensive, but is not as effective and is more expensive to maintain.

Other non-chemical treatment devices generally are only effective when you limit the cycles of concentration to levels lower that those seen with chemical treatment programs. This may qualify as "non-chemical", but increasing water consumption instead of reducing it is not "Green". You will not be burdening the environment with chemicals, but the goal is to conserve and this means looking to reduce water usage.

Of all of the systems I have investigated over the years, only Ozone has filled the bill of essentially chemical free treatment that also conserves water. Ozone is not new. It has been in use for over 100 years for disinfecting drinking water and for at least 30 years for treating cooling towers. There is not a commercially available biocide that is as effective as Ozone. As an oxidizer, it has been found to be more than five times more effective than chlorine without the hazardous by-products. In fact that is one of the keys to ozone's effectiveness and environment friendliness. With a half life of less than 20 minutes, any Ozone not used reacting with bacteria and environmental debris reverts back to the more stable O_2 form of oxygen and is released into the atmosphere. Thus the discharge water contains no residual ozone that could negatively impact the environment into which it is discharged.

Ozone has been used to treat cooling towers for a number of years. My first experience with it was in the late 1980s where it functioned well as a biocide, but we continued to use chemicals to protect the system from scaling and corrosion. Numerous failures of other systems were seen and reported on during this time and even some of the successes were minimal due to the added electrical costs required to generate the ozone. In reviewing these, almost all of the failures were the result of improper application, not an inadequate treatment system. Most companies selling and applying these treatment systems lacked a fundamental understanding of water chemistry and of cooling system operations to properly apply the Ozone.

Being always open to seek the best solutions to customer water treatment problem, I had always investigated new technologies as I became exposed to them. While many ideas spoke of how they would alter system characteristics, none of the solutions held up to my understanding of Physics and Engineering. The "well it just works" explanation just never sat well and time always proved that the device did not "just work". In 2005 I was exposed to a system engineered and manufactured by a Virginia based company named Clean Streams™ (formerly known as Zentox Corporation). While their primary business was water reuse, air purification through PCO (photo-catalytic oxidation), and ground water reclamation, their background was process water treatment and in this they excelled.

Clean Streams™ was the first group that I had come across that stressed two major ideas that other distributors and manufactures of either Ozone or other non-chemical devices never discussed. The first point was that making the Ozone was not the key – properly getting the ozone into the water was. This includes controlling how much Ozone is produced and fed into the system being treated. Too little Ozone would lead to biological growth and program failure; too much would cause system corrosion.

The second point was that the system was not a piece of equipment so much as it was a treatment program. Just like a chemical treatment program, proper monitoring and management of water chemistry in the system was critical to the success of the program. Ozone keeps the system being treated significantly cleaner, included removal of even small amounts of biofilm from heat transfer surfaces (thus increasing energy efficiency). The cleaner system also allows the facility to run higher cycles

concentration (thus reducing water usage). However, these higher cycles are still based on saturation indices meaning that in coming water quality and tower bulk water quality must still be monitored and managed to insure system protection and program integrity.

While there are other systems on the market, the bulk of my experience has been with the Clean Streams™ system. Clean Streams has been manufacturing Ozone treatment systems for over 15 years and has systems that have been in continuous effective service during this tenure. Anyone can throw together a system (ozone or other non-chemical), but the end user must look for established success. Talk is cheap, but successfully engineered application of a technology is the key to system success. Systems in continual use for long periods of time are also proof of success.

Use of the Clean Streams™ technology has been successful in saving customers both water and energy. Removal of biofilm from the heat transfer surfaces greatly improves energy efficiency. As little as one tenth inch of biofilm reduces heat transfer by 10%. While energy savings of 10% or more have been seen, it should be expected that a properly managed Ozone treatment system can routinely reduce electrical consumption by 2% to 4%. Without the biofilm on these surfaces, it is also much more difficult for deposits, especially carbonate scale, that lead to reduction in transfer to adhere to them. Further, for disinfection and prevention of the spread of infectious disease, Ozone is superior to other biocides. Bacteria cannot develop immunity to ozone due to the way it licenses the cell wall, a process sometimes referred to as "cold combustion". When the contents of the cell are spilled into the water, ozone works in a similar manner until the bacteria is completely oxidized.

Water quality plays a crucial role in how much water can be conserved. The rule of thumb is that the dirtier the water (higher concentrations of mineral contaminants), the higher the percentage of water savings that can be achieved by implementing an Ozone treatment system. Proper application of these Clean Streams™ systems has been seen to reduce water consumption anywhere from 10% to 40% (sometimes even greater). This results in the conservation of millions of gallons of water every year. Adding pH control by CO_2 can further increase water conservation again without hazardous chemicals.

Further savings have been achieved through the diversion of bleed water (necessary to properly control cycles of concentration and the mineral content of the water) to the environment and away from the sewer system. Generally a wavier from the presiding Environmental Quality Authority is necessary, but essentially the water being discharged is little different that the water being used to water the grass. In fact I have been strongly recommending to facilities and design engineers that this discharge water be dedicated specifically to this use. One job performed by the Clean Streams™ systems in the early 2000s was for a 6000 ton chiller plant where the owners used the bleed discharge to fill and maintain a decorative pond on the grounds of the facility.

Ozone should be considered the most practical system for proving chemical free treatment to cooling water systems. It should not be considered a system that can

provide zero water discharge from the tower system – while you can elevate the saturation points of the water and reduce water usage, there are still limits and violating them will lead to cooling system failure. Ozone can be considered the best system for killing microbiological cells and preventing exposure to infectious disease that have been found in cooling tower water.

To conclude, non-chemical treatment devices should be explored to implement "Green" programs where every practical. To be truly "Green" the system must save water and energy, not just be chemical fee. Of these devices, only Ozone has an explainable mechanism and a proven track record of success in treating cooling water system. When looking into Ozone systems it should be remembered that engineered application of the system is more important than the system specifications – it is not how much Ozone you produce, it is how much you get into the water being treated.

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