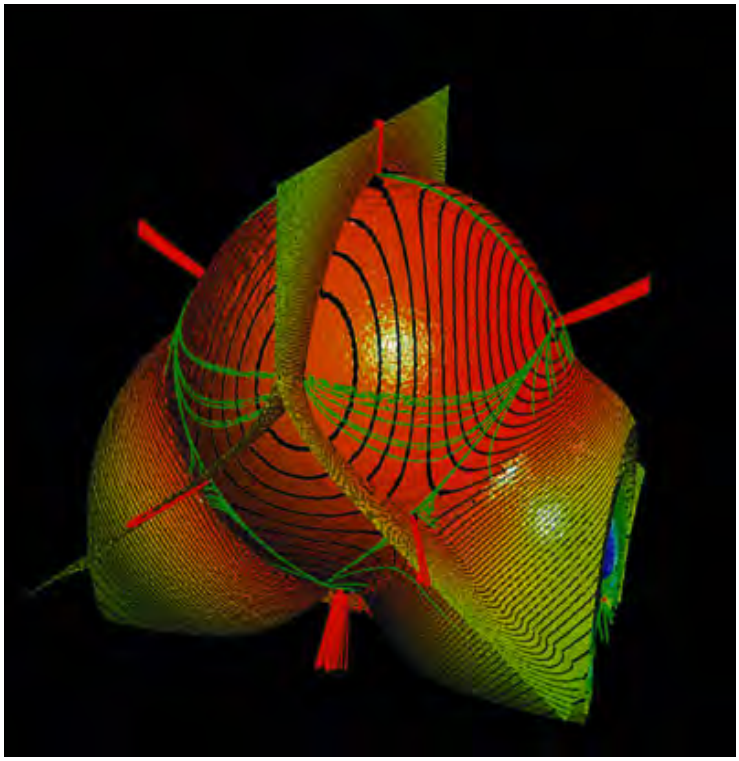
ABOUT H H SYSTEMS, INC.



We are constantly developing new methods to serve the growing needs in the industry and our efforts have led us to become a highly competitive, full-service, engineering, and design manufacturer. Our emphasis on performance and low maintenance continues to give H H SYSTEMS, INC. the edge in electronic water treatment solutions. Our approach will continue in the tradition of service into the next century, bringing new solutions to our clients with new technologies and techniques for higher performance and faster delivery.

Introduction to ION Generation

A cooling tower functions to cool a circulating volume of water. The tower acts as a heat exchanger by driving ambient air through falling water, causing some of the warmed water to evaporate (evaporation gives off heat, providing cooling), and then circulating cooler water back through whatever equipment needs cooling (such as a chiller condenser). Typically, chemicals such as chlorine and chelating agents are added to cooling tower water to control biological growth (called "biofilm") and inhibit mineral build-up (called "scale"). The control of biofilm and scale is essential in maintaining cooling tower heat transfer efficiency. As the water volume in the tower is reduced through evaporation and drift, the concentration of these chemicals and their byproducts increases. Cooling towers also pick up contaminants from the ambient air. To maintain chemical and contaminant concentrations at a prudent level, water is periodically removed from the system through a process called "blowdown" or "bleed off". The blowdown water and the water lost through evaporation and drift are replaced with fresh "make up" water (which will also contain minerals and other impurities).

Blowdown water must subsequently be discharged to a local wastewater treatment facility or discharged on site to the environment. Blowdown water from a cooling tower can be sent to a municipal drain, or it may require on site pretreatment prior to disposal to a drain. In some cases, blowdown may be stored on site and then retrieved by a disposal service. If water and sewer services are purchased from a municipal or public utility, reducing blowdown and make-up water requirements will trigger a series of resource and cost savings in those utilities. If the site operates its own water treatment and wastewater treatment facilities, reducing blowdown and make-up water requirements will allow the

facility to realize benefits. The blowdown water typically contains organic material, and the local wastewater treatment facility might charge extra sewage fees for accepting the water. These costs can be significant in the overall costs of operating a cooling tower. Discharge of the blowdown water to the environment on site is coming under increasing EPA regulation due to the contaminants/chemicals typically found in blowdown water.

Cooling tower water is continuously exposed to airborne organic materials, and the buildup of bacteria, algae, fungi, and viruses present hazards to the tower system and to the health of humans encountering the water. For example, Legionnaire's Disease is caused by the bacterium Legionella, pneumophila that frequently thrives in cooling tower environments. High levels of bacteria can also lead to an increased risk of microbially influenced corrosion. Sulfate-reducing and iron-metabolizing bacteria can destroy iron piping in as little as nine months. Moreover, a biofilm coating on heat exchanger surfaces reduces heat transfer efficiency. Scale and biological deposits reduce the ability of refrigerant condensers and industrial-process heat-exchangers to transfer heat.

Another phenomenon requiring treatment in cooling towers is mineral buildup. Minerals such as calcium and magnesium, which are common dissolved solids in water, are deposited by two different mechanisms, thermal and biological. As the water in a tower evaporates, dissolved solids concentrate in the recirculating water. Biofilms also start to form on the walls and other components of the tower. In essence, the biofilm acts as an adherent for mineral micro-crystals. Over time, deposition of organic and inorganic matter increases scale thickness. One operating concern of a cooling tower is the gradual corrosion of various parts of the tower. Much of the corrosion in cooling towers is associated with bacteria that create conditions favoring micro-biologically induced corrosion.

Why use ION Generation for Cooling Towers ?

The use of water ionization as a maintenance treatment for cooling towers presents potential for operation and maintenance savings. Water ionization acts as a powerful biocide that eliminates the need to remove quantities of water from the cooling tower in order to decrease the concentration of organic and mineral solids in the system. Water ionization can also eliminate the need for chemical additives added to the cooling tower water. In a properly installed and operating system, bacterial counts are reduced, with a subsequent minimization of the buildup of biofilm on heat exchanger surfaces.

The resulting reduction in energy use, increased cooling tower operating efficiency, and reduced maintenance effort provide cost savings as well as environmental benefit and regulatory compliance with respect to discharge of wastewater from blowdown. Cooling towers associated with chillers for air-conditioning are good candidates for a water ionization application.

How ION Generators Work

Ionizers use the process of electrolysis (passing electric current through water) to create metallic ions in water. An ion is an atom or group of atoms that possess an electric charge. An ion gets its electrical charge by losing or gaining electrons. If it gains an extra electron then it is a negative ion, also called an anion. If it loses an electron it is a positive ion or a cation. Passing an electric current between two metal electrodes in water will create positively charged ions of the metal of the cathode. If the cathode is copper then copper ions (Cu^{2+}) are created.

Copper ions in water significantly reduce or eliminate algae growth, as well as killing many bacteria. Ionizers work by passing a low DC current through a set of metallic electrodes, placed in line with the water circulation system and set slightly apart from each other. The voltage causes some of the outermost atoms of the electrodes to lose electrons, which attempt to flow across the space between the electrodes but instead are carried away by the flow of water.

The rate of ion creation is proportional to the ratio of copper and titanium in the electrodes. The ion levels are monitored electronically by the system and are controlled and adjusted by changing the current flow across the electrodes.

Removal of organics is also accomplished in the ion chamber where, in addition to producing ions, the electrodes also electrolyze the water separating it into two elements, hydrogen and oxygen. The ion generator oxidizes the biofilm that serves as a binding agent adhering scale to heat exchanger surfaces.

Ion generators loosen and remove the scale when the biofilm is present. Polarized minerals in the water stay in solution and as the existing scale softens and dissolves the attached minerals are released into the flow where they are trapped and continuously filtered out of the water. When scale buildup on condenser tubes is eliminated, higher heat transfer rates are achieved. Increasing the condenser heat transfer rate will reduce the chiller head pressure, which then allows the chiller to operate more efficiently and consume less energy.

Properly maintained and sensibly applied an ionizer system is capable of satisfying basic purification, descaling and cleansing needs. These properties have made ionization very effective for cooling tower water treatment. For decades, ion generators have been used to purify drinking water, and most recently have been applied to swimming pools, where algae and bacteria find a fertile environment.

During the last 20 years, technological improvements have made commercial ion generators economically feasible. Ion generators to treat cooling tower water is a relatively new practice, however, its value as a result of water and energy savings and environmental benefits greatly exceed standards relative to traditional processes.

Cooling Tower
Water Ionization and Oxidation

The Technology
The principle of ionization to purify water has been common knowledge for years, and many practical uses of the principle were developed during the early years of space travel by NASA. The Ion Generation System implements those principles along with the release of hydrogen and oxygen, this process confined between the plates of the tube.

Ionization of cooling tower water will eliminate algae, bacteria, and viruses that cause serious health and maintenance problems. Ionization is produced through a process where copper ions are emitted into the water by an electrical current polarizing opposing copper alloy electrodes. The copper ions created by the electrodes kill algae, bacteria, and viruses which are then removed from the water by the filter. The copper ions also strip the bonding properties of the existing scale adhered to the pipes and components, reducing the scale to fine particles as it softens and are then removed by the automated filtering system.

This introduces a process that conditions the water by polarizing the minerals in the water which lowers their surface tension so they stay in solution rather than affixing themselves to the various elements of the cooling tower. Mineral molecules normally bond to one another and cling to surfaces forming scale. Existing scale will flake off after the conditioning process is implemented, loosening the attached minerals and releasing them into the flow where they are continuously filtered out of the water.

The System's electronic Ionization and sensing components will continuously eliminate any algae or bacteria that develop in the water, break down the existing scale, and prevent any new scaling from forming. The filtering component of the System removes all solid particulates filtered from the treated water through its automated backwash cycles.

The System
An Energy-Saving Chemical Free Electronic Cooling Tower Water Treatment System is better serviced and maintained by our own factory trained technicians. The system replaces an existing chemical delivery system, which will be disconnected from the water supply system. The new rack mounted system is either placed in the mechanical room or on the roof, depending on the water piping required for proper operation. The System requires a 120V AC receptacle and a communication line which will be installed if not readily available. A drain line for the filter's automated backwash will be installed into an open drain, (sanitary drain is in not required as there are no toxic chemicals being used). Our experienced service department will continually monitor the electrical characteristics of the cleansing process, the total dissolved solids, conductivity, filter pressures, chiller loading and head pressures, etc., and immediately respond to any alarm condition detected by the electronic control and monitoring system.

The Benefits

As detailed above, the cooling tower will operate free of chemicals, therefore will no longer subject the facility to a monthly sewer charge for the blowdown water, and, will use considerably less water and less electrical power. Those savings can all be accurately measured and will provide our basis for cost savings.We will not try to measure several other savings benefits the system will provide such as, within just the first month the system will clean out the existing scale which will improve the heat transfer process resulting in less loading of the chillers (resulting in less wear and fewer breakdowns). More efficient operating conditions will result in extending the useful life of the chillers, and the cleansing of the piping and various other surface area of the condenser and tower will result in less deterioration and common of the metals, extending the useful life of the entire water cooling system.

Ion Generation
Product Features

Real Cooling Tower Solutions

The Ion Generation System uses EPA approved patented electronic technologies to clean and treat cooling tower water by ionization through an electrolysis process. Copper, zinc, hydrogen and oxygen ions are introduced into the water when it is made to flow through an ionization chamber where the metal electrodes are electically charged. Both poles of the DC voltage are present within the generator tube. The process occurs at this point. There is no electrochemical process occuring to the equipment and piping.

The ions kill any algae or bacteria found growing in the water, dissolve any existing scale, and prevent new scaling or bio-films from developing in the condenser unit that would inhibit the water flow.

The System is equipped with a special filtering system which contains layers of various filter media that remove the dissolved scale, minerals and particulates through its automatic backwash cycles dumping the non-toxic water and sludge into an open drain.

* Totally eliminates the need for a chemical additive system to kill algae and bacteria.
* Totally eliminates additional sewer charges for discharged water as it is no longer toxic.
* Dramatically reduces the volume of water used by eliminating the "blowdown loss."
* Dramatically reduces chiller head pressures by improving the heat transfer that results from having clean water flowing through a clean condenser unit.
* Dramatically reduces electrical demand and consumption as the efficiency of the chiller system is improved, runs less loaded and cycles off more often.
* Dramatically reduces maintenance and down-time on chiller equipment and extends the useful life on all system components through continuous cleansing.
* Works effectively on all cooling tower systems meeting the EPA ban on toxic dumping.

Designed specifically for commercial, institutional, industrial and military facilities. Installed with no capital required on five year service and maintenance agreement with guaranteed energy saving exceeding monthly fee.

System Specifications

Model LYKL 500
Produces chemical free treatment and cleansing for up to 500 ton Cooling Tower systems

Model HXL 1500
Produces chemical free treatment and cleansing for up to 1500 ton Cooling Tower systems

SOLVING
Cooling Tower Water Problems

Cooling towers do just one job: they cool the heated water that goes through the chiller to remove the heat from the refrigerant that is cooling the building.
60% of the problem is scaling
20% of the problem is bacteria
10% of the problem is corrosion
10% of the problem is filtration

A CHEMICAL-FREE solution to these problems
is achieved by using a combination of deploying electronically generated copper ions into the water, oxidation and polarization of the minerals in the water, and a filtration system specifically designed to remove the biological residues and dissolved solids from the water.

SOLUTIONS
The incoming water condition and amount of evaporation are defining factors in the amount of particulate concentration which occurs in cooling towers. A reading of 30ppm (parts per million) of chlorides is common in many commercial areas, and that reading will rise and fall as the environment changes so readings are taken continuously to determine the ppm level and to control the ion levels required to maintain a system free of algae, bacteria, virus, corrosion and scale.

When treating a cooling tower. we must treat the entire water circulation system, i.e., all water flowing through piping and fittings, reaching all areas of the system.

In water treatment terminology, one often encounters the term "cycles of concentration". This refers to the number of times the dissolved solids in the circulating water have increased as a result of evaporation. For example, if the make-up water has 100 parts per million (ppm) of Total Dissolved Solids (TDS), and the condenser water contains 300ppm, 3 cycles of concentration has been reached.

As each cycle of concentration takes place, a large amount of water is lost because cooling towers utilize an open-air evaporation process to cool the water. After an average of 3 to 6 cycles, depending upon the hardness factor of the incoming water, a lot of water

has been lost due to evaporation, leaving the minerals and bacteria in the remaining water.With chemicals, your system responds when a conductivity sensor, which monitors the electrical state of the water, sends a signal to a bleed off valve to purge a specific amount of water, known as the "blowdown". At the same time the system refills itself with fresh water, known as "make-up water". This purging process and make-up water induction reduces the cycles so scaling can be controlled and does not clog up the tube bundle in the condenser or the tower itself.

It is also important to note that scale control chemicals are automatically injected into the water to help control scaling. After installation of the Ion generation system, the existing chemical injection system and blowdown process just described will both be totally eliminated. This creates an annual savings in both water and chemical cost annual savings and will eliminate the cost of brushing the tube bundles and acid treating the tower, condenser, and piping each year.

During the initial ionization and treatment period, the particulate levels in the water will buildup at a fast rate due to the removal of existing scale and biofim throughout the system and equipment. The only effect of this buildup will be to activate the automatic backwash cycle more frequently. After a few short weeks, the frequency will normalize and the system will remain clear of algae, bacteria, viruses and scale.

Filtration, Conductivity, pH Control and Backwash

FILTRATION in heat transfer/cooling systems is needed for three reasons:
The removal of any airborne particulates which are caught by the system, for example, dust, dirt, etc., being caught by the cooling tower and then re-circulated throughout the system. Such dust, dirt, etc., could readily plug heat exchanger tubes and flow channels.
The removal of existing scale in a system as the oxidation and polarization of the water softens and renders the existing hard scale on heat transfer surfaces clean.
The prevention of scale buildup on heat transfer surfaces, when a system is clean so that the normal precipitation and nucleation of solids which occurs from solution can be removed.

The make-up water that replaces water lost in the backwash process contains minerals and sometimes chemicals, bacteria and viruses that add to the problem, which is then held in solution and removed by the specially designed filtration system in order to maintain the system free of scale and biofilm.

CONDUCTIVITY in heat transfer/cooling systems must be carefully controlled.

When the water conductivity reaches a set-point level, the system's electronic control system sends a signal to the ion generation electrode adjusting its ion output to alter the level of electrochemical action within the water stream. The conductivity measurement is based on the level of ions in the water which varies the electrical conductivity of the water and is used as the control parameter for the level of input needed to clear the water. In a typical cooling tower application the control of conductivity ranging from

between 800 to 1,200 microhms/cm will usually produce required cycles of concentration and control the cooling tower water adequately.

pH CONTROL is important in minimizing the rate of corrosion in a heat transfer/cooling system, pH being the universal indicator of water acidity

The measure of the concentration of hydrogen ions present in a solution is critical. A pH= 7 reading means the solution is essentially neutral. To avoid corrosion problems, controlling the pH in an alkaline range of between 7.5 and 8.5 is important, to our purpose.

The Ion generation system also handles that problem in that it can effectively operate in pHs (pH saturated) condition to inhibit scale deposits.

The ion generation system electronically monitors both the pH and conductivity levels within their control range providing continuous cleansing of the water resulting in a scale-free operation. Scale acts as a host substance upon and inside which algae and bacteria can grow and hide. Elimination of the scale removes the host substance and eliminates the possibility that biologicals in the water will cling to any surface on contact. The copper ions generated by the system will kill the bacteria and algae and keep the residue in solution until it is trapped and removed by the filtration system.

CORROSION

The presence and growth of micro-organisms in heat transfer/cooling systems cause plugged water passages and severe deterioration of metal surfaces by under-deposit corrosion. Iron deposition and corrosion is caused by the metabolism of "iron bacteria", which can remove water soluble ferrous salts and deposit them as insoluble ferric oxides. These oxides tend to grow rapidly and can reach sizes large enough to restrict water flow. The ion generation system kills the micro-organisms.

Another group of bacteria produce acids and waste which attack metal surfaces directly. These organisms can convert water-soluble sulfur compounds into hydrogen sulfide. One of the most common sulfate–reducing bacteria is desulfovibria. This bacterium uses organic nutrients from the decomposition of other bacteria or algae as food. This process often takes place under existing biofilm or scale deposits. The corrosive action of desulfovibrio can produce condenser tube penetration in as little as six weeks.

A third group of corrosive bacteria common to cooling towers are known as nitrifying bacteria. The bacteria react with dissolved ammonia to produce nitric acid. This acid lowers pH and causes localized attack on both copper and steel. Lastly, algae, a major source of trouble in cooling tower water systems, adheres to metal surfaces and accelerates pitting by the release of oxygen during the metabolic process. Large algae growths also impede the effectiveness of biocidal treatments by absorbing them.

NOTE:ChemFreePro is the chemical free SOLUTION to Cooling Tower Water Problems.

COMPARING IONIZATION to OZONATION

Comparing these TECHNOLOGIES
There are currently two chemical-free alternates commonly used to control cooling tower and process water circulation systems to eliminate the existence of algae, bacteria and viruses in the water, and preventing scale buildup and corrosion, in order to reduce the system maintenance and operational problems, and, to eliminate the environmental pollution resulting from the use of chemicals.

In many areas today, the use of chemicals has been banned through local code restrictions and one or the other of these alternative methods of water purification and control has been chosen to solve those problems as well as to reduce the operating costs of the water circulation systems. It has been reported that the use of chemicals has been banned by the EPA in new construction in some cities causing developers to choose an alternate water management system.

Although both Ionization and Ozonation eliminate biological growth in water circulation systems the technologies are not similar in how the two actually effect biocide, (killing the algae, bacteria and viruses). Ozone is a very short life span oxidizer that kills the organisms immediately on contact, but it has no residual effect as it lasts only a few minutes in water before changing state. Ionization, on the other hand, has a very long residual oxidizing life span, kills the organisms slowly, and is effective in the water even when the circulation system is idle. In actual use, the Ozone injected into a partial sidestream of water loses its oxidizing power before much of it mixes with the main flow of water so it rarely affects some of the critical elements of a circulation system, leaving pumps, condenser tubes, etc., unprotected from algae and bacteria growth.

Another failure with Ozone treatment is the fact that its powerful oxidation properties will actually stimulate corrosion. Oxidation and corrosion are in effect the same thing, and since Ozone is a very strong oxidant, it has a strong tendency to initiate corrosion and ultimately cause pitting in metal fittings and components in a circulation system. Although ozone treatment does leave a thin layer of metal oxides on metal surfaces preventing further corrosion, that oxidized surface slightly deters heat transfer, the primary function of a water cooling system.

Ozone does not loosen existing scale nor prevent sodium or silica based scale from forming, as does Ionization of specific metals used in Ionization.
However, ozone is effective in stopping biological growth which, when allowed to live, hides and adheres to existing scale, so the effect of the treatment limits scale buildup to some extent. An Ionization system polarizes the suspended minerals and compounds in the water and DOES cause existing scale and corrosion to release and break up, dissolving them into solution which is then removed from the circulating water via filtration.

Unlike Ozonation, the Ionization of a copper alloy acts as an algaecide. a bactericide and a virucide and its dissolved copper minerals have a long residual effect, are not affected by varying temperatures, and actively kill biological growth wherever it lives in a water circulation system. Copper ions actively control algae, bacteria, and virus even during periods when the circulation system is not in use. The resulting dissolved particulates are also removed from the water via filtration.

The ION Generation System produces the necessary purification and cleansing results required in maintaining an efficiently operating and thoroughly clean water circulation system unlike any other type of system in use. By integrating water purification, scale and corrosion release and dissolution, and particulate removal through filtration, the ion generation system eliminates chemicals, stops the water wasted during "blowdown", eliminates most of the maintenance procedures required, and reduces the circulation system's annual operating costs dramatically.