THE PROBLEMS INHERENT IN COOLING TOWER OPERATION:

Cooling towers are an integral component of many heat transfer systems, providing comfort or process cooling across a broad range of applications. Cooling towers using large thermal transfer areas wetted by re-circulating water to dissipate heat through evaporation - consuming large amounts of potable water resulting in hefty annual utility, maintenance and operation costs. However, with water-cooled cooling tower operation, there are inherent operational challenges like corrosion, scale, bacteria infestation, bio-fouling and algae proliferation faced by maintenance engineers.

In addition to scale formation phenomenon, biological systems such as algae, mould, fungi and bacteria thrive in cooling tower water due to its high mineral content with their growth supported by favourable water temperature, pH range, dissolved oxygen, sunlight, and organics that provide food source. These bio-deposits are transferred throughout the piping and water distribution system of cooling tower, which obstruct the heat transfer surfaces and impede flow through narrowed pipe cross sectional area, partial clogging of nozzles and valves.

The combination of warmth, moist areas, and re-circulating water creates ideal conditions for scale formation, bacteria and mould growth. Together they create major operational issues, including health hazards to maintenance workers, increased electricity usage, increased water consumption, reduced cooling efficiency and shortened life expectancy of equipment.

The common method of water treatment of cooling towers to control the above problems entailed the use of harsh toxic chemicals and blowdowns to control water quality. Both these traditional methods do inhibit scale deposition to a certain degree but have numerous disadvantages like high chemical usage, excessive water bleeding, toxic chemical handling, high operating cost, excessive chemical loadings to sewer, etc.

Conventional chemical treatment for cooling towers require that acidic chemicals or alkaline chemicals be periodically added to manipulate and re-balance the pH. Alkaline is added to raise pH to avoid corrosion if the pH is less than 7 and to lower pH with acid to prevent scale formation if pH exceeds 9 in the water distribution system. In addition, periodic dosing of biocides is needed to retard biological growth and other chemicals to control corrosion in the chillers and piping systems. Therefore, toxic chemical handling is the norm for traditional chemical treatment regime. As such there exist potential health hazard consequences to workers as well as public health and environmental issues due to accidental chemical spills, chronic chemical exposure (even at low levels), and bio-accumulation of persistent chemicals in the food chain.

THE LIMITATIONS OF CHEMICAL WATER TREATMENT:

Treating cooling tower water to prevent biological fouling, scale, and corrosion is a complex, and a highly monitored process. Most are accomplished with biocidal, water conditioning, dispersant, and scale-inhibiting chemicals, including chlorine, various brominated compounds, phosphates, molydenates, acids (including sulfuric acid), and zinc compounds. The traditional chemical treatments have inherent technical challenges. Chemical water treatment is a highly complex process requiring close monitoring and constant manipulation of these various chemicals to ensure a delicate chemical and ionic balance to avoid corrosion, scale, bacteria infestation, bio-fouling and algae proliferation. The inter-relationships of and inter-dependencies between cause and effect of the standard chemical treatment approach is certainly not a one-size-fits-all solution.
THE SOLUTION: HVS-ECA SYSTEM – CHEMICAL-FREE WATER TREATMENT FOR COOLING TOWER

HVS-ECA System Technology

HVS Engineering has developed a proprietary pulsed technology electrochemical activation with certain ionic species in water which enable rapid de-scaling and removal from bulk water as well as on-site disinfectants production to provide water sanitization and pH manipulation capability, which in turn inhibits bio-growth, bacteria, scales and corrosion.

HVS-ECA System is a novel dual function electrochemical activation system that promotes rapid removal of calcium, magnesium, carbonate and silicate scale-forming ions physically and generates a slew of mixed oxidants on-site during the process of electrochemical activation of water to replace the traditional standard chemicals and oxidizing agents.

Utilising electro-chlorination technology, HVS-ECA System infuses the cooling tower water with on-site generated powerful hypochlorites and a slew of oxidants to replace the conventional harsh and toxic chemical usage in the cooling tower water treatment.

HVS-ECA: Technical Innovation:

- Proprietary Ultra-Short Pulsed DC Technology
- Highly Efficient Oxidation-Reduction Process
- Cold Electrochemical Activation System
- Functionalised Electrodes Design
- Self-Cleaning Electrodes

Advantages of HVS-ECA over existing non-chemical treatment system:

- Green technology
- Zero Toxic Sewer Load
- Low energy system
- Easy operation
- Low Maintenance
- No toxic chemical storage hazard
- Modular design
- Small footprint

Potential Benefits of HVS-ECA System for Cooling Tower operation:

- 100% savings on harsh chemical (no more toxicity to sewer)
- 40~80% savings on bleedwater (Operate at higher COC- depending on make-up water quality)
- 50~90% savings on labour cost (Near Automatic System)
- Absolutely environmentally safe (Green Technology)
- Modular design, small footprint, easy installation - no disruption to cooling tower operation.
Consultant’s Specification for HVS-ECA System – Chemical Free Water Treatment System

The chemical-free (non-chemical) water treatment system for cooling tower water distribution system shall comprise the following main modules:

- Computerized Master Operational Control Panel
- Electrolytic Anode-Cathode System for electrochemical activation of water
- Rapid Scale Precipitation Reaction Chamber for hardness reduction
- Electro-Chlorination Generating System for bacteria disinfectant
- Automatic Foulsants Removal System using reverse polarity protocol
- Real-time Water Quality Monitoring and Control System (with BMS/BAS linking options) linked to pH, TDS/Conductivity, Salinity and ORP sensors to initiate onsite just-in-need water treatment
- Mechanical Components, Solenoids & Piping Control System within engineering skit

Construction & Operation of HVS-ECA System

HVS-ECA System is an independent equipment and can easily be installed separately without affecting the heat exchanger’s cooling water circuit. Water from the cooling tower basin is continuously circulated through the HVS-ECA System via pressure differential protocol or circulation pump or as appropriate.

Rapid Scale Extraction Chamber: (Illustration of scale formation/removal using a scale down transparent model)

DC current passes from proprietary cathode, through the electrolyte (water) in the reaction chamber, to the proprietary anodes. Due to the electro-activation process, the dissolved form of calcium and magnesium ions are deposited on the cathode and the treated water is returned to the cooling tower with a reduced concentration of calcium/magnesium ions.

Electrochemical reaction produces hydroxide ions, which causes carbonate and silicate scale to automatically peel off and sink to the bottom of the collection chamber during the reverse polarity process. The removed scale will then accumulate at the base of the collection chamber and shall be extracted by drain valve periodically.

Rapid Bacteria Detection System: (To confirm efficacy of HVS-ECA)

Mycometer has been used to monitor the hygiene in a large cooling systems. Based on the information provided by Mycometer as a reference, a normally effective operating cooling system will have a BQ value of less than 15,000 for Total Bacteria Count and less than 1,000 for Total Legionella Count.
Test Results of Scanning Electron Microscopy SEM/EDX of HVS-ECA System

Shown below are the results of the Scanning Electron Microscopy SEM/EDX Analysis using extracted scale samples after undergoing HVS-ECA System treatment. It is can be verified and confirmed that the major components of the extracted scale are Calcium, Magnesium, Carbonates and Silicates – these are the major ions that contribute to substantial hardness of water that lead to scale fouling. With a balanced and continuous extraction process of such scale forming ions using HVS-ECA System, cooling tower can operate at much higher cycle of concentration resulting in reduction of blowdowns.

HVS-ECA System has demonstrated the capability to physically extract Calcium, Magnesium, Silicate, Carbonate, Sodium, Potassium, Chloride, Iron, Aluminium ions continuously from the cooling tower water circulation loop. The bulk of the scales removed by HVS-ECA System are Calcium Carbonate, Calcium Silicate, Magnesium Carbonate and Magnesium Silicate. The elements that are extracted by HVS-ECA System and as detected by SEM/EDX Analysis are as shown below:

Below shows the Thermo Gravimetric Analysis of the scale samples after and before HVS-ECA treatment respectively. The scale sample tested before HVS-ECA treatment shows the organic endothermic peak at low temperature. Such a peak is clearly not visible in the samples after the HVS-ECA process. This scientific evidence clearly confirms the removal of organic matrix by HVS-ECA process – resulting in an efficient scale mitigation protocol.

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