Scientific Evaluation Report
"ElimiCal" Sidestream Electrolytic Device for Cooling Towers

Device Evaluated

"ElimiCal" sidestream electrolytic device manufactured by Aqua Green Technologies, Inc., 13560 Colombard Court. Fontana, CA, 92337, as marketed by Aqua-Serv Engineers, Inc., same address. Shown to the left are two ElimiCal devices, one device each installed in a sidestream mode per treated cooling tower.

Facility History

A large public school system in Arizona installed ten ElimiCal devices at five separate locations in June, 2011. The total installed cost was $300,000 with a project objective to reduce water use by operation of cooling towers at six (6) cycles of concentration (COC) and eliminate use of water treatment chemicals. The units have been operated on a continuous basis since installation. We conducted an evaluation of two such equipped cooling tower systems on March 29, 2012.

Facility Data

The cooling system consists of four stainless steel Evapco Model LSW 144351 fluid cooler cooling towers with galvanized steel tube bundles operated in parallel as a closed loop water source to facility chillers. The open loop water side of each cooling tower operates as a separate system and is equipped with a conductivity blowdown unit. Each cooling tower has a single ElimiCal device plumbed as a sidestream unit into the cold water basin. During our evaluation, only two cooling towers were operating due to the low thermal load in March. No corrosion coupon racks were installed and untreated makeup water was drawn from the Phoenix city water supply.

Claims Made
No literature or claims were found on review of either the Aqua Green Technologies or Aqua-Serv Engineers WEB sites (aquagreentechnologies.com and aqua-serv.com).

School employees noted that installation of the ElimiCal devices was made with the expectation of reducing water use by increasing cooling tower COC from a typical 2.5 - 3.0 to 6.0, cutting blowdown by at least half, and eliminating all use of chemical water treatment products.

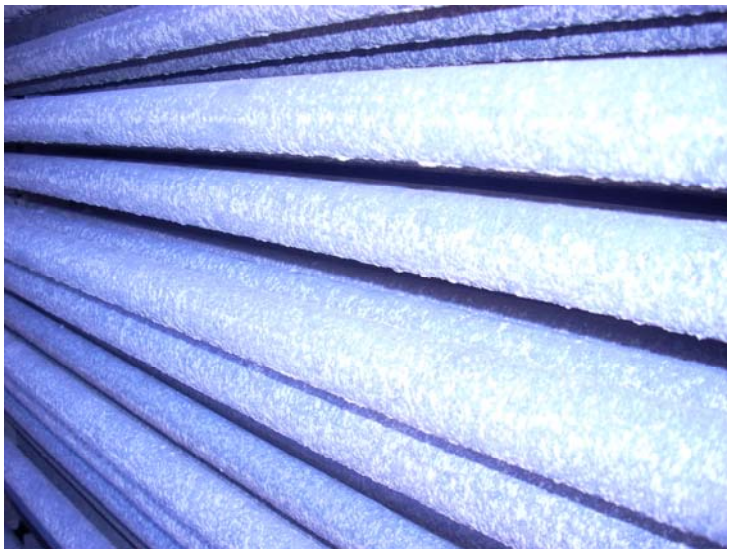
Mode of Operation
On examination the ElimiCal device was found to consist of a low voltage DC power supply feeding into an electrolytic cell where calcium and magnesium would be removed from the water flowing through the cell by electrolysis precipitation. Solidified calcium and magnesium would be removed from the electrolysis cell by routine polarity reversal of the cell followed by a purge, or blowdown, of high solids wastewater to sewer. It was reported that the electrolysis cells had to be manually disassembled and solid deposits removed on a routine basis to keep the devices operational.

The chemical equations governing this set of reactions are:

$$2Na + 2e \rightarrow 2Na$$
$$2\ Na + 2H2O \rightarrow 2\ NaOH + H2\uparrow$$
$$2\ NaOH + Ca(HCO_3)_2 \rightarrow 2\ CaCO_3\downarrow + Na_2CO_3 + 2\ H_2O$$

This is a very ineffective means to remove calcium from water as compared to a standard cation exchange water softener as the above reactions have a lot of competing reactions proceeding at the same time.

Review
Our inspection of the cooling towers found the tube bundles were severely corroded, white rust (zinc) corrosion products are present as shown in the photograph to the right. A slight amount of hard, gray scale was also present between the corrosion deposits. No significant scale or deposition was observed in the cold water basin.



Another cooling tower equipped with an ElimiCal device at this location was also inspected. It was not operating at the time, but did have a corrosion coupon rack installed. On inspection, the steel corrosion coupon present, following photo, was found to be very badly corroded.

We discussed this overall installation with the former Aqua-Serv Engineers service technician for the facility, he noted that corrosion seemed to be a major problem with the ElimiCal technology.

Samples of makeup and cooling waters were obtained for laboratory analysis by Analytical Services, Inc., Brockway, PA, a state certified laboratory, PADEP #33-411, with the following results reported:

Analytical Results

Parameter	makeup	cooling tower 1	cooling tower 2
pH	7.8	8.4	8.6
total alkalinity, mg/l as $CaCO_3$	130	175	195
conductivity, mmhos	959	1553	2160
calcium, mg/l	69.4	99.0	120.0
magnesium, mg/l	22.4	36.4	46.0
calcium:magnesium ratio	3.1	2.7	2.6
iron, mg/l	<0.03	<0.03	<0.03
copper, mg/l	0.12	<0.02	<0.02
zinc, mg/l	<0.005	0.035	0.046
silicon, mg/l	2.2	5.0	5.7
chloride, mg/l	95	190	260
sulfate, mg/l	225	202	118
total phosphate, mg/l as PO_4	<0.46	<0.46	<0.46
suspended solids, mg/l	-	< 2	4
total hardness, mg/l as $CaCO_3$	265.5	397.1.	489.1
cycles on chloride	-	2.0	2.7
ATP, rlu	-	164	25
saturation index 100 F	+0.5	+1.4	+1.7

Discussion

The makeup water as supplied was found to be scaling, saturation index (SI) of +0.5. Concentration by evaporation of this water would result in a substantial increase in scale formation potential.

Considering the COC calcium mass balance, cooling tower #1 was expected to have calcium at 138.8 mg/l present, 99.0 mg/l was found. Cooling tower #2 should have had a calcium level of 187.4 mg/l, 120.0 mg/l was found. The difference between expected and found calcium levels, and absence of substantial scaling, shows that calcium was likely being removed from the cooling waters by the ElimiCal device.

Removal of calcium from cooling water by electrolysis has been confirmed by ProChemTech using laboratory electrolysis cells as well as sidestream operation of such devices on cooling towers. It is, however, a very inefficient process due to the many competing reactions taking place in the electrolysis cell.

Found pH levels, 8.4 and 8.6 in the cooling waters, are above the 8.2 where white rust becomes a major concern. Control would require either pH adjustment by acid feed or use of a specific corrosion inhibitor for zinc. It is apparent from the observed condition of the tube bundles that the ElimiCal technology does not control white rust corrosion on galvanized steel.

Our major finding is that the cooling towers are not being operated at the desired six (6) COC and are actually being operated at a COC typical of a standard phosphonate-polymer water treatment program. Thus there has been no reduction in water use following expenditure of $300,000 on the ElimiCal devices and their installation.

Based on the tonnages of the systems reported to be equipped with the ElimiCal devices, annual chemical cost for a chemical based water treatment program would be approximately $15,000. Using just the installed cost, with no consideration for power use or maintenance costs, the simple return on investment for the ElimiCal devices is 20 years.

Conclusions

Based on our observation, the ElimiCal devices were not obtaining the desired water savings by being operated at the desired six COC. In addition to this failure to obtain the desired water use reduction, it is also apparent that white rust corrosion of the tube bundles is a problem and will result in premature corrosion failure of these rather costly units.

Given the reported steel corrosion and device maintenance issues, additional study would be needed to determine the extent and costs associated with these two items.

With the apparent failure of the ElimiCal device to achieve the desired water use reduction, the simple ROI of 20 years does not justify the installation of such devices on the basis of cost reduction resulting from elimination of chemical based water treatment.

Reporter

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