Case History Report – HighCycle Cooling Tower Water Use Reduction At Phoenix Sky Harbor Airport

CHR 0114

Traditional treatment for operation of a cooling tower with hard alkaline makeup water uses acid to control scale via adjustment of the cooling water pH into a non-scaling range with phosphate used to control corrosion. While this chemistry has been successful in many applications, the use of phosphate in cooling waters has been restricted in many areas due to environmental considerations while the use of acid has been discontinued due to environmental restrictions (SARA Title III), pH control problems resulting in severe corrosion damage, and the substantial health and safety risk (OSHA) involved. The water management industry responded to this challenge by developing the currently used phosphonate-polymer programs.

Corrosion Proof Delta Cooling Tower

HighCycle Water Treatment

Our firm has invented patented, and patent pending*, HighCycle tm cooling water treatment products that enable cooling towers to be operated at least two (2) cycles of concentration (COC) higher than current phosphonate-polymer water treatment programs. One of the best monitored HighCycle programs in the country is at Phoenix Sky Harbor Airport, which has four (4) large cooling tower systems for HVAC service. Prior to the HighCycle program, airport cooling towers were operated using a current typical phosphonate-polymer treatment program and averaged 2.5 COC.

HighCycle differs from all other water treatment programs in that makeup water calcium hardness (CaH) and total alkalinity (TA), both as $CaCO_3$, are used to calculate the desired COC on every service call. The cooling tower blowdown controller is then reset to this calculated COC to compensate for the varying water quality of many water supplies. The equation used is:

$$COC = 2 + \sqrt{\frac{110{,}000}{CaH \times TA}}$$

Cooling towers using a HighCycle program are evaluated on every service call where the conductivity, CaH, and TA results are determined on the makeup water and cooling water and used to calculate COC values for these three parameters. A simple comparison of these calculated COC values, the CaH and TA values should exceed the conductivity COC value within test method error limits showing that no scale if forming within the cooling tower systems.

A sample of "typical" makeup water analyzed, results as follows, was used to calculate a desired COC of 4.2, current typical technology would operate at a COC of 2.2.

Parameter	Result	Parameter	Result
pH	8.1	total alkalinity	155 mg/l
conductivity	854 mmhos	calcium as Ca	59.2 mg/l
magnesium as Mg	23 mg/l	iron as Fe	<0,03 mg/l
copper as Cu	0.03 mg/l	zinc as Zn	<0.005 mg/l
silicon as Si	7.5 mg/l	chloride as Cl	134 mg/l
sulfate as SO_4	87 mg/l	total phosphate as PO_4	0.81 mg/l
total hardness	242.5 mg/l	saturation index	+0.8

Please note that the city water supply varies substantially with time, thus the "typical" designation. Conductivity can vary from around 800 to 1100 mmhos in a short period of time with similar, but not proportional, changes in total alkalinity and calcium hardness.

HighCycle Performance

Applying this technology to operation of Sky Harbor Airport Terminal 4 cooling tower system , 9,250 tons capacity, over the June - August, 2013, time period an average conductivity COC of 4.2 (13 data points) was obtained. Makeup water use over this time period was 17,272,000 gallons, from which an average evaporation rate of 13,161,905 gallons with a blowdown of 4,113,095 gallons is easily calculated. If this system had been operated at the previous supplier’s average of COC of 2.5, the blowdown would have been 8,774,603 gallons, a 113% increase of 4,661,508 gallons.

A water use reduction of 4,661,508 gallons over three months operation is very significant in a water short area like Phoenix. Please note that HighCycle products are basically a "drop in" replacement for current phosphonate-polymer products, no new feed and control equipment is typically required. As less treatment chemical is flushed down the drain in excess blowdown, treatment chemical cost is generally the same, or less.

Total control of scale formation in the Terminal 4 cooling tower system was verified by running on-site analysis and COC calculations for conductivity, total alkalinity, and calcium hardness at each weekly service call. For the June-August time period the calculated desired conductivity COC was 4.4, with achieved COC for conductivity of 4.2, total alkalinity 4.9, and calcium hardness of 4.8, all results average of 13 data points.

During the recent annual condenser inspection, the contractor noted that the condensers were scale free and eddy current tube analysis indicated no corrosion.

Corrosion control has also been excellent as shown by the following corrosion coupon study results.

Corrosion Coupon #	061	C50716
Material:	C1010 steel	C1010 steel
Date Installed:	12-07-12	06-14-13
Date Removed:	03-08-13	11-19-13
Results:	0.44 mils/yr	0.77 mils/yr
Comments: Localized discoloration, corrosion around holder		Localized under deposit corrosion
Corrosion Coupon #	055	Z7159
Material:	CDA 110 copper	CDA 110 copper
Date Installed:	12-07-12	06-14-13
Date Removed:	03-08-13	11-19-13
Results:	0.02 mils/yr	0.03 mils/yr
Comments: Dark discoloration		Dark discoloration
Corrosion Coupon #	30	A1687
Material:	zinc	zinc
Date Installed:	12-07-12	06-14-13
Date Removed:	03-08-13	11-19-13
Results:	4.53 mils/yr	5.60 mils/yr
Comments: General corrosion		General corrosion

Note: Program does not have ZincGard for control of white rust corrosion of galvanize.

Environmental

The environmental, or **"green"**, profile of HighCycle products shows that all the components are readily biodegradable with low toxicity values. Use of these products at recommended dosages thus presents no problems as to environmental degradation or pollution. Sky Harbor Airport realized a substantial **"green"** benefit by dramatically reducing water wasted to cooling tower blowdown via use of a HighCycle program with higher COC operation of the cooling tower systems.

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***US patent 8,496,847 and patent application 13/852,624**