Case History Report
"Dolphin" Nonchemical Device
Cooling Tower

Device Evaluated

While this is our third case history report (Dolphin III), on the "Dolphin Pulsed Power" non chemical device (NCD) for water treatment, it is our first case where the makeup water is highly scaling, having both high hardness and alkalinity. The "Dolphin" device is marketed by Clearwater Systems LLC, 145 Dennison Rd., P.O. Box 463, Essex, CT 06426, ph: 860-767-0850 FAX 860-767-8972 WEB www.clearwater-dolphin.com and are now being sold by some EVAPCO distributors.

System Data

A Clearwater sales agent, reportedly an EVAPCO distributor, designed a water treatment program based on a "Dolphin" NCD, for treatment of a HVAC cooling tower/chiller system at a newly constructed Phoenix, AZ, company headquarters building. At the time of our site review, the system had been in operation approximately two (2) years. We were invited to review the system due to concerns by the mechanical contractor for the installation as to observed excessive corrosion, deposition, and scaling in the cooling towers and chiller condensers.

Two (2), 125 ton capacity, EVAPCO AT series counter flow cooling towers are used to provide cooling for the condensers of two chiller units. Typical load is one unit base, one unit in reserve. System metallurgy is galvanized steel, stainless steel (tower basins), black iron piping, copper tubes, and some brass valves. **The Dolphin NCD was specified by the owner for the water treatment program based on his desire to be more "green", or environmentally friendly, than a "typical" chemical water treatment program.**

A conductivity based blowdown control was installed for control of concentration cycles while a hydrocyclone was installed on the cooling tower system for control of suspended solids. Makeup water is obtained from the City of Phoenix with the reported analytical data being typical for this area. Note that City of Phoenix water quality varies substantially area to area, and with time, due to use of local source wells.

Claims Made

The Dolphin WEB site was reviewed in October, 2006, for current claims. We found under the cooling tower "Fact Sheet" that this NCD "prevents mineral scale – controls bacteria – inhibits corrosion". Also noted were statements that one could "Gain green building tax credits and reduce toxic release inventory." and "Eliminate biofilm as a breeding ground for microbial life and Legionella amplification." We also discovered on the "Operating Principals" pages that the unit is no longer claimed to be biocidal, just bacteriostatic, and that the primary mode of operation is basically coagulation of microorganisms via calcium carbonate precipitation in the cooling system. A secondary claim is that the magnetic field generated by the NCD causes sub-lethal injuries to bacteria passing through the field.

History
The Dolphin unit was installed concurrent with construction of the building with start-up in 2004. Operation has continued since using only the installed NCD system for treatment of the cooling water. We have confirmed, as of October, 2006, that the building owner still holds the opinion that the NCD program is providing acceptable results, in spite of the severe corrosion, deposition, and scale problems noted during our review of the cooling system. Permission to take photos and additional samples was refused at this time by the owner and we were informed that some remedial action was on-going.

Review
PCT personnel visited the site on April 23, 2006, to walk the system and examine the cooling towers. The site visit was at the request of the mechanical contractor due to concern about obvious scale and corrosion problems. During the visit, our personnel observed substantial corrosion, deposition, and scaling in the cooling towers and chillers. A significant amount of deposition (sludge) was present in the cooling tower basins while the chillers had hard scale deposits present. Samples of the deposits from both chiller condensers were obtained for analysis. The cooling towers were observed to be suffering from extreme white rust, accelerated corrosion of the galvanized steel. Samples of makeup and cooling waters from the cooling tower system were obtained. Due to the owner withholding permission, no pictures were obtained of any system components.

Analytical Results
All obtained samples were analyzed by Analytical Services, Inc., a state and ISO certified laboratory, with the following results reported.

"Dolphin" Treated Cooling Tower System Water Analysis

Parameter	Makeup water	Cooling tower water	CT/MU - cycles
pH	7.7	7.8	
total alkalinity as mg/l CaCO3	130	120	0.92
conductivity as mmhos	1166	1538	1.32
calcium as mg/l Ca	89.3	96.4	1.08
magnesium as mg/l Mg	32.4	45.2	1.40
Ca/Mg ratio	2.76	2.14	-
silicon as mg/l Si	3.3	4.6	1.39
chloride as mg/l Cl	132	188	1.42
sulfate as SO4	174	365	2.10
total hardness as mg/l CaCO3	356.6	427	1.20
Saturation Index -100 F	+0.5	+0.5	

Condenser Deposits

Parameter	Condenser #1	Condenser #2
loss on ignition - %	42.5	-
aluminum - % as Al2O3	0.16	0.10
calcium - % as CaO	50.2	49.4
copper - % as CuO	1.37	5.88
iron - % as Fe2O3	1.98	1.89
magnesium - % as MgO	1.18	1.15
silicon – % as SiO2	1.19	0.99
sodium - % as Na2O	0.39	3.10
zinc – % as ZnO	0.77	-

Results reported as % on dry weight basis

Discussion

Environmental: We would first address the "green" claims made for the "Dolphin" device, which was found to be operating at a true cycles (average of magnesium, silicon, and chloride cycles) of 1.4. For comparison, we looked at a similar sized, chemically treated, HVAC cooling system in the same area as the "Dolphin" installation, which we reviewed and sampled on September 20, 2006. The following results were obtained on makeup and cooling water samples from this system.

Chemically Treated Cooling Tower System Water Analysis

Parameter	Makeup water	Cooling tower water	CT/MU cycles
pH	8.0	8.8	
total alkalinity as mg/l CaCO3	123	380	3.09
conductivity as mmhos	1102	3930	3.57
calcium as mg/l Ca	65.1	210	3.23
magnesium as mg/l Mg	27.1	87.7	3.24
Ca/Mg ratio	2.40	2.39	-
silicon as mg/l Si	2.9	10.2	3.52
chloride as mg/l Cl	132	410	3.11
sulfate as SO4	256	772	3.02
total hardness as mg/l CaCO3	274.6	887.5	3.23
Saturation Index -100 F	+0.64	+2.40	

This chemically treated system is running at a true (again an average of magnesium, silicon, and chloride cycles) cycles of 3.29 with no evidence, analytical or physical examination, of system scaling. Comparing the water usage due to the difference in system cycling, assuming an equal 120 ton load, we see that the "Dolphin" treated system would be blowing down 7,965 gpd, while the chemically treated system would be blowing down just 1,391 gpd. **In other words, the green "Dolphin" treated system will have 5.7 times as much blowdown, water wasted to sewer, than the chemically treated system.**

The chemically treated system uses a complex phosphonate – terpolymer product for scale and corrosion control, which contains no pollutants of concern and is totally biodegradable when discharged to a POTW. Stabilized bromine, the biocide in use, degrades to harmless bromide ion in the system; thus the **chemical program presents no environmental problems as to blowdown disposal or residual environmental effects.**

Scale Control: Analysis of the condenser deposit shows that the vast majority of the deposit consists of calcium carbonate, typical of scale from hardness precipitation. This conclusion is further verified by the makeup and cooling tower water analysis data, which shows a depletion of both calcium and alkalinity, as would be expected with precipitation of calcium carbonate from the cooling water. Based on this data, and the amount of scale and sludge seen in both the condensers and cooling towers, it is an obvious conclusion that the "Dolphin" device does not control scale formation with highly scaling makeup water.

Corrosion Control: While this "Dolphin" installation is typical in that no corrosion coupon rack was installed for routine corrosion rate monitoring, serious "white rust", accelerated galvanized steel corrosion, was observed on both cooling towers. This is unusual in that white rust is normally not seen with a cooling water pH below 8.2 and the pH of the cooling water when sampled was 7.8. Given previous experience with "Dolphin" installations, we believe that higher cycle operation was attempted prior to the scale problem becoming evident, which resulted in a high pH environment which caused the white rust corrosion observed. In any event, it is clearly evident from the white rust corrosion observed that the "Dolphin" had no effect on this easily chemically controlled form of corrosion.

Biological Control: Considering the "controls bacteria" and "eliminate biofilm - -" claims, we note that coagulation of bacteria during precipitation is a common CHEMICAL procedure practiced in many potable water treatment plants world-wide. Unfortunately, for cooling tower operation, one must consider control of both planktonic bacteria, which are removed by coagulation, as well as the sessile bacteria (and algae!), which are not. Sessile bacteria and algae form the biofilm in cooling tower systems, not planktonic bacteria, thus this claim does not hold up under even a simple consideration of the facts.

Any control by "sub-lethal" injury is impossible as the sessile bacteria and algae in the biofilm are stationary in the system, thus they do no pass through the NCD and cannot be exposed to any magnetic fields, or their possible effects.

Conclusions

Based on the analytical data and observed scale and corrosion; it is evident that the "Dolphin" device does not control scale formation, or white rust corrosion, with a highly scaling, alkaline makeup water.

Comparison with a similar chemically treated cooling system in the same area also shows that the "Dolphin" treated cooling system would discharge 5.7 times as much blowdown.

Thus the “green” claims made for the “Dolphin” NCD are not substantiated by actual operation when compared to an environmentally friendly chemical based program.

As there are no adverse environmental effects associated with the chemical program in use, it is apparent that the chemically treated cooling system is superior from the “green” standpoint than the “Dolphin” treated system due to a substantial reduction in blowdown resulting in less water use. A building or facility owner cannot obtain LEED credit for a system that actually uses substantially more water than alternative technology, a typical chemical treatment program, and has no demonstrated environmental benefit.

Concerning claims for control of bacteria related biofilm, review of the NCD “Operating Principals” clearly shows that it cannot affect biofilm within a cooling system. Since the “Dolphin” device cannot control biofilm, there exists a significant probability that systems using such treatment devices as their sole means of microorganism control will harbor legionella bacteria and thus present a health hazard.

On the economic side, controlled calcium precipitation within a cooling tower system could be accomplished in a much simpler, more cost effective way by simply adding sodium carbonate solution via a low cost chemical pump instead of a costly NCD, such as the “Dolphin”. While controlled calcium precipitation is not an effective water management chemistry for cooling tower use, it is commonly employed in treatment of many potable waters for scale control via hardness reduction.

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