Case History Report
"Fluidtron" Nonchemical Device
Cooling Towers

Device Evaluated

"Fluidtron Systems" electrostatic non-chemical device (NCD) manufactured by Electrostatic Equipment Company, Kansas City, MO, and marketed by several distributors, such as Dotson Sales in Phoenix, AZ.

System Data

A WalMart cold storage warehouse was started up in June, 2001. The cooling system consisted of five (5) Frick screw type ammonia compressors, remote pump set and cold well, and a single four (4) cell Evapco evaporative condenser cooling tower rated at 1100 tons. The cooling water side of the system was equipped with a conductivity type blowdown unit and a total of five (5) "Fluidtron Systems" NCD manufactured by Electrostatic Equipment Company of Kansas City, Mo. No corrosion coupon rack was found. Makeup water was untreated and drawn from the local city water supply.

History

Site personnel reported that the cooling tower was commissioned in June, 2001, using a chemical treatment program. Minimal information was gathered on this program. System operators did report that blowdown was about 6000 gpd and that there were some scaling issues.

In an effort to reduce blowdown and address the scaling issues, the chemical program was discontinued during February, 2002, and four (4) NCD were installed, one in the sump of each cell in the cooling tower. Shortly after installation, operators found scale deposition in the conductivity probe, strainer, and return line. A fifth NCD was installed in the return line to address this problem. Blowdown is automatic using the conductivity controller, setting at about 3000 mmhos, resulting in 1000 gallons average discharge per day.

Operators report that system conditions are better now, with the NCD, than when the chemical treatment program was in use.

Claims Made

Fluidtron sales literature and WEB site information claimed that the NCD "will eliminate existing scale and stop reformation", "corrosion coupon tests show our systems to perform equal to or better than chemical treatment", "breaks up biofilm", and "biostatic environment created by Fluidtron Systems will control even the most persistent, hard to kill bacteria such as Legionella". The claim is made that the NCD imparts a "charge" to particles and water passing through the device, as well as reducing the water surface tension.

We checked for a USEPA registration number, required due to the biological control claims made. No registration was found in the WEB site literature or at the USEPA.

Review
We were requested by WalMart's consulting engineers to examine the technology being used at several of their cold storage warehouses relative to problems experienced and reduction of blowdown. The above system was offered as an example of successful application of the NCD technology as no problems had been reported since conversion from chemical treatment.

Steve Morton, an experienced water treatment expert (30+ years), visited the site on October 15, 2002, to examine the cooling tower and obtain water samples. During the visit, plant personnel reported that the system was running better with the NCD in place than when the chemical program was used. Visual inspection of the cooling towers showed that there was a moderate amount of gritty calcium based scale on the drift eliminators. Shutting down one cell of the cooling tower and close examination of the tube bundles reveled about 1/16" of hard scale buildup. This type of scale buildup would not be evident on casual examination. No white rust was noted.

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

Analytical Results

Parameter	Makeup	Tower	Parameter	Makeup	Tower
pH	7.7	8.6	total alkalinity mg/l	95	615
conductivity	399	3300	calcium mg/l	14.4	12.4
magnesium mg/l	18.4	78.0	Ca:Mg ratio	0.8	0.2
iron mg/l	<0.03	<0.03	copper mg/l	<0.02	<0.02
zinc mg/l	0.079	0.009	silicon mg/l	8.2	60.8
chloride mg/l	30	325	sulfate mg/l	64	774
total phosphate mg/l	1.2	16.1	dissolved solids mg/l	268	2142
suspended solids mg/l	< 1	24	total hardness mg/l	112	352
cycles on chlorides	----	10.8	LSI 100F	-0.4	+1.2

A Fluidtron Systems control box was examined and found to contain a high voltage transformer and rectifier. Steve remarked that it was similar to many other such units he has examined in the past 30 years. Fluidtron literature indicates a power consumption of about 0.035 milliamps by the NCD.

Discussion
We would comment that the makeup water is non-scaling, saturation index (SI) of - 0.4. While the water is classed as "hard" due to a total hardness of 112 mg/l as CaCO3, 75.7 mg/l of that hardness is due to magnesium, which **typically does not form scale in cooling towers.** Thus, the makeup, as provided, has a low scale potential for cooling tower use.

When cycled up, the water does not become scaling until about 3.7 cycles and chemical treatment is not required to prevent scale formation until this cycle value is exceeded. At 10.5 cycles, close to the 10.8 cycles at which the cooling tower is actually being operated, our calculations project an SI of 2.53, which indicates severe scaling potential. The low SI, 1.2, actually found in the cooling water is caused by precipitation of calcium and alkalinity from the cooling water, which also lowers the conductivity.

This gives us a "Catch 22" situation, where precipitation lowers the conductivity, resulting in lowered blowdown, further concentrating calcium and alkalinity which then precipitate, lowering the conductivity and repeating the cycle. Thus, we have high cycles, low SI, and scale.

On review, the most startling item in the laboratory analysis is the **disappearance of calcium from the cooling water.** Based on operation at 10.8 cycles, there should be 155.5 mg/l calcium present in the cooling water; the laboratory reports just 12.4 mg/l (analysis by atomic absorption). This, coupled with the substantial change in Ca:Mg ratio between the makeup and cooling water, and the observation of scale on the tube bundle, documents that scale formation is taking place within the cooling tower.

While one would expect more scale to be present than reported by Steve given the substantial calcium deficiency, some chemical control of scaling is taking place due to the high level of phosphate in the makeup water. The 1.2 mg/l total phosphate in the makeup cycles up to 16.1 mg/l, a level higher than that carried in many cooling water chemical treatment programs.

Additional chemical control of scale is also occurring via carbonate precipitation of calcium in the bulk water due to development of an alkaline pH via cycling. This is confirmed by the finding of 24 mg/l suspended solids in the cooling water as well as noting that the makeup alkalinity has not cycled up, a good indication of removal via bulk precipitation as calcium carbonate and bicarbonate. The use of alkaline calcium precipitation as a means to control scale is a well known industry water treatment practice; it is commonly used in many boilers as the "carbonate cycle" treatment program.

Typically, we see white rust at operating pH values above 8.2. The absence of visible white rust in this system can be explained by noting the low developed alkalinity and high scale potential. White rust requires a pH above 8.2, substantial alkalinity, and clean, no scale, galvanize surfaces to become a visible problem.

The literature from the Fluidtron WEB site on the technological basis of the NCD was reviewed. Basically, it was found to be a mix of pseudo-scientific ramblings, none of which are consistent with accepted scientific principles. The key claim made is that the device establishes an "electric field" in the water being treated, thus "charging particles" so that subsequent precipitation behavior of calcium, and the water surface tension, is changed.

A simple test, checking to see if any voltage differential exists in the water being treated, will show no voltage and thus the electric field claimed does not exist. It is a fact that it is impossible to establish an electric field, shown as a voltage differential, across a conductor, and cooling water is a good conductor. In addition, to create a "charged" particle, electrons must be added, or removed; since the NCD does not supply any current (electrons) to the water, it is obvious that it cannot be "charging" anything.

Conclusions

1. The makeup water as supplied does not contain a substantial amount of scale forming minerals and in fact is non-scaling until about 3.7 cycles is reached.

2. Operation of the cooling tower above 4.5 cycles increases the pH to the point where bulk water precipitation of calcium will occur, preventing much of the calcium present from forming a hard scale.

3. A substantial amount of phosphate is present in the makeup and this known scale inhibitor chemical is helping to control scale formation within the cooling tower.

4. In spite of the above chemistry and the presence of five (5) NCD in the system, **the cooling water is severely depleted in calcium and the tube bundles have a 1/16" layer of hard scale present.**

5. The literature on the NCD presents no explanation, grounded in the laws of either physics or chemistry, showing how the NCD can provide all the benefits claimed.

6. Based on the above data and information, we conclude that the operation of the subject cooling tower system can be explained via generally accepted chemical principals and that the NCD present are doing nothing.

7. Continued operation at the high cycles found will result in additional accumulation of scale on the tube bundles, at some point this will have to be removed via chemical or mechanical means to restore heat transfer efficiency.

Reporter
Timothy Keister, FAIC CWT
Chief Chemist

ProChemTech International, Inc.
"Innovation in Water Management"
Apache Junction, AZ, and Brockway, PA
814-265-0959 www.prochemtech.com