

# Case History Report – Cooling Tower Systems Operated with Corrosive, High Alkalinity Softened Makeup Water

CHR 0309

## Problem

A large casino in Arizona was self supplied with well water for makeup to a number of cooling towers used to air condition the facility. Since ProChemTech started the water management program in 1995, the water quality from the wells had declined by June, 2006, to the point where at 1.5 to 1.6 cycles of concentration (COC) in the cooling towers the saturation index was between 2.7 and 2.8. Both water and chemical use was high due to the high blowdown rate required and scale formation in the cooling tower fill was becoming a critical issue. The following table shows some typical makeup water quality data from 1995 to 2006.

Parameter	08/14/95	08/14/98	03/16/05	06/07/06
pH	8.00	7.60	7.70	7.50
total alkalinity mg/l	170	180	340	325
conductivity mmhos	410	448	869	897
calcium mg/l	40	34	75.6	76.3
magnesium mg/l	17.2	6.7	47	44.5
silicon mg/l	7.2	8.4	15.6	14.8
chloride mg/l	34	20	45	112
sulfate mg/l	32	33	90	98
total hardness mg/l	171	112.6	382	374
SI @ 100 F	0.64	0.17	0.87	0.64

## Solution

After a discussion of various options for increasing cycles to reduce water and chemical usage while addressing the scale problem, the decision was made to convert to a ProChemTech **SofTek™** program using cation softened water as cooling tower makeup. ProChemTech supplied water softeners for the three separate cooling tower systems with installation being completed in October, 2006. The ProChemTech **SofTek** water management program was implemented following equipment installation and startup.

## System Information

The cooling tower systems consisted of three, separate galvanized steel, plastic fill cross flow units of 500 tons capacity each typically operating 24 hours per day, seven days a week with high efficiency copper tube chiller condensers running from 50 to 105% of load. The water management program uses conductivity controlled blowdown with timed biocide addition and makeup proportional chemical feed. Three place corrosion coupon racks were installed in 1997 when the systems were being operated at 3 to 4 COC. Treatment with hard water makeup consisted of a molybdate traced PBCT phosphonate and terpolymer product with azole, hydrogen peroxide was used as the biocide during this time period, 1995 to 2006.

The new ProChemTech **SofTek** water management program uses a single inhibitor product with a single oxidizing biocide, PCT 3026 - n, n, dibromosulfamate, with COC maintained between five (5) and six (6). Molybdate was replaced with **BlueTrace™** as the control tracer in the new inhibitor to reduce product cost and as a way to simplify control testing.

## Results

Following conversion to softened makeup water and SofTek water management program, the scale problem in the cooling tower fill has been completely eliminated. The following table compares makeup and cooling tower analysis results on October 2, 2006, approximately 3 months after the conversion.

Parameter	makeup water	CT #1	CT #2
pH	8.0	9.4	9.6
total alkalinity mg/l	368	1413	2738
conductivity mmhos	1098	3770	7030
calcium mg/l	<0.03	0.14	0.15
magnesium mg/l	<0.005	0.158	0.215
iron mg/l	<0.03	0.05	0.1
copper mg/l	<0.02	0.38	0.12
zinc mg/l	<0.005	0.155	0.073
silicon mg/l	12.6	41.6	81.2
chloride mg/l	76	250	425
sulfate mg/l	103	466	833
total hardness mg/l	0	1.07	1.41
cycles on conductivity		3.4	6.4
SI @ 100 F	-	0.38	0.87

As corrosion is a major concern when operating with a corrosive, cycled soft water, we are fortunate to have corrosion coupon data to compare from both before, and after, conversion to soft water makeup. The following table summarizes the average data for thirteen (13) sets of NACE corrosion coupons from operation on hard and soft water makeup.

coupon material	hard makeup - mil/yr	soft makeup - mil/yr
C1010 steel	2.52	1.01
CDA 110 copper	0.092	0.105
zinc	2.81	3.66

Steel corrosion coupon results with soft water are substantially better than the 2.52 mils/yr obtained with hard water makeup and would be considered excellent by any water management industry standard. The copper corrosion rate has increased slightly, which is likely due to the change from hydrogen peroxide to bromine as the biocide, but is still in an acceptable range. While the zinc corrosion rate has increased the most, considering the very high cycled alkalinity and pH, it is still in a very acceptable range.

In addition to completely resolving the previous scale problem while obtaining excellent control of corrosion, the **SofTek** water management program has also more than tripled the COC obtained in the cooling system from 1.5 to 5, cutting the system blowdown by a **factor of 8**, which substantially reduces water use and the cost for water treatment chemicals.

Since the conversion to soft water makeup, the casino has added a resort hotel with a large cooling tower system, which was started up on a **SofTek** water management program. Shown below is the new cooling tower system about six months after start-up.



The patented ProChemTech **SofTek** water chemistry had its beginnings in 1984, when softened makeup water was first used to address severe scale problems on recirculating cooling tower systems providing cooling water to large, very high temperature glass melting furnaces. Application of softened makeup water eliminated the scale problem, but caused severe corrosion problems. Our research on corrosion control technology to resolve this problem lead directly to the advanced corrosion control technology used today in our **SofTek** soft makeup water management programs.

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