General Services Administration
Public Buildings Service

045 | OCTOBER 2020

AWT: CONTINUOUS MONITORING AND PARTIAL WATER SOFTENING

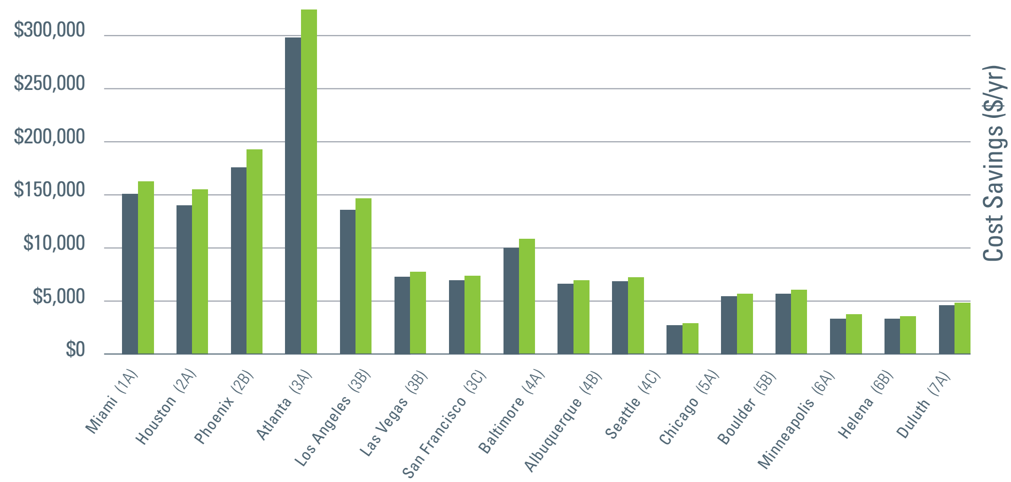
Supplemental Treatment System Saves 15% Water

Cooling towers are responsible for some of the largest potable water loads in commercial office buildings. Traditional chemical-based cooling-tower water treatment systems routinely flush, or "blowdown," as much as half their water to control mineral build-up. With rapidly rising water rates[1], GSA's Center for Emering Building Technologies (CEBT) has evaluated several alternative water treatment (AWT) technologies that can reduce blow down. The most recent evaluation of a continuous-monitoring and partial-water-softening system was conducted by the National Renewable Energy Laboratory (NREL) at the Lloyd D. George Courthouse in Las Vegas, Nevada. Unlike other AWT systems evaluated by CEBT, this one does not replace the legacy chemical-water treatment system but rather supplements it. The partial-water-softening technology consists of two components—continuous programmable logic control (PLC) monitoring and side-stream filtration with partial water softening. The PLC determines the optimal amount of blowdown required to satisfy all water chemistry targets. Side-stream filtration removes suspended matter while dispensing softened water to achieve targeted makeup-water hardness. At the testbed, researchers measured a 52% reduction in blowdown and a 15% reduction in makeup water. At GSA average water rates of $16.76/kgal and minimum load requirements, payback was under 3 years.

INTRODUCTION

Modeled Cost Savings per Cycles of Concentration (CoC)

Most water savings are achieved by a CoC of 10; 84% of the savings achieved at 30 CoC were captured at 10 CoC



Cost Savings (10 CoC)
Cost Savings (15 CoC)

"Not needing to change our water treatment processes made this AWT technology a very simple add-on. The system had little impact on our day-to-day operations and it saved water. We give it a thumbs up."

—Jacob Lewis
Deputy Property Manager
U.S. General Services Administration
PBS, Nevada Field Office (9PDN)

What Is This Technology?

CONTINUOUS PLC MONITORING AND PARTIAL-WATER SOFTENING

Based on optimal settings and sensor readings, the continuous PLC monitoring and partial-water-softening system automatically dispenses softened makeup water, reducing hardness, increasing target cycles, and thereby reducing blowdown. The system monitors corrosion, pH, conductivity and oxidation reduction potential (ORP). It also calculates cycles of concentration (CoC)—the ratio of solids in the blowdown water to solids in the make-up water—by which it determines the optimum amount of blowdown required to satisfy all water chemistry limits. Continuous corrosion and pH monitoring allows water chemistry treatment to be adjusted responsively to prevent excessive corrosion and scale. ORP measurements verify that the specified chemical chlorination regimen is being observed. System performance and alarms can be integrated with an existing building management system (BMS) with standard protocols, such as Modbus and BACnet, or accessed through the built-in display and internet-based interface. The integrated side-stream filtration system removes particles down to 5 microns in size. The AWT system is self-contained, mounted on a skid, and does not require remote hosting. The size of the system depends on cooling tower capacity and water condition but it can be retrofitted to any condenser water system. The technology assessed was provided by Aqualogix.

What We Did

SUPPLEMENTED TRADITIONAL CHEMICAL TREATMENT

The technology was installed in a 1,150-ton chiller plant at the Lloyd D. George Courthouse in Las Vegas, NV. Researchers established baseline data from September through October of 2018. The partial-water-softening treatment system was installed in March 2019 and monitored during 2019's peak cooling season, from July 5 to October 12, when chillers were operating on a regular basis. Blowdown and makeup water were metered, and water consumption was recorded daily for both the baseline and the testing periods. In addition, researchers assessed monthly water chemistry, corrosion rates, ease of operations and overall cost-effectiveness.

FINDINGS

15% WATER SAVINGS AND 52% REDUCTION IN BLOWDOWN The baseline CoC averaged 2.8. With the AWT system, the CoC averaged 4.2 resulting in water savings of 15% and blowdown sewer savings of 52%. In other locations, the potential for water savings could be higher, depending on the makeup water quality and baseline operations. With water that is softer or has fewer dissolved solids, operators can run higher CoCs.

WORKS ALONGSIDE TRADITIONAL CHEMICAL TREATMENT The continuous-monitoring and partial-water-softening system is used alongside traditional chemical treatment and does not significantly change plant operations. Maintenance consisted of monitoring the system to make sure it was operational and replenishing salt. Semi-annual system checks and annual instrument calibration are also required. The vendor can provide these services for a fee or train on-site staff. At the Las Vegas testbed, site personnel opted to do this work themselves, to avoid the cost of an annual maintenance contract. Currently, staff monitor performance and alarms via a built-in system display, but they are in the process of integrating data points into the facility's BMS.

ENERGY USE INCREASED The technology draws 0.883 kW per hour and at the testbed increased annual electricity use by 7,735 kWh. Some AWT systems previously evaluated by CEBT save energy by reducing scale build-up on process piping and mechanical systems. This technology monitors water quality and allows higher cycles of concentration, while limiting scaling factors through partial-softening. If scaling conditions are present, an alarm is generated, so the anti-scale chemical dosage can be checked or changed.

STRAIGHT-FORWARD INSTALLATION Installing the skid, wiring and plumbing was straightforward. The installation took two days, though existing piping made it easier. If the skid can be situated close to the cooling water supply and return piping, the slipstream piping runs are short. Because the system takes over blowdown, installation costs can also be reduced if the skid can be situated near an existing drain. The skid footprint was 40 inches square, with a height of 91 inches and a dry weight of 1,275 lbs (1,625 lbs operating weight). A separate brine tank had a 30-inch-by-30-inch footprint.

MAINTAINS WATER QUALITY There were no significant changes to water quality. Real-time monitoring could potentially increase equipment lifespan by sending alarms when conditions would lead to corrosion. Traditionally, corrosion is monitored using 90-day copper and mild-steel coupons that are sent out to a lab for analysis.

LIFE-CYCLE COST EFFECTIVE At the testbed load and local utility rates, payback was 7.5 years. The measured 1.6 million ton hour annual load at the testbed was lower than the target load of 3 million ton hours. Assuming the target load and GSA average water costs of $16.76 per kgal, the simple payback period drops to 2.6 years.

CONSIDER PROVEN AWT FOR ALL COOLING TOWERS The technology can be retrofitted to any cooling tower. Facilities are encouraged to get estimates of proven AWT technologies and choose the most cost-effective system for their location. Ongoing maintenance costs should be considered when selecting an AWT system.

Monitoring and Partial-Softening Return-On-Investment

@ 3-million ton target load and GSA average water/sewer cost of $16.76/kgal

	Partial Softening	Notes
Installed Equipment (200-1000 ton load)	$38,371	GSA discounted pricing
Annual Maintenance	$783	$250 for annual calibration, $533 for salt
Annual Energy Increase (@$0.11/kWh)	$851	7,735 kWh/yr
Water Savings (@$16.76 kgal/yr)	$16,480	938,273 kgal
Payback (yrs)	**2.6**	Payback assumes target load of 3-million ton hours. Payback at the testbed was 7.5 years based on the measured 1.6 million ton hour load and utility rate of $12.59 kgal

CONCLUSIONS

What We Concluded

SAVES WATER AND INTEGRATES WITH EXISTING O&M CONTRACTS

With rapidly rising water rates, technologies that save water are an attractive investment opportunity for GSA. The main challenge for widespread GSA deployment of AWT systems is separating those that work from those that don't and ensuring proper installation and operation. Cooling tower water treatment is a specialized niche in the building maintenance industry. To perform it properly, technicians must be knowledgeable about several subject areas, among them heating, ventilation, and air conditioning; water chemistry; and organic growth. CEBT has now completed five successful evaluations of proprietary AWT water treatment systems for cooling towers.[2] At GSA average water rates of $16.76 per kgal, all five AWT technologies had payback under 3 years. The continuous-monitoring and partial-water-softening system did not reduce blowdown as much as the four previously evaluated AWT technologies—52% reduction vs 94%-99% reduction—and it does not directly control scale and corrosion or eliminate chemical use. But through the application of partial softening, continuous monitoring and notification, the system improves standard and familiar water treatment practices and may offer an easier and more failsafe deployment opportunity for GSA facilities.

Deployment Considerations

Water savings are site-specific Sites in hot climates with long cooling seasons and long cooling-tower run times will typically have the largest water savings. Water quality also impacts performance. Locations with excessively hard water, high pH, or high TDS typically operate at lower CoCs, and have the greatest opportunity for savings. For the partial water softening system, total hardness, silica and conductivity are the primary variables impacting the potential to increase CoCs.

Majority of water savings captured at CoC of 10 Typically, CoCs for GSA facilities using traditional chemical water treatment are between 3 and 6— high CoCs are related to low levels of blowdown and vice versa— indicating that a relatively large amount of cooling-tower-makeup water is consumed as blowdown. Water savings from reducing blowdown and increasing CoCs is nonlinear, however, with the majority of makeup water savings coming from increasing CoCs from 3 to 10. The reduction in water usage starts to level off above a CoC of 15.

Cooling tower warranties may impact allowable CoC The material used to construct a cooling tower can determine the maximum CoC levels a given manufacturer allows without voiding the warranty. Stainless steel typically costs more than galvanized steel but allows for higher concentration levels of certain parameters.[3]

These Findings are based on the report, "Continous Monitoring and Partial Water Softening for Cooling Tower Water Treatment," which is available from the GSA website, www.gsa.gov/cebt

For more information, contact GSA's Center for Emerging Building Technologies cebt@gsa.gov

Footnotes

[1]Between 2014 and 2017, GSA's water rates increased 41 percent.

[2]*CEBT-proven AWT systems for Cooling Towers: Advanced Oxidation Process, Salt-Based, Chemical Inhibition, Electrochemical, Monitoring and Partial-Water Softening.*

[3]*All About Condenser Water Cycles,* Building Green, accessed May 4 2020 ((https://leeduser.buildinggreen.com/content/all-about-condenser-water-cycles-0)

Technology for testbed measurement and verification provided by Aqualogix.

Reference above to any specific commercial product, process or service does not constitute or imply its endorsement, recommendation or favoring by the United States Government or any agency thereof.