General Services Administration
Public Buildings Service

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BLOWDOWN RECOVERY SYSTEM FOR COOLING TOWERS

Supplemental Treatment System Reduces Cooling Tower Water Use by 16%

Chilled water plants use cooling towers to transfer waste heat to the atmosphere through evaporation. As water evaporates, the mineral content suspended in the remaining water becomes increasingly concentrated and is periodically flushed to minimize mineral build-up and scale, a process known as "blowdown." As a result, cooling towers are responsible for some of the largest potable water loads in commercial office buildings (28%).[1] With an average annual rate increase of 6% and droughts across the country, particularly in the West, GSA is exploring alternative water treatment (AWT) technologies that can reduce cooling tower water use.

The blowdown recovery system reduces cooling tower water use by capturing, purifying, and reusing a percentage of blowdown. Green Proving Ground (GPG) worked with researchers from the National Renewable Energy Laboratory (NREL) to assess the effectiveness of the blowdown recovery system at the Lloyd D. George Courthouse in Las Vegas, Nevada. Unlike many AWTs, the system works alongside traditional chemical water treatment instead of replacing it. Researchers found that the blowdown recovery system at the testbed reduced blowdown by 53% and overall water use by 16%. Payback was less than 3 years at the 2017 GSA average combined water/sewer rate of $16.76/kgal.

INTRODUCTION

Blowdown Recovery Return on Investment

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

	Blowdown Recovery System
Equipment (200-1000 ton load)*	$35,403
Installation**	$11,422
Annual Maintenance***	$475
Annual Energy Increase (3,541 kWh/yr @$0.11/kWh)	$390
Water Savings (1,040,400 kgal @$16.76 kgal/yr)	$17,437
GSA Average Payback (yrs)******	**2.86**
GSA Average Savings-to-Investment Ratio	**5.3**

* Includes startup; assumes $688 shipping and $1,473 for training
** Assumes no tie-in with Building Automation System
*** Includes $350 annual support, membranes replaced every 5 years ($125 per membrane).
**** Payback assumes target load of 3 million ton hours. Testbed payback was 4.8 years with1.6 million ton hour load @ $18.97 kgal

"For more than a year now, blowdown recovery combined with partial water softening has been running smoothly."

–Isaac Atay
Deputy Property Manager
U.S. General Services Administration
PBS, Nevada Field Office

What Is This Technology

RECOVERS AND PURIFIES BLOWDOWN

The blowdown recovery system optimizes chilled water system performance by capturing and purifying a percentage of the blowdown. This water is returned to the condenser water system with zero hardness. The technology incorporates sidestream filtration, carbon filtration, reverse osmosis (RO), demineralization, and a control system. Condenser water (blowdown) is ported from the discharge side of the sidestream filtration through a carbon filter to remove chlorine and then to an RO pump, where the water is pushed through permeable membranes to extract minerals. The conductivity setpoint for tower blowdown remains unchanged, and the system does not replace traditional chemical treatment. A self-cleaning unit injects antiscalant into the RO inlet water stream to prevent scaling on the membrane surfaces, extend membrane life and reduce maintenance. (This feature was retrofitted onto the testbed system partway through the evaluation period.) The blowdown recovery system, provided by Aqualogix and on the GSA Federal Supply Schedule, can be run as a standalone unit or combined with the continuous monitoring and partial water softening (PWS) system, assessed in GPG Findings #045.

What We Did

SUPPLEMENTED TRADITIONAL CHEMICAL TREATMENT

The blowdown recovery system was installed in a 1,150-ton chiller plant at the Lloyd D. George Courthouse in Las Vegas, NV. Las Vegas gets 90% of its water from the Colorado River, which is facing the worst drought in the river basin's recorded history. There were two data collection periods after the technology was installed in May 2021. The first data set was collected from June through August 2021; however, due to improper facility chemical maintenance and a water overflow from a power outage, the data was unreliable, and the evaluation period was extended from August to October 2022. Blowdown and makeup water were metered, and water consumption was recorded daily for the baseline and testing periods. In addition, researchers assessed monthly water chemistry, corrosion rates, ease of operations, and overall cost-effectiveness.

FINDINGS

53% REDUCTION IN BLOWDOWN AND 16% WATER SAVINGS The blowdown recovery system reduced blowdown by 53% and saved 16% of makeup water. Blowdown was reduced by 60% when the blowdown recovery and partial-water-softening systems ran in tandem. The vendor estimates up to a 93% reduction in blowdown when the systems are combined. Savings for the combined system will be highest for sites with hard water and moderate conductivity(e.g., less than 500 microsiemens per centimeter µS/cm]). At the testbed in Las Vegas, water total hardness was 278 ppm, and conductivity was 992 µS/cm.

WORKS ALONGSIDE TRADITIONAL CHEMICAL TREATMENT The blowdown recovery system is used alongside traditional chemical treatment, and the conductivity setpoint for tower blowdown remains unchanged. Maintaining the blowdown recovery system includes semi-annual system checks and annual instrument calibration. Annual vendor support is $350 per year plus the cost of replacing the RO membranes every 5 years. ($125 per membrane. The testbed system had 5 membranes.)

INCREASED ELECTRICITY COSTS BY $354 A YEAR The technology draws 0.404 kW per hour and, at the testbed, increased annual electricity use by 3,541 kWh; $354 at the testbed energy rate of $1.10 kWh. In comparison, the previously evaluated PWS system draws 0.883 kW per hour.

STRAIGHTFORWARD INSTALLATION Installing the skid, wiring, and plumbing was straightforward and took 2 days. The piping to and from the skid is the most variable expense, but piping runs can be short if the skid can be located close to the cooling water supply and return piping. The skid also requires a nearby drain for discharge and 120/240/480V electricity. The system is shipped in a crate that fits through a 3-ft wide door.

MAINTAINS WATER QUALITY According to the data that was gathered monthly, there were no significant changes to water quality. Alkalinity, pH, conductivity, scale (mineral deposits), corrosion rates, and overall chemical makeup were within the acceptable range defined by GSA. Chemicals and biological treatment dosages were adjusted as required.

LIFE-CYCLE COST-EFFECTIVE At the testbed load of 1.6 million ton hours and local utility rate of $18.97, payback was 4.8 years. Assuming the target load of 3 million ton hours and the 2017 GSA average combined water/sewer costs of $16.76/kgal, the simple payback period drops to 2.8 years. Sites in hot climates with long cooling seasons and long cooling-tower run times will typically have the most significant water savings.

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.

CONCLUSIONS

These Findings are based on the report, "Blowdown Recovery System for Cooling Tower Water Treatment," which is available from the GPG program website, www.gsa.gov/gpg

For more information, contact GSA's GPG program gpg@gsa.gov

Footnotes

[1] Demonstration and Evaluation of an Advanced Oxidation Technology for Cooling Tower Water Treatment, Jesse Dean, Dylan Cutler, Gregg Tomberlin, James Elsworth (NREL), December 2018

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.

What We Concluded

SAVES WATER AND INTEGRATES WITH EXISTING O&M CONTRACTS

Water/sewer rates have increased more rapidly than any other utility for GSA. In the past 10 years, they have increased more than 40%. Reducing blowdown from cooling towers is an attractive investment opportunity for GSA. GPG has completed six successful evaluations of proprietary AWT water treatment systems for cooling towers. All were shown to save water and functioned well during their evaluation periods. However, after the evaluations concluded, the two AWT systems that didn't use chemicals struggled to operate as designed and were subsequently de-commissioned. The non-chemical approach to water treatment is very different from current practice and requires changes to system operation and O&M practices. 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: heating, ventilation, and air conditioning; water chemistry; and organic growth. The alternative water treatment technologies that use chemicals improve standard and familiar water treatment practices and may offer an easier and more failsafe deployment opportunity for GSA facilities.

Deployment Considerations

Tower Performance is Location-Specific. Incoming water quality variables such as hardness, TDS, alkalinity, conductivity, seasonal changes to water quality, airborne particulate matter and local insect populations all impact cooling tower water treatment system strategies and effectiveness. These factors influence the level of biological growth, scaling, corrosivity that needs to be controlled, and the amount of particulate matter that needs to be removed.

Operational vs. Effective CoC. The operating Cycle of Concentration (CoC) remains unchanged with the blowdown recovery system, but the effective CoC is higher. Because a percentage of blowdown is returned as purified water, the concentrated water that goes to the sewer has a higher CoC. At the testbed site, the CoC increased from 2.8 to 4.9.

Consider Operations and Maintenance. Some of the other AWT systems that GPG evaluated saved more water but required more substantial changes to GSA maintenance practices.