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Capturing & REUSING

AIR HANDLER CONDENSATE

WITHOUT DIGGING UP THE CAMPUS

THE COST AND AVAILABILITY OF NATURAL RESOURCES HAS BECOME A REAL CONCERN for educational facilities worldwide. Twenty-five years ago, water was abundant in Birmingham, Alabama. However, within the past decade, especially during the last five years, water has become an expensive and scarce commodity. Factors contributing to this include summer droughts that lead to water use restrictions and intra-state legal fights over water consumption rights for the rivers flowing through multiple states.

The University of Alabama at Birmingham (UAB) has experienced rapid growth in the last decade. In addition to educating over 17,000 students annually, UAB is a major research facility and academic healthcare center. UAB has over 200 buildings with approximately 16 million square feet of space spread over 80 city blocks, taking up much of the southern half of Birmingham. With over 18,000 employees, UAB is Alabama's largest employer and the single largest contributor to Birmingham and central Alabama's economies, with a $4.6 billion annual impact.

Due to growth and expansion, UAB requires more and more water to sustain operations. The central chilled water system serves over half the campus. The buildings served by this system are critical facilities (60% acute healthcare and 40% research labs). Reliability of this system is imperative, making the supply of water to sustain system operations vital.

UAB's central chilled water system has three central plants connected to an underground closed loop distribution system.

UAB'S PHYSICAL PLANT INFRASTRUCTURE

- Centrifugal Chillers: 15 (2,000 – 4,000 tons)
- Cooling Towers: 19
- Condenser Systems: 9
- Supply: 42°F
- Return: 54°F
- PLC controlled to maximize operation and efficiency
- Central Plants: 3
- Total Capacity: 38,000 tons
- Peak Cooling Load: 28,000 tons
- Minimum Winter Load: 5,500 tons
- Distribution: 4.5 miles
- Piping: ranges from 6"– 36"
- Total Chilled Water Volume: over 1.5 million gallons
- Area Served: over 8 million ft² on chilled water loop

SUSTAINABILITY: A HIGH PRIORITY

UAB is an established sustainability innovation leader in Alabama, so any project must meet sustainable criteria. The central chilled water system is a major energy consumer, responsible for nearly one third of total campus electrical use. Alabama's heat and humidity results in heavy air conditioning need. The demand at UAB has increased with the university's growth; 2010 electrical power consumption was up 18 percent from 2006, despite effective conservation efforts.

ENERGY CONSERVATION MEASURES

Programs to reduce energy consumption were implemented for the central chilled water system:

1. Removed all three-way valves
   a. Eliminated low delta T syndrome
   b. Increased delta T, which increased overall efficiency
2. Upgraded to high-efficiency cooling towers
   a. Replaced old 78°F wet bulb towers with new high-efficiency 80°F wet bulb towers
   b. Reduced entering condenser water temperatures below design
3. Improved average chiller efficiency to 0.59 kW/ton

Existing chilled water distribution system piping could be used to move the condensate from the buildings to the main plants.

RELIABILITY IS CRITICAL

Approximately half the space at UAB (8 million square feet) employs chilled water cooling from the central chilled water system. Fifty-two of UAB's key buildings utilize this system, including critical care units and research labs.

The central chilled water system air conditioning is vital at the acute care hospital. For life-support patients in the 1,000-plus bed facility, maintaining levels throughout temperature dependent surgical suites and intensive care units is imperative. Other buildings served by chilled water include research facilities with specialized procedural labs, animal housing, and labs with research stored in freezers. Each building is connected to the distribution system with a flow meter and is billed monthly for MMBTU usage.

RELIABLE MAKEUP WATER SUPPLY IS ESSENTIAL

Alabama experiences about 100 days of extremely hot weather annually. During peak summer months, the UAB central chilled water system requires over 1.2 million gallons of cooling tower makeup water daily due to evaporative and blowdown losses. With over 86 blocks of campus, frequent droughts and subsequent water restrictions, and ongoing tri-state water rights battles, concerns about water use and conservation continue.

THE SOLUTION

UAB considered recovering and using the millions of gallons of high-quality condensate water being wasted down the drain. The main obstacle was that most of the condensate would be collected in buildings far from the cooling towers where the water was needed. Digging up the streets in downtown Birmingham to install a distribution system to pipe the air handler condensate back to the chilled water plant's cooling tower was not viable. However, a simple solution was already in place: the existing chilled water distribution system piping could be used to move the condensate from the buildings to the main plants.

ANALOGY OF A MASS TRANSIT SYSTEM

The central chilled water distribution system has long been considered solely a closed loop running throughout the campus. With their new water recovery concept, UAB viewed the central chilled water distribution system like a mass transit subway network, where people enter and exit at different locations.

Seeing the system from that perspective, the existing lines of the chilled water distribution system were already near the condensate drains and the plant cooling tower water return lines. Everything was in place near the areas where water needed to be put in and taken out.

CONDENSATE COLLECTION

Two to five small condensate recovery tanks were installed in the main mechanical room to collect the condensate water at each building in the program (the condensate drains by gravity into the tanks). Each tank has a small, standard sump pump to move the condensate to large, centrally located collection tanks, typically holding 250 or 500 gallons. These larger tanks can generally handle the condensate from two to four small tanks. Water from the large collection tanks is pumped through a filter into the main chilled water return. Water meters are on all points of feed into the chilled water return.

RELIEVING FIN WATER TO THE COOLING TOWER

At the central plant, the chilled water return line is over-pressurized by the condensate water pumped into the system at the building locations. The return line is typically maintained at 76 psig (pounds per square inch, gauge), so the control valve has a set point of 76 psig to bleed water into the cooling tower system.

As a safety precaution, the controls are programmed for the fin water control valve that relieves into the cooling towers to remain closed if any makeup pump is running. Also, there is a remote safety in place to limit pressure by stopping all condensate pumps if the pressure in the return line exceeds the set point with a maximum of 80 psig.

PROJECT CONCERNS

UAB was entering uncharted territory for condensate transport so initial concerns existed:

a. Over pressurization
b. Flooding in collection areas
c. Water chemistry changes
d. Increased maintenance

To enforce system reliability, several safeties and redundancies were installed. The high-pressure safety set point in the PLC (programmable logic controller) logic stops the remote collection pumps if the pressure builds above 80 psig. To protect against power outage or pump failure, all collection tanks and pumping tanks fail back to the drain by gravity. The discharge temperature of the water at each pumping location is monitored with RTDs (resistance temperature detectors) that indicate water is actually being pumped (a temperature increase indicates water is not flowing).

WATER CHEMISTRY CONCERNS

- Fin water is basically pure distilled water and therefore more corrosive than Birmingham city water, which was previously used as makeup.
- Fin water is "oxygen rich," having been freshly aerated at the air handler coils. This adds to the corrosion loading.
- Fin water at some air handlers is "dirty," creating a filtration need.
- Fin water is not sterile, making it important to create an effective biological control program for the chilled water that is not corrosive to the system metallurgy.
- Any chemistry used in the chilled water must be compatible with the cooling tower chemistry as the two programs comingle in the tower system.

The first two problems required a stronger corrosion inhibition package that would not rely on oxygen scavenging as a corrosion inhibition mechanism. To accomplish this UAB evaluated corrosion inhibition technology and did significant laboratory research on a proprietary blend of silicates, azoles, and polymers (patent applied for). This resulted in excellent corrosion inhibition while providing the benefit of compatibility with the cooling towers' ongoing treatment regime.

The corrosion rate for mild steel averaged less than 0.015 mpy (mils per year) and copper averaged less than 0.025 mpy. Of note is the fact these rates are better than what is normally achieved using traditional chemistries. Corrosion rates were monitored continuously using Rohrback model 9020 dual channel corrators and confirmed with corrosion coupons.

The next challenge was that the fin water at many of the air handlers was contaminated with dust, dirt, and other debris. This was resolved by installing filtration at the main collection points and filtering the water before adding it to the main chilled water distribution system. UAB used Harmsco filter bodies with Watts Co. 100 micron filter cartridges.

The final challenge was biological control for the chilled water system. Far greater quantities of water would now be added into the chilled water system without the benefit of residual chlorine (as found in city water). This water is a natural and productive breeding ground for bacteria.

Based on the projected amount of fin water to be recovered and the pass through rate to the cooling towers, traditional non-oxidizing biocides were dismissed for performance and economic reasons. Traditional halogen (oxidizing) chemistries were also rejected due to potential for increased corrosion. Chlorine dioxide (ClO_2) emerged as the preferred biological control agent. Recent advances in ClO_2 technology made this approach safe, economical, and effective. Due to the loop's size, three Pureline Model HP-10 ClO_2 generators were installed (10 lbs of ClO_2 daily). UAB selected Pureline because the units use a single chemical precursor, thereby reducing the potentially hazardous chemicals onsite.

Since ClO_2 did not have to be fed continuously to the chilled water system, excess ClO_2 was available for feed to the cooling towers, which allowed UAB to eliminate bromine feed. ClO_2 residuals were measured and controlled using 12 SensoreX low-range ClO_2 probes. One probe was installed in the main chilled water line in each of the three central plants, plus one in the cooling tower water supply line to each of nine condensers.

Biological activity in the closed chilled water systems and the three tower systems was monitored using both ATP testing and standard dip slides. Results in all systems were excellent, but to be noted are the chilled water results where, after initial control was achieved, results using both test methods were essentially below the levels of detection by the tests.

PROJECTED ECONOMIC BENEFITS

UAB calculates Return on Investment (ROI) on a "per building" basis. Fin water projects completed in the heavy research buildings have a ROI of approximately three to three and a half years. These buildings are 100 percent outside air and typically have 25 to 40 air exchanges per hour.

EXAMPLE

UAB Bevill Biomedical Research Building (ROI was calculated on water savings only)

- Area: 223,712 gsf
- Outside Air: 100%
- Condensate Collection: from five air handlers
- Peak gpm: 5
- Annual Gallons: 2+ million
- Water Cost: $3.17/ccf
- Estimated Annual Savings: $9,000
- Estimated Project Cost: $30,000
- Simple Payback: approximately 3.33 years

PROJECT ROI BONUS

The chilled water loop makeup rate is 500 gph, which totals 4,380,000 gallons/year. Previously, the makeup water came in at 65°F. Currently, the makeup demand is completely met with the recovered fin water at 45°F. This is a savings of 20 BTUs per lb, which is 730 MM BTUs annually, for another $10,000/year. Additionally, the cold water makeup to the cooling tower increases the approach by approximately one degree, resulting in additional savings.

POSITIVE RESULTS ACHIEVED

The first fin water recovery system was installed in May of 2011 in a group of research buildings. Throughout 2011, five other systems were installed. Currently, six large research buildings have fin water recovery systems in place. Since May 2011, UAB has collected 3.7 million gallons of recovered water. With just these six buildings, UAB projects to collect over 10 million gallons in 2012. By summer 2012, two more large research buildings came online, which added approximately 5 million more gallons.

Benefits of the fin water recovery system are both economic and ecological. By recovering the fin water, UAB has reduced the amount of domestic water usage and wastewater while conserving a valuable natural resource. Although the amount of collected and recycled condensate water varies seasonally, the water is most abundant during warmer months when the need for makeup to the cooling towers peaks. Furthermore, the cold condensate provides additional cooling to the cooling tower, circulating water free of cost.

As UAB's campus grows and expands so will the fin water recovery system. Future construction of new buildings will incorporate plans for a corresponding fin water recovery system during the design phase. UAB's goal is to recover over 20 million gallons of condensate annually within the next three to five years.

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