Using Wastewater for Cooling Tower Makeup

A resort hotel on the Caribbean island of Aruba used the proximity of its laundry and central chilled water plant to recover laundry wastewater as cooling tower makeup water. Because the cooling tower consumed millions of gallons of water annually (at more than $13 per thousand gallons [$3.43/1000 L]), this plan has saved about $50,200 in annual water costs.

Our design firm's initial reaction to the hotel's plan was negative. We had observed laundry water recovery systems that ranged from systems that were turned off to those that required significant operating and maintenance staff attention. In no case was 90%+ of the water recovered because washing laundry requires a significant percentage of fresh water. However, we agreed to perform an initial feasibility study for the project.

Initial Feasibility

The cooling tower's water consumption was first estimated by reviewing cooling tower makeup water meter readings. Annual consumption was estimated to be more than 10 million gallons (38 million L) of water. Laundry water consumption was calculated at 3 gallons (11.4 L) of water per pound (0.45 kg) of laundry processed. At occupancies noted in the feasibility study phase, laundry water consumption was about 6 million gallons (23 million L) per year. It was determined that most of this water could be recovered using commercial technologies already available to hotel operators. A storage tank of about 4,000 gallons (15 200 L) was needed to match the nearly constant water use of the towers, with the laundry's discharges of hundreds of gallons in short bursts during one eight-hour shift per day. In addition, cooling coil condensate could be recovered from nearby systems for use in the recovery system. A concern was expressed about the thermal load added to the cooling tower from the warm laundry water. This load was estimated to be less than 2.5% of the cooling tower capacity (peak) and much less than 1% of the tower capacity on an annual basis. Therefore, this did not appear to be significant. Heat recovery also was considered for the project. However, average water temperatures leaving the laundry (about 95°F to 100°F [35°C to 38°C]) were close to the incoming utility water temperature at about 90°F (32°C). The opportunity for recovered heat was limited. The design did include piping taps for future heat recovery. Annual water savings, net of auxiliary power and chemical costs were estimated at about $70,000 at hotel occupancies at that time. Construction costs were estimated to be $100,000 to $150,000, resulting in a payback of two years or less. Estimating costs was problematic because we had no experience with this unique combination of systems, and it appeared unlikely that a local contractor could be found to be responsible for the work. Also, the construction material of the storage tank (stainless steel, fiberglass or concrete) was not finalized at this time.

Design Phase

The engineer's preliminary design included a flow diagram, specification and questions and issues for other parties, including:

• Who would serve as the general contractor? It was determined that the hotel would serve as general contractor, since multidiscipline contractors are in short supply on the island. Fortunately, the property's staff was wellqualified for the task.

• Would the cooling tower operate properly, and would chiller tube cleanliness be affected? Chemical treatment was essential to avoid chiller and tower damage. The chemical treatment supplier reported a positive review of the design.

• What is the best material for constructing the laundry water storage tank? The engineer had limited knowledge on locally available materials. The hotel's insight into this issue was important. The choice of an on-site constructed concrete tank over a fiberglass or stainless steel tank was made based on concrete materials and installation expertise available.

• The selection of prefilters and lint removal were major concerns. An expanded metal screen was proposed in the existing trough ahead of the transfer pump suction pipe. A 177- micron vibrating screen separator was suggested to remove fibrous material upstream of the storage tank. The wastewater would then be discharged into the storage tank. The project's final design consists of several major components:
• A trash pump to transfer laundry wastewater from the waste trough to initial filtration and the storage tank.
• A 177-micron filter to remove particulate and lint.
• A 4,000 gallon (15 000 L) storage tank that serves as a flywheel with up to 500 gallon (1900 L) bursts from the laundry and the relatively constant usage of the tower.
• Chemical treatment system including biocide, anti-foam and pH control.
• A 5 micron filtration (final filter) and pump system that recirculates water through the storage tank. Water is bled off the filter discharge to supply the cooling tower.
• Recovered cooling tower makeup water is metered for diagnostics and documentation purposes.
• Alarms and controls include tank level, filter backwash, pumps' start-stop and chemicals.

Operation and Maintenance

Because the hotel served as general contractor, it was already familiar with the system design. Reviews by the hotel during design were invaluable. Examples of other operation and maintenance features include:
• Commissioning and training by the equipment vendor.
• Using commercially available filtration and controls. The hotel is familiar with similar filtration systems for water features such as fountains and pools.
• The significant involvement of the chemical treatment vendor in the design (in recommending equipment) and operations. The vendor regularly visits the property for other systems and has incorporated system chemical treatment observation for the laundry water recovery system in their scope of services.
• Metering of water use (cooling tower) and recovery has been included to monitor ongoing system performance.

Cost Effectiveness

The project has operated for nearly two years. Current operating results for the system and construction costs are summarized here:
• Water recovery rate of an average of 376,000 gallons (1.4 million L) per month, or 4,512,000 gallons (17 million L) per year.
• Annual water savings of approximately $50,200.
• Parasite costs of chemicals and electricity of $270 per month, or $3,240 per year.
• Construction costs total $126,000.
• Payback on invested capital of 2.7 years (actual, based on metered water recovery and actual costs).

Environmental Impact

The environmental impact of the project is significant. Wastewater from the hotel has been reduced by more than 4.5 million gallons (17 million L) of water per year. The project reduced facility water consumption in 2001 by about 13%. The island's wastewater treatment facility does not have to process this waste stream. Suspended solids are largely removed and treated as solid waste. A portion of the fats, oils and greases are removed in the filtering and treatment process. The remaining portion is blown through the tower chemical treatment system, ultimately imposing fewer impurities on the island's sanitation system.

Innovation

Most laundry water recovery systems recover heat only or water and heat for reuse in the laundry process. These systems typically recover 30% to 80% of the water used. Compared to other recovery systems, this project's

system recovers a higher percentage of water than commercially available systems. More than 90% of the water is recovered using our design.

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