ΔT FOR TEXAS: SMART HVAC IN HOUSTON

Pressure independent control valves proved to be a key in wringing the benefits out of smartly managed chilled water temperature, but that wasn't all. Airside energy recovery, desiccant dehumidification to eliminate reheat in operating room environments, and upgrading to ECM fan systems have all contributed to this hospital's fiscal wellness.

By David Schurk DES, CEM, LEED AP, CDSM, SFP, CWEP

Houston Methodist Hospital (HMH), the flagship hospital of The Methodist Hospital System, is located in the Texas Medical Center (TMC) in Houston. The hospital has consistently ranked as "One of America's Best Hospitals" according to *U.S. News & World Report* and, most recently, as the no. 1 hospital in Texas. Their TMC operation comprises over 5 million sq ft of patient care and research space, with a central utility plant (CUP) capable of producing 14,800 tons of chilled water capacity to help combat Houston's hot and humid summer and keep patients and staff comfortable year-round.

HMH Facility Management Services (FMS) is responsible for maintaining all aspects of buildings and grounds, not limited to mechanical systems engineering, service, and maintenance. Bruce Flaniken, P.E., manager of design and construction engineering; James Law, manager of HVAC operations and BAS; and Rusty McInnis, manager of plumbing and electrical operations all agree that this is no small undertaking. Tasked with everything from keeping systems fully functional to ensuring peak efficiency, Flaniken comments, "We are constantly under pressure to not only maintain operations, but to do so with equipment that sometimes underperforms, making our job more that of a magician than an engineer."

With typical profit margins in the single digits, Energy Star reports that every $1 a nonprofit health care organization saves on energy can have the equivalent impact on the operating margin of increasing revenues by $20. The Methodist FMS team understands the importance this can have on the hospital's bottom line and aggressively pursues ways to reduce systems energy without interfering in the deliverable of improved patient outcome and satisfaction. Flaniken has been involved in many technically challenging projects for a range of hospital facilities, including the recent installation of a cogeneration turbine serving their 1.1 million-sq-ft research institute building (a move that saved over $2 million annually in energy costs the first year of operation).

When it comes to complex energy reduction strategies Flaniken, Law, and McInnis have analyzed them all. The Methodist FMS department has also implemented an array of energy-efficiency upgrades to facilities, including the following.

- The application of airside energy recovery (in this case, SEMCO units) to precondition massive amounts of outdoor ventilation air. In health care settings which operate 24/7 year-round, both wheel and fixed-plate recovery devices can transfer large amounts of sensible and latent heat between the exhaust air stream and the incoming supply air to generate substantial utility cost savings.

The Btus that can be moved between air streams do not need to be supplied to or removed from this air by boilers and chillers. In hot and humid climates like Houston, savings can be upwards of $18,000/yr for each 10,000 cfm of ventilation air introduced to the building, with an electrical rate of $0.10/kWh and natural gas at $1.10/therm.

- Replacement of outdated and inefficient low-pressure, constant-speed centrifugal chillers with newer units utilizing R-134a refrigerant and variable-speed compressor technology (HMH selected Daikin magnetic bearing units) can reduce central plant energy consumption, with efficiency increases of as much as 0.30 kW/ton. When considering the extended chiller runtime in a hospital setting, expected energy cost savings may be upwards of $20,000/yr for each 500-tons of installed chiller capacity. Use of heat recovery chillers, which provide both cooling and beneficial heating to the building, can further improve operational savings. For the same 500-ton cooling load, a heat recovery chiller (running at full-load) producing 7,200-Mbh of hot water can generate utility cost savings of over $80/hr more than that of a combined high-efficiency electric chiller and 95% efficient natural-gas boiler.
- Hospital operating rooms (OR) may be conditioned through the use of low-temperature chillers. These chillers produce very low temperature leaving water used to help dehumidify air supplied to the space. This air must be "overcooled" in order to deeply dry it, and therefore it requires reheating to a neutral temperature in order to maintain occupant comfort. Reheat is very inefficient and contributes to one of the most wasteful energy consuming processes in a hospital environment. Upgrades using desiccant dehumidification (in this case, from Munters), producing dehumidified supply air at neutral temperatures, can help ensure healthy, sterile, and comfortable surgical environments for both patients and staff, possibly eliminating the requirement for reheat altogether. For each 50 tons of low-temp chiller/boiler capacity replaced by desiccant dehumidification, a hospital may stand to save $5,000/yr or more in utility cost.
- With the introduction of ECM (Electronically Commutated Motor) fan systems made by MAS HVAC, comes the opportunity to lower the hp penalty for transporting the millions of cfm of conditioned air delivered throughout a hospital each hour. Older AC (alternating current) fan/motor combinations may see efficiencies ranging from 50-75%, while ECM fan/motor assemblies will obtain efficiencies upwards of 86%. A 10% increase in fan-efficiency could reduce the operating cost of an air-handling system (running full speed around the clock) by as much as $9,000/yr per 100,000 cfm of air delivery capacity. In addition to efficiency improvements, the hospital may enjoy the added benefit coming from smaller AHU footprints, lower noise-generation, improved reliability and redundancy, the elimination of externally mounted VFDs, and integration simplicity.

One problem that can plague large chilled water and hot water central plants, and an issue experienced by HMH, is low return water delta-T (ΔT). Low ΔT is characterized by secondary system water that returns to a chiller or boiler (from AHU coils) at temperatures below design. An example would be a variable flow system returning 52°F water to a chiller designed to operate at 54˚F return and 42˚F supply (12˚F ΔT). If operated under these conditions with full capacity being required, an approximate 17% decrease in chilled water production would be experienced because of low ΔT. If more cooling capacity was required to meet the building load, additional chillers and pumps would need to be started, versus utilizing the already operational chiller and pumps to their fullest ability, wasting energy and possibly reducing overall plant capacity.

Low ΔT can be caused by a number of different issues that negatively affect system performance, including fouled heat transfer surfaces, water flow imbalance, and pressure fluctuations.

"Our campus struggles with low secondary chilled water ΔT which limits the capabilities of our CUP and requires additional chillers and pumps to run unnecessarily, increasing energy consumption," says Law.

He explains that Low ΔT carries penalties resulting from reduced thermodynamic performance of chillers and boilers, subpar terminal unit (coil) temperature delivery, and increased water flow, all leading to higher utility bills. Law adds "Our ultimate goal is to maximize CUP performance by optimizing the equipment, piping, pumping, and controls already installed. We've made a major financial investment, having purchased the most efficient equipment possible; now we need to tweak and fine-tune things to create a functional synergy."

With a 2015 goal to reduce energy consumption and associated carbon footprint by at least 10% over the next 12 months, the hospital's FMS team is constantly searching for high-impact opportunities to increase plant performance and reduce energy. Flaniken considers improving chilled water ΔT a viable process in helping achieve this goal.

"We see ΔTs ranging anywhere from 9°F to 14˚F where the design may be as high as 20˚F. Reduced return water temperatures like these yield a substantial performance and energy penalty that we consider unacceptable. We have targeted the improvement of low ΔT as a major action item moving forward," he said.

Methodist Hospital took big steps forward on a recent upgrade project with the installation of pressure independent control valves (PICV) on several existing AHUs that had been found to be underperforming. Law has ultimate responsibility for the hundreds of AHUs serving the hospital campus. Law remarks, "When you consider the huge impact that air delivery systems have on a hospital's energy profile, it doesn't take long to realize that if you can cost-effectively improve performance, it will have a big bang for the buck. We consider the steps we took in our upgrade initiative to have proved extremely rewarding."

One underperforming 100% outdoor AHU was singled out by Law.

"We couldn't seem to get this unit to provide properly conditioned supply air regardless of how much additional chilled water we tried to flow through the coil," he said. "Based on Houston's high summertime humidity and our need to provide deeply dehumidified air to certain areas of the facility, this unit was designed to produce leaving air at 47˚F, but unfortunately we were not getting air anywhere close to this temperature."

So FMS staff cleaned the unit's cooling coils and replaced the old chilled water control valve with a new Danfoss PICV. The combination of removing dirt from the coil surfaces and installing the new Danfoss pressure independent control valve improved chilled water ΔT across the cooling coil by 63% (from 13.5˚F to 22˚F). The AHU was once again functioning properly and with additional capacity to boot.

Law remarked on the installation, "The pressure independent control valves allowed us to quickly field-calibrate each valve for precise chilled water flow without cumbersome test and balance. These valves maintain the design flow rate to the cooling coil regardless of any flow/pressure fluctuation that may be occurring elsewhere in the system. PICV ensures the coil always sees its required flow, no more, no less, and helps maintain the proper fluid temperature rise across the terminal unit. This is what helps wipe out low ΔT and improves performance in large plants like ours."

Flaniken summarizes the outcome. "We are now producing lower leaving air temperatures while reducing water flow by about 97 gpm on this one unit. We've calculated this will decrease the pumping requirement by almost 4 hp and save us around $1,600 per year in pumping cost alone. It may not seem like a big deal until you stop and consider how many units like this we have strewn over 5 million sq ft of floor space. The savings can add up pretty fast. Keep in mind this doesn't take into account the reduction in energy consumption we will experience by being able to fully load operational chillers while delaying the start of additional pumps and chillers until they are actually required."

McInnis adds, "This is something that is a big contributor in our ability to reduce operating loads and cost impacts to the electrical system, even though our needs and costs continue to increase steadily."

In closing Flaniken summarizes, "It's almost like getting a virtual pump and chiller with every valve we install because of the additional capacity we are able to get out of our existing equipment. Of course, the best outcome was that we are once again assured to be providing the temperature and humidity levels that the original design indicated would deliver the highest level of comfort for the patients and staff we serve." **ES**

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