Houston Methodist Hospital Gains Energy & Performance Benefit from Improved Chilled-Water Delta-T

David Schurk DES., CEM., LEED AP., CDSM., SFP

Director of Healthcare Accounts for Heat Transfer Solutions

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Houston Methodist Hospital (HMH), the flagship hospital of The Methodist Hospital System, is located in the Texas Medical Center in Houston, Texas. The hospital has consistently ranked as "One of America's Best Hospitals" according to U.S. News & World Report and most recently, the No. 1 hospital in Texas. Their Texas Medical Center operation comprises over 5-million square feet of patient care and research space, with a central utility plant (CUP), steam production and CHP 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.

From left: Eric Herrera, James Law and Bruce Flaniken, Houston Methodist Hospital Engineering Staff

HMH Facility Management Services (FMS) is responsible for maintaining all aspects of buildings and grounds, including, but not limited to, mechanical systems engineering, service and maintenance. Incorporated in these duties is the responsibility to recognize and implement cost-effective energy-efficiency opportunities that increase performance and reduce utility costs without interfering in the delivering of improved patient outcome and satisfaction. Bruce Flaniken, P.E., Manager of Design and Construction Engineering, Eric Herrera, MBA, Manager of Central Plant Operations, 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. With a central plant as large as this one operated by HMH, countless issues and problems arise that must be overcome on a daily basis. 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. This can make our job more that of a magician than an engineer."

One problem that can plague large chilled-water and hot-water central plants 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 operating 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 Herrera. 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. Herrera 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 goal to reduce energy consumption and associated carbon foot print 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. Bruce 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."

Underperforming central station AHU

Newly installed Danfoss Pressure Independent Control Valve

Methodist Hospital took a big step forward on a recent upgrade project with the installation of Danfoss pressure independent control valves (PICV) on several existing air-handling units that had been found to be underperforming. James 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. 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. Unfortunately we were not getting air anywhere close to this temperature," said Law. 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 air-handling unit was once again functioning properly and now with additional capacity. Law remarked on the installation, “The Danfoss 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 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 square foot of floor space; the savings can add up pretty fast. Keep in mind this doesn’t take into account the reduction in energy consumption generated by being able to fully load operational

43°F chilled water supply

After PICV = 64° F return water temperature (63% improvement)

chillers while delaying the start of additional pumps and chillers until they are actually required.” McInnis added, “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.” McInnis agrees that with typical hospital operating margins being considered, saving just one dollar in energy costs is equivalent to removing the burden of about $20 in high cost patient care that doesn’t have to be provided or collected upon. “It reduces our liability substantially,” said McInnis.

In closing Herrera adds, “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.”