MIT Tests New Energy Valve Technology at Charles Hayden Library And Reaps the Rewards of Higher Delta-T!

Low Delta-T Syndrome is a common (and costly) problem in many large facilities, especially on sprawling campuses with central chilled water plants. This was and still is the case at The Massachusetts Institute of Technology (MIT). But the problem isn't as bad as it use to be. Facility engineers within the University's Sustainability and Utility Planning are now optimistic that it will continue to improve. This is in thanks to new valve technology from Belimo that was applied to MIT's Charles Hayden Library as a beta test for a new Belimo product – the Belimo Energy Valve™. The results are promising for any large facility currently battling Low Delta-T Syndrome.

It was a serendipitous occasion in 2010 when Walt Henry, director of the Systems Engineering Group at MIT's Department of Facilities, mentioned to Marc Thuillard, Head of Research at Belimo, that the University would be interested in partnering with Belimo on some product development testing – particularly if it was a control technology that might solve some of the campus energy problems.

"Marc asked for an example of such a problem and I mentioned our problems with maintaining an acceptable difference between entering and exiting chilled water temperatures at our chilled water plant," said Henry. "I thought that a modification of some existing Belimo control valves might help."

As luck would have it, Belimo was already well on its way to developing a valve with enhanced capability to help combat Low Delta-T Syndrome, a product that would later be named the Energy Valve.

With the Energy Valve, Belimo set out to design a "smart" valve that would combine the function of an electronic pressure independent control valve that also included a flow sensor, and a return and supply water temperature sensors, along with the communications and logic capability to use these sensed values for improving coil performance. The technology would be used to optimize the heat transfer performance of individual coils by continuously monitoring the coil Delta-T and comparing this value to the desired Delta-T setpoint. If these values were not the same, or suitably close, the valve would readjust itself. Furthermore, data

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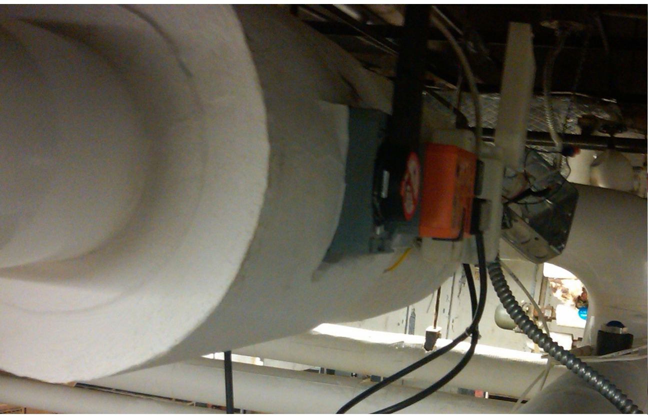


gathered at the valve would be reported back to the Building Automation System (BAS) and used for further trending and diagnostics.

It just so happened that MIT had the perfect test case opportunity for this developing technology: The Charles Hayden Library.

Why Hayden Library?

Engineers at MIT were well aware that Low Delta-T Syndrome problems were a significant energy cost to the campus. Campus wide, they determined that this problem alone was costing the campus nearly $1.5 million annually when all associated energy consumption from chillers, pumps, and cooling tower fans was taken into account.

The problem was particularly pronounced at the Charles Hayden Library where data showed that coils throughout the building had average Delta-T readings as low as 6ºF, resulting in far more water being pumped through the building than was necessary or even advantageous.

According to Henry, the library's problems were caused by a combination of several factors. First, many of buildings coils were designed with a lower Delta-T than would be done today and also because originally the building had its own chiller plant and operated under constant flow conditions. Second, many if not all of the coils had lost much of their heat transfer capacity due to fouling. Other factors might also have included oversized control valves, improper or non-dynamic water balancing, and air handling unit (AHU) control logic reliance on air sensor inputs.

According to Peter Cooper, Manager of Sustainable Engineering and Utility Planning at MIT, Hayden Library had fairly homogeneous demand patterns (i.e. no laboratories or other special demand spaces) to factor into the control scheme, making it a more straightforward test site. Plus, the library is a far distance from the chiller plant so by increasing Delta-T and thus reducing flow to and from the building, there was greater potential for energy savings.

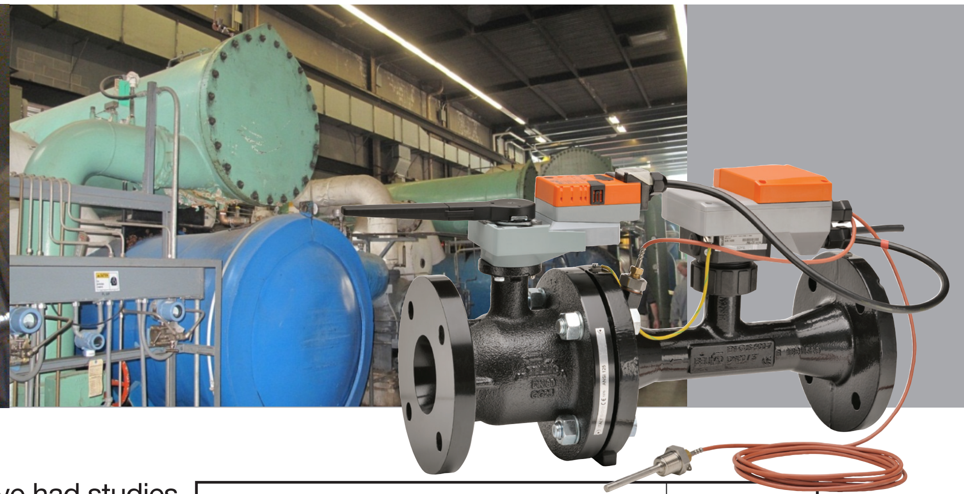
How It Works

The Belimo Energy Valve technology was retrofitted to (5) air-handling units (AHUs) at the library. Operating under this control technology, the valves eliminate the over-pumping through coils that occurs when the coil becomes power saturated – meaning that its heat transfer capability has been exhausted and any additional flow will only result in wasted pump energy.

The Energy Valve provides accurate automatic flow control through its characterizing disc, which has high rangeability and turndown ratio. The equal percentage characteristic of the disc decreases "hunting" and stabilizes system output through small, incremental changes in water flow during the first 10 to 30 degrees of valve opening—where control accuracy is most critical.

Precise pressure independent flow regulation of the valve is the result of continuous monitoring and analysis of flow and Delta-T. The Energy Valve continuously monitors the coil Delta-T and compares this value with the desired Delta-T value setpoint. Ideally these values will be the same. However, if the actual Delta-T deviates from the setpoint, the valve will readjust itself to bring it back in line. Once the appropriate Delta-T is established, the valve logic resumes its normal pressure independent operating mode.

Inherent software also monitors and can trend all sensed or calculated values, which include



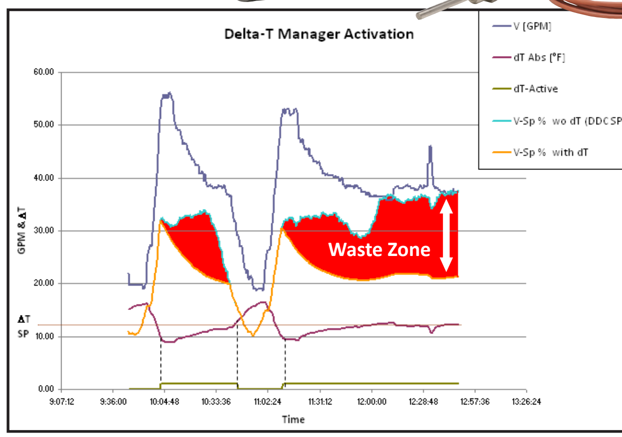
but aren't limited to water flow, return and supply water temperature, power, and energy. All of this information is reported back to the BAS via BACnet MSTP or BACnet IP where it can be used for additional trending and analysis.

Flows Cut In Half!

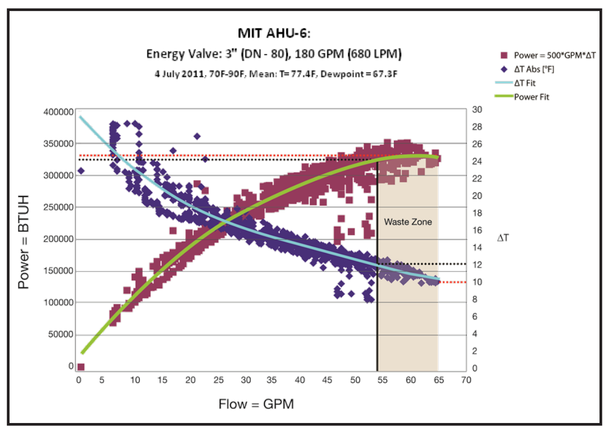
Before the retrofit, the total average Delta-T for the coils at the Hayden Library was 6.15°F, based on metering data taken from the period of August 9, 2010 thru October 9, 2010. After the retrofit, the building was metered for the exact same calendar period (August 9, 2010 - October 9) in 2011. The average Delta-T had risen from 6.15°F to 12.14°F, reducing chilled water flow to the building by 49%. This percentage is weather normalized, meaning that it has been adjusted for variances in outdoor temperature that occurred during the metered period. Thus, the 49% is an exact and accurate representation of the overall flow reduction.

What does such a reduction in flow amount to, in terms of actual energy savings for a facility like MIT? According to Peter Cooper, the savings from reducing flow and increasing Delta-T is substantial.

"We've had studies done at MIT that indicated annual savings would be as high as $1.5 million if we were able to fix all our low Delta-T issues," said Cooper. "You can save many times that much by avoiding the cost of extra chillers," he added, pointing out that better control allows you to squeeze more capacity out of existing equipment.



The beta testing at the Hayden library convinced Cooper of something else: the value of data.



"One thing that impressed us was having such intelligence right on the valve actuator," said Cooper. "You can characterize a coil's performance with just a couple of pieces of data and with that information you can observe the degradation of coils and refocus your maintenance efforts accordingly. That's very useful when you are a campus dealing with limited maintenance resources."

MIT anticipated adding more Belimo Energy Valves to other areas of the campus as they continue their battle against low Delta-T.

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