Belimo Energy Valve™ at a global technology company

Belimo and Optimum Energy Test Energy Valve's Ability to Sustain HVAC Performance

Since its establishment in 1975, Belimo has innovated a number of major developments in HVAC actuator technology and became a worldwide leader in the HVAC industry. With its partner, Optimum Energy, a member of the U.S. Green Building Council and specialists in data-driven HVAC energy optimization for campuses and large facilities, a pilot project was undertaken at the headquarters of one of Optimum Energy's Fortune 100 clients. The purpose was to test the impact of the award-winning Belimo Energy Valve on long-term sustainability by combatting HVAC system problems associated with low Delta-T.

Building type	Office Building
Project type	Evaluation Site
Trade	Technology
Products	Belimo Energy Valve

Low Delta-T Syndrome

Low Delta-T Syndrome occurs when the difference between supply and return chilled water temperatures across an Air Handling Unit (AHU) coil is less than intended design specifications, sending lower temperature return water to the chiller. This can be caused by any of a number of anomalies, such as coil degradation, fluctuating system variables, oversizing, lack of dynamic balancing and or incorrect setup of controls.

Whatever the cause, the result is the same—the HVAC system does not operate at design Delta-T. So when there is a call for more cooling, the valve at the air handler opens farther in a wasteful effort to achieve control settings. This occurrence can go on for years undetected and it often results in inefficient use of chillers and pumps.

The Belimo Energy Valve

The Belimo Energy Valve is a two-way, pressure-independent smart valve that documents and optimizes water coil performance. Through its flow meter and sensors, the proprietary built-in Belimo Delta-T Manager™ continuously measures the differential temperature between the supply and return water (otherwise known as the Delta-T) across the valve and compares it to the desired Delta-T setpoint. If the actual Delta-T drops below the setpoint, the valve readjusts itself at the coil through accurate and automatic flow control, which increases efficiency and improves performance.

Additionally, the valve has built-in BACnet capability, providing real-time, around-the-clock diagnostics and prognostics, accessible from any Internet connection, and generating reports that can be used for trending.

The Perfect Pilot

The infrastructure of the client's facility was perfect for testing. It consisted of a main building, with three AHUs and three identical wings, each with two AHUs (a total of nine AHUs). According to Ian Dempster, Optimum Energy's Senior Director of Product Innovation: "Having three identical AHUs in the main building and three identical wings provided an ideal opportunity to compare baselining and instrumenting."

The Testing Procedure

"It was, basically, a three-step process," explained Dempster. "We began by connecting flow meters and temperature sensors to all the existing valves to get baselines. We then swapped out the old valves and replaced them with Belimo Energy Valves. Then, when we brought the Energy Valves on line, with their own sensors and meters, and with the Delta-T Manager, we could immediately compare the findings and view any adjustments that were being made."

Periodically, over the course of two weeks, readings were taken and recorded at 30-second increments with the Energy Valves operating in different modes.

The Findings

The AHUs in the wings were found to be functioning properly. However, one of the AHUs in the main building was open nearly 100% of the time. According to Dempster, "the Delta-T Manager not only immediately limited the flow to almost half, but because of enhanced visibility into the system, we could determine which AHU was experiencing a problem."

Dempster explained that this particular air handler had a very large coil that was split into four sections, each with its own isolation valve. After investigation, building managers found that during maintenance, someone had left one of the isolation valves closed, preventing adequate flow. When all of the isolation valves were opened, coil efficiency and water flow returned to normal.

"This had gone undetected for nearly six years," said Dempster, "and it could have gone on for another six. Yet with real-time visibility and diagnostics, the problem was identified and fixed in under a month, ultimately leading to improved performance and less waste."

Dempster also explained that while this was the most significant problem that was found and corrected, others were observed and fixed as well. He said, "Not all of the issues were like that. In some cases, the valves were dirty, and in one instance, the discharge air setpoint for the AHU had been set to an unobtainably low setpoint. But this was automatically adjusted when the Delta-T Manager was turned on."

In another example, it was found that the old pneumatic valve on one AHU had been operating at a Delta-T of about 6° - 7°F. Once the valve was replaced with a Belimo Energy Valve, the Delta-T improved to 8° - 10°F.

"A key benefit was that, in smart mode, we didn't even have to look at the data. The problems corrected themselves", added Dempster.

Figure 1 shows the performance of a single AHU at the facility using the Energy Valve and illustrates how the Delta-T Manager was able to significantly improve its efficiency. The gray data points show how the valve performed using standard position control. When in this mode, the Delta-T Manager is not enabled and the valve is essentially operating as a conventional control valve. The orange data points stated"Flow Control" show how the valve performed using independent flow control, and finally, the orange data points stated "Delta T Manager" show how the Energy Valve performed with the Delta-T Manager enabled.

By examining the graph, it can be seen that when the Delta-T Manager was enabled, the Energy Valve used roughly 2.5 times less water to achieve 60 tons of cooling capacity than when it was mimicking a conventional control valve. Delta-T also increased from approximately 6°F in conventional control mode to 15°F using the Delta-T Manager.

Long-Term Sustainability

Ben Erpelding, Chief Technology Officer at Optimum Energy, was in charge of analyzing the data collected during the pilot program. He explained that, while in some cases, use of the Belimo Energy Valve has yielded tremendous energy and cost savings—a potential $1.5 million annually—the real lesson of this particular test was how the valve could be used as a preventative maintenance tool and its importance in creating long-term sustainability.

"In our industry, it's not only about what we can get right when the system is first installed," said Erpelding, "it's whether we can maintain it at peak performance in the years between commissioning and retro-commissioning."

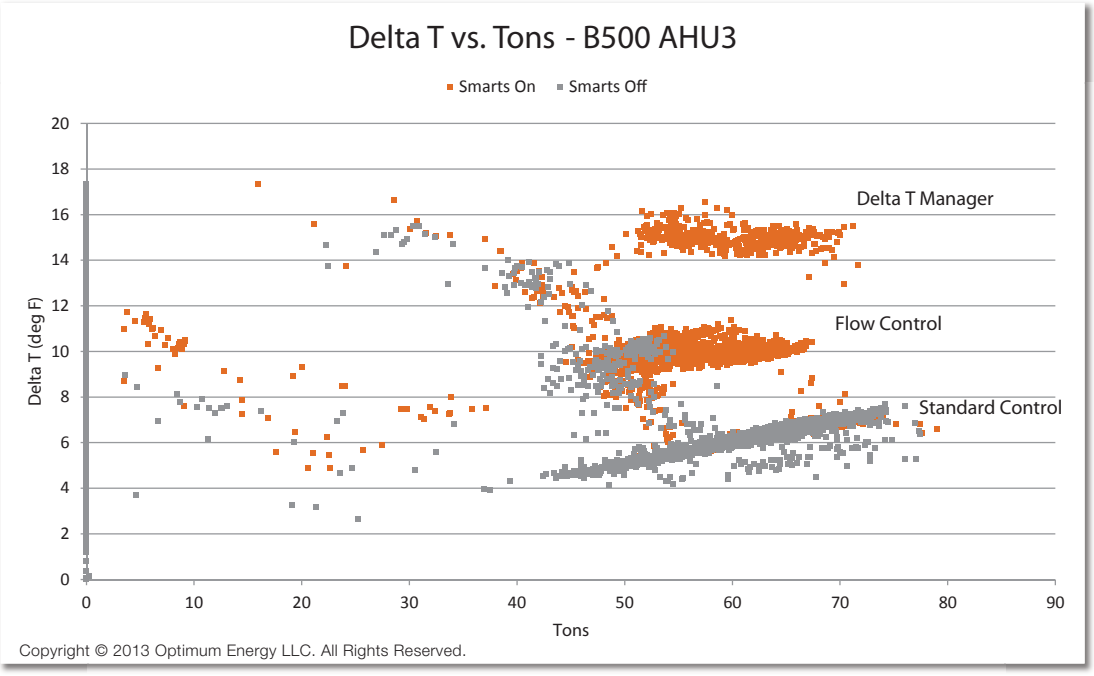
Once brought online, the Belimo Energy Valve becomes part of the "Internet of Things (IoT)". In addition to allowing facility managers to see what's happening in real-time, the Energy Valve accurately and continuously records more than 40 different data points and plots the data over a 13-month period. This enables managers to monitor trends and pinpoint when a problem occurs and when it self-corrects.

While Optimum Energy's pilot program involved retrofitting an existing building, Erpelding believes the Belimo Energy Valve also has serious potential in the new construction market. "By installing the valve in new buildings, proof that systems are working as intended is available at system start-up. The guesswork is taken out of the commissioning process. Engineers and building owners see, first-hand, that temperature, water flow, Delta-T, and other parameters are all set to their intended points. It completely aligns with the thrust toward monitoring-based commissioning."

For Erpelding and Dempster, the future of the HVAC industry is about more than reacting to problems when they occur, no matter how quickly; it's about seeing problems coming before they impact system efficiency or occupant comfort.

"As shown in this test," said Dempster, "both the diagnostic and prognostic capabilities of the Belimo Energy Valve proved to be an extremely useful tool for ensuring successful commissioning and sustaining high performance over extended periods of time."

Figure 1: Operating Mode Comparison – Courtesy of Optimum Energy



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