BELIMO ENERGY VALVE™

Johnson GEO CENTRE in St. John's, Newfoundland and Labrador achieves 18% Energy Savings

In 2002 the GEO CENTRE in St. John's, Newfoundland and Labrador, Canada opened its doors to the visitors and since then offers many attractions to explore the geological history of the region and the planet. Due to its interesting environment, in the middle of rocks, and the fact that the building usually needs to be heated and cooled at the same time, it's a very interesting place from the HVAC point of view as well. The HVAC system was continuously optimized and after about 15 years of operation, Belimo Energy Valves were installed together with VFD's for some pumps. This optimization led to energy savings in the range of 20% which saves up to C$20,000 per year.

TYPE OF BUILDING
Museum and Event Center

PROJECT
Johnson GEO CENTRE

SECTOR
Geothermal Water Source Heat Pump

PRODUCTS
Belimo Energy Valve

BELIMO

The Building

You don't even need to step inside to know the GEO CENTRE is a stunning and unique building. The GEO CENTRE is a geological interpretation centre - a twelve million Canadian dollar project that is the result of more than four years of research, planning, design, and construction. It was built in a natural rock basin that was originally filled with peat, covering glacial till and boulders. The basin was excavated and the CENTRE constructed to fit between over 152 linear meters [500 feet] of exposed rock walls. Even the building's heating system is an attraction. Six geothermal wells, each over 152 meters [500 feet] deep, were drilled to either extract heat from the deep rocks in winter or dissipate heat into them in summer. The large, glass-encased entry, standing 2.5 stories high, is the only part of the building above ground, leaving approximately 85 percent of the building's 2,970 square meters [33,600 square feet] of floor space underground.

The HVAC System

On any given day no matter what the weather is outside there can be a need for cooling in the lobby. Also being underground, the weather has little effect on the heating load. This building maintains a constant chilled water supply year round of 6° to 10°C [43° to 50°F] based on primary load of glass lobby and a constant hot water supply year round of 35° to 45°C [95° to 113°F] based on outside air temperature. All heat produced on the condenser side of the system as a by-product of producing the required cooling, as illustrated in Figure 1, is first used to maintain the hot water supply available to heat parts of building where needed (1 on diagram). Once this is satisfied, heat can be rejected to the ground (2 on diagram) through the wells and as a last resort, excess heat can be rejected through the dry cooler outside (3 on diagram). The primary goal is to waste as little heat as possible.

"The savings will be dramatic. Making the building even more energy efficient just makes economic sense.
Any dollar saved is a good dollar. We are a not-for-profit organization. So, the more money we can save on heating, cooling and lighting the building, we can put into exhibits, school programs and whatnot."

Dennis Keough, Manager, Exhibits and Facilities, Johnson GEO CENTRE

Retrofitting Energy Valves and VFD's

The system has been running already for 15 years. Recently, Belimo Energy Valves have been added to the system to improve the energy efficiency of the building and VFD's were set on 8 of the 12 pumps. With the Energy Valve's flow meter and two temperature sensors for supply and return lines, cold water supply and hot water supply pumps are controlled based on Delta T.

Energy Valves were installed on the ground source wells in which the maximum flow is limited to avoid over-pressurizing the wells. On the discharge of each of the 7 heat pumps, an Energy Valve was installed as well. The condenser loops (discharge of heat pumps) are controlled based on the ideal temperature range, allowing heat pumps to run at an efficient operating point. As the refrigerant condensing pressure follows the average condenser water temperature, the temperature control does not have to be particularly fast.

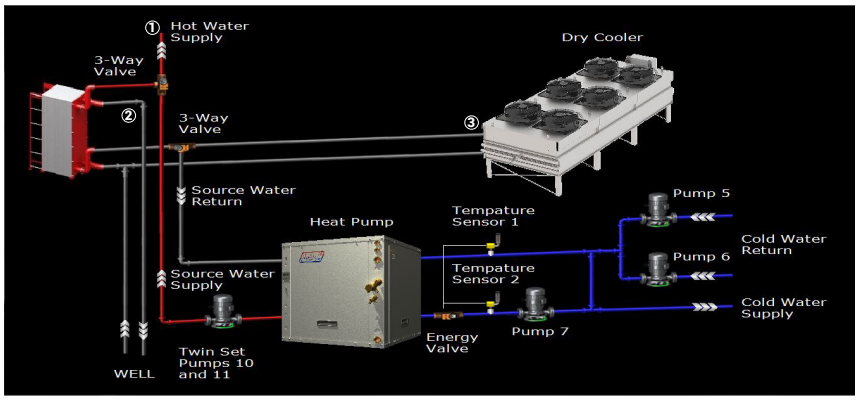


Figure 1: Diagram showing the basic setting of the plant.

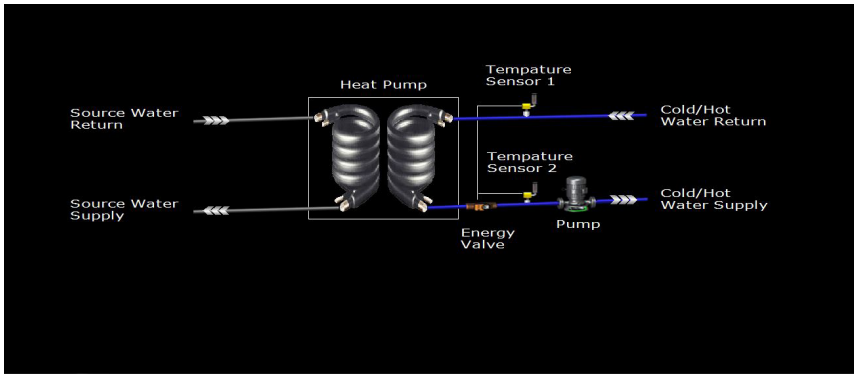
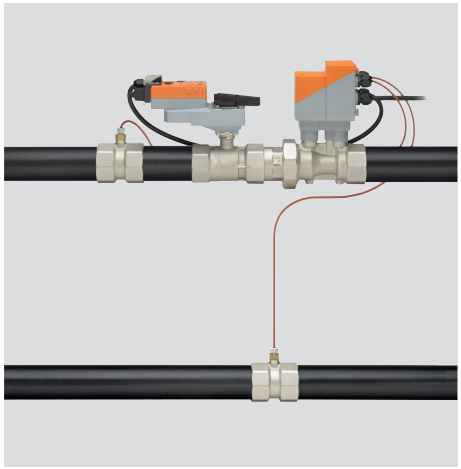


Figure 2: The inlet temperature is monitored to the internal heat exchanger and modulates flow through the heat pump to ensure optimal efficiency for current load.



BELIMO ENERGY VALVE

The Energy Valve is a pressure independent valve, that measures, controls and records coil energy by using an embedded electromagnetic or ultrasonic flow meter, along with supply and return water temperature sensors. The Belimo Energy Valve has a built-in and patented Delta T Manager logic, which monitors coil performance and reduces potential energy waste by maintaining Delta T. Two temperature sensors are matched to have a high accuracy. In addition to configurable analog input and feedback signal, it communicates with the Building Management System via various interfaces like BAC-net (MS/TP or IP), Modbus (TCP or RTU) or MP-Bus. The built-in web server simplifies commissioning, optimization and maintenance by providing web pages for configuration and data monitoring. The data logger collects up to 13 months of data that can be downloaded and used with external tools for further analysis and optimization. Some of these features contribute to LEED points. Since 2017, the Energy Valve can be connected to the Belimo Cloud in order to get access to recorded data from anywhere in the world during the whole lifetime of the product.

The Benefit

Jamie Valone, Branch Manager - Centinel Services explains the benefits of the Energy Valve as follows: "In past years, Technology wasn't able to give us this amount of data in the price point. We can use this data to make intelligent decisions to control the heat pumps more efficiently. Nothing from the original design was changed we just have more data available to make intelligent logic decisions and finally have a means of controlling the flow through each individual heat pump. There is no more capacity to this system we are just giving the heat pumps the ideal conditions to run in. The difference is that we can effectively stage down and run without trips on part load days. Where this system is going to really shine compared to the past is on shoulder seasons."

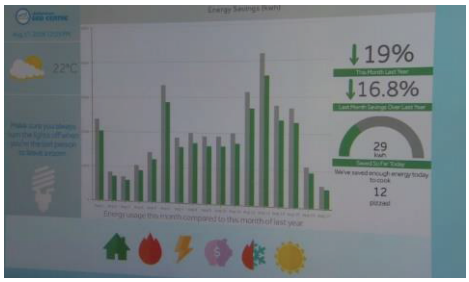


Figure 3: An interactive display at the GEO CENTRE shows visitors how heat pumps are working to save energy and money. (Glenn Payette/CBC)

It costs about C$100,000 a year to heat and light the CENTRE. Without the geothermal unit, that figure would be closer to C$160,000 a year. Together with replacing the halogen lights through LED, the GEO CENTRE's Property Manager, Dennis Keough, said "The savings will be dramatic. Making the building even more energy efficient just makes economic sense. Any dollar saved is a good dollar. We are a not-for-profit organization. So, the more money we can save on heating, cooling and lighting the building, we can put into exhibits, school programs and whatnot." Keough also said the GEO CENTRE prides itself on being an environmental steward. "We like to set an example. If we can save energy, we are not only saving money, we are saving the impact on the environment."

The new monitoring system will help to lower the cost even further. Simulations using the Kaizen system by CopperTree Analytics predict a further significant reduction of the energy costs

Conclusion

The Belimo Energy Valve plays a central role in the project. The water flow is modulated depending on the heat pump requirement. The valve now controls the volumetric flow to ensure that the return temperature remains within the acceptable pressure range of the Heat Pump. The building management is informed at all times as to whether the heat pump is working efficiently.

The energy valve does not only have a stabilizing effect on a plant through its dynamic balancing capabilities, but also has a very positive effect on the energy generation; in this example the heat pumps - in other examples the chiller or a condensing boiler. The energy savings at the Johnson GEO CENTRE were at the end of the first phase around 16.8%. After completion of the second phase of improvements (the decoupling of the pairs of heat pumps) the savings raised to 18% after part month implementation but is looking like a +22% for the upcoming month.