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Advantages of Pressure Independent Control Valves

This paper describes the advantages of a pressure independent control valve over a conventional control valve.

Introduction

Pressure independent control valves are an automatic temperature control valve and an automatic flow regulating valve packaged in one valve body. A ball valve with a characterized insert performs as a regular actuated temperature control valve, and a pressure control cartridge provides automatic flow regulation to maintain a constant flow of hot or chilled water regardless of system pressure changes. They are used in many closed loop HVAC applications.

Systems with pressure independent control valves do not need to be balanced and rebalanced during commissioning. They regulate and maintain a constant flow to the coil as water pressure in the system varies with the changing loads. This delivers better comfort, increases energy efficiency, reduces actuator operation and reduces expensive call backs. Pressure independent valves allow the system to perform better. With the right flow to each coil, boilers and chillers are most efficient.

The Importance of a Balanced System

The purpose of an automatic flow regulating valve is to ensure that each coil has the correct flow at all times and under all load conditions. An HVAC system is in balance when fluid flow through the coil is within plus or minus 10% of the design flow. If the system is not in balance, the unequal distribution of flow will create too much flow in some of the coils, and too little flow in others. Coils with inadequate flow rates will not condition adequately. Coils with surplus flow will not perform efficiently. They will waste energy because the flow will be too high to maximize the amount of energy transferred between the water and the air flowing through the coil increase pumping energy and occupants will complain about hot and cold spots in the building.

A manual balancing valve is used to adjust actual fluid flow through each coil to design flow, with all automatic control valves open to full flow position. This is done by manually setting the balancing valves, one at a time. One valve is set, then the next valve and so on. Each time one is adjusted the system changes, so the valves that were previously balanced are no longer balanced. This is why ASHRAE recommends that each valve is set at least 3 times to obtain actual flow within plus or minus 10% of the design flow and be considered "balanced".

Problems in HVAC Systems Using Conventional Control Valves

Even after a system is manually balanced, it is only balanced at full flow position. Once any valve in the system changes position, it changes the pressure of the system and causes the system to become unbalanced and reduces efficiency. This will cause comfort issues, however it can also cause an issue known as low delta T syndrome.

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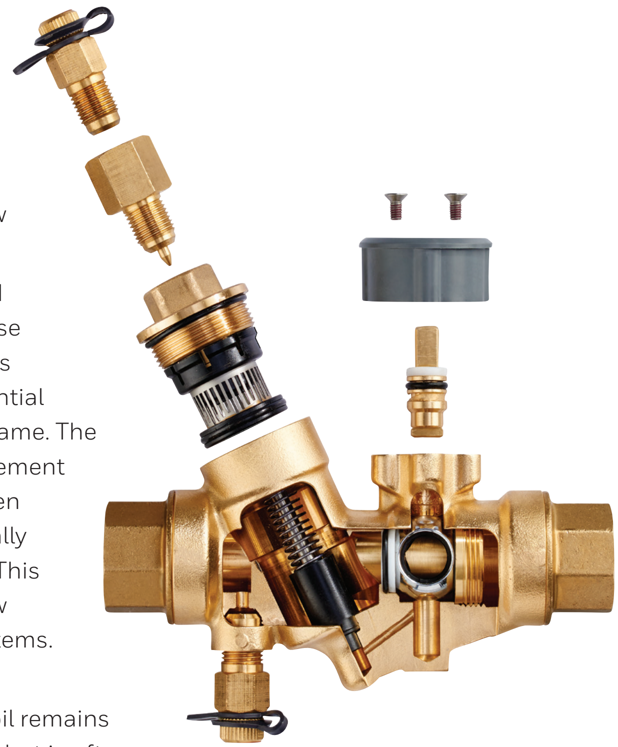

Delta T is the water temperature difference on each side of the coil. If the flow of the water through the coil is too high, it will not extract heat from the space efficiently. In the cooling mode, the return water temperature will be colder than designed because the water didn't spend enough time in the coil to have adequate heat transfer. Many of today's modern HVAC systems have variable flow pumps to save energy. Variable speed systems use less energy than constant flow systems when the pump motor is driven at slower speeds.

In theory, variable flow systems with conventional control valves should improve the delta T at the coil. However as the pressure changes in these systems, the flow through the valve will increase or decrease. This fact is evident in the basic flow formula (Flow=CV$\sqrt{\Delta p}$). As the pressure differential (delta P) increases, the flow has to increase if the open area stays the same. The only time we want to change the flow in the coil is when the load requirement changes, then the actuator should respond by changing the valve's open area. These changes in flow without a change in actuator position usually result in excessive flow, especially when calling for high coil flow rates. This will result in a low delta T in cooling and heating. Control valves with low range-ability make controlling the flow even more difficult in these systems.

Coil delta T that is lower than design delta T indicates that there is an inefficient heat transfer and the cold water that has been sent to the coil remains cold when it heads back to the chiller. This can be caused by dirty coils, but is often caused by too high of flow caused by these pressure fluctuations in the system. This increased flow causes poor cooling in the occupied space and causes the pump to work unnecessarily hard. Chillers may stage up in response to flow and not load. It could even cause the chiller to ice up. If you can control the flow to the coil by slowing it down, you can increase delta T while saving pump energy.

Low delta T also causes issues in heating systems, especially when using condensing boilers. If the energy is not completely transferred to the heating coils, the temperature of water returning to the boiler will not allow the boiler to condense. When this happens, the boiler becomes an expensive conventional boiler. These factors will increase the cost of operation and make the space less comfortable.

Low delta T also requires additional equipment to heat or cool the water since the flow-rate is so high. The flow-rate is directly related to delta T and the heat transfer in the equipment. Delta T = BTUH/(500 gpm) so if the flow-rate can be reduced, the delta T will increase so less equipment can be used to heat or cool the water. If the flow-rate is cut in half the delta T is doubled. This can result in capital expense savings since buying additional chillers or pumps can be avoided.

Valves in an inefficient system like this will frequently change position to compensate for the temperature fluctuations caused by the changes in flow. This increases wear on the valve actuators, so they may fail prematurely.

Pressure Independent Control Valve Advantages

Pressure independent control valves integrate dynamic balancing and control functions into a single product. They respond to changes in pressure in order to maintain the desired flow. The differential pressure regulator part of the valve incorporates a rubber diaphragm that is moved by pressure differential and a spring. It is exposed to the inlet pressure on one side, and the outlet pressure on the other. As the diaphragm moves, it operates a valve that keeps the pressure drop across the ball valve constant regardless of system pressure changes. The ball valve section then modulates to maintain room setpoint so the flow is varied by room demand, not by changes in system pressure.

And because the valve is both a control valve and automatic balancing valve in one, the installation is easier. There is no need to purchase and install a balancing valve and a control valve. This, in addition to no system balancing and re-balancing, saves installation costs.

Pressure independent control valves reduce first cost with lower cost, smaller, equipment capacity, and smaller piping size. They also eliminate the need for expensive and complex reverse return piping. They greatly reduce the labor of testing, adjusting and balancing. This is especially pronounced in phased projects where the entire system must be balanced again as each new phase is completed.

Valve Selection, Installation, and Maintenance

To meet various applications, pressure Independent control valves come in a wide variety of incremental flow settings. Select the correct valve for your application by choosing a valve that matches the coil design flow rate. Select the smallest valve capable of delivering this design flow rate, but round up to the next size when needed.

As with any installation it is best to use isolation valves to make maintenance easier.

Pressure independent control valves have small channels in the valve body to either side of the diaphragm. This makes good water quality important. Strainers installed before each valve are effective at removing relatively large contaminants. These strainers will also protect the system's coils and equipment. However they will not filter very tiny particles. For this it is important to ensure the quality of media with on-going water treatment and filtration with a side stream (bypass) filter. Proper commissioning includes flushing the system.

In addition, if the pump speed is controlled with a remote differential pressure sensor, the greatest savings will achieved by placing the sensor at the pressure independent control valve located furthest from the pump. This way the pump is driven to develop only the head required to support the most remote valve and coil in the system.

Conclusion

In conclusion, pressure independent control valves make installation and commissioning simpler. They deliver a constant flow even as loads change and valves in the system open and close. This reduces actuator operation and delivers better zone control. They also reduce costs and make the entire system work better because with the right flow to each coil, pumps and chillers operate efficiently.

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