FloControl knows

Minimum Flow Circulation in Variable Flow Systems

In this article we review system design strategies that ensure minimal flow circulation in HVAC systems to address branch dead leg, pump protection and the prevention of potential system vibration.

Pressure Independent Control Valves have become the most widely used valve when designing variable flow systems, delivering overall cost and energy savings.

Initially, variable flow systems were designed as an evolution of the constant flow system to reduce the running cost and the carbon footprint of commercial buildings in the UK. It was recognised that in a variable flow system differential pressures across all parts of the system would vary as control valves opened and closed in line with demand. To compensate for this, Differential Pressure Control Valves were introduced, maintaining a relatively constant differential pressure across the control valve as shown in Figure 1.

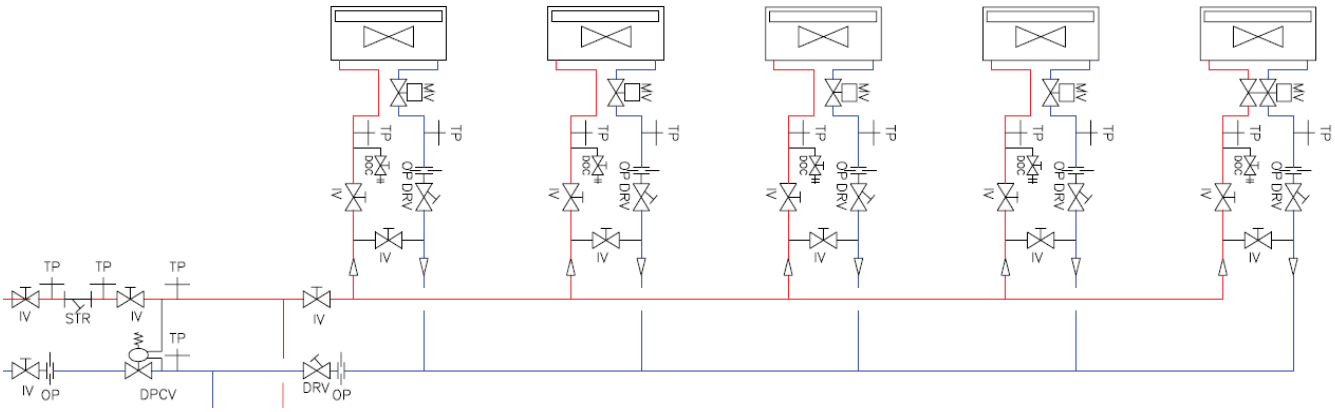

Figure 1: Typical branch with DPCV and 2 and 4 Port Control Valves (BSRIA BG2/210)

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Current approach to variable flow system design with PICV's

The Pressure Independent Control Valve is used for flow balancing, differential pressure control and temperature control in variable flow heating and cooling systems, combining these 3 functions in one valve. PICVs are being used for a variety of primary and secondary applications including air handling units (AHU), plate heat exchangers (PHE), fan coil units (FCU) and chilled beams.

The PICV is typically installed at the terminal unit replacing the traditional 2 Port Control Valve, Commissioning Valve and DPCV, removing the need for additional system balancing valves and DPCVs The PICV will operate effectively at all differential pressures between the minimum and maximum rating for the valve. Pump speed must be controlled to maintain a minimum pressure differential at a selected point (or points) in the system. The most energy efficient approach is to locate a differential pressure sensor across or close to the index sub-branch. When all the PICVs are approaching their closed positions, there needs to be some path open for flow to prevent the pump operating against a closed system. An effective end-of-line relief and low-flow-pump-protection strategy is therefore essential to prevent dead legs, poor temperature response, poor return temperature control and pipework vibration.

End Of Line Relief

The introduction of a 3 or 4 Port Valve at the end of the branch provides a continuous flow path as illustrated in Figure 2.

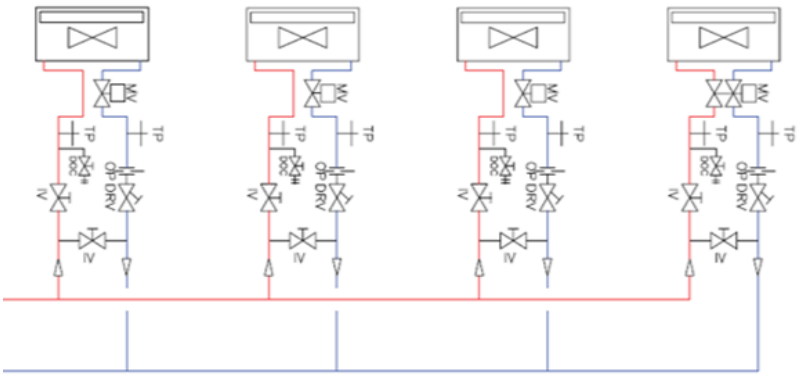

Figure 2: End of Line detail with 4 Port Control Valve (BSRIA BG2/210)

Additional 3 or 4 Port Valves are sometimes installed to ensure that at least 20% of the pump maximum capacity (pump minimum turndown) is available to avoid the pump operating against a closed head. This approach is simple and works but fails to exploit the full potential energy savings available from a well-designed variable flow system as typically only 80% of the system is under variable speed control and the branch return temperature can be adversely affected.

The issue of dead leg and low flow pump protection should be considered as separate design requirements and the system design strategy developed accordingly. This article will propose an End-Of-Line relief strategy. The strategy for the prevention of dead leg and low flow pump protection will be published next.

End Of Line Relief Strategy

There will be instances where 3 or 4 Port Valves should be designed into the system. This is largely dependent on the type of terminal unit being served, e.g. over door heaters. However, it has been found that generally all terminal units can be fitted with PICVs, with all other Commissioning Valves, DRVs or DPVCs being omitted.

At the end of each branch, a correctly sized By-Pass Valve should be fitted. It is recommended that this valve should be a dynamic constant flow valve. The Automatic Balancing Valve is ideal for this application. The Automatic Balancing Valve should have an adjustable and removable control element (insert/cartridge) to enable trouble free flushing and maintenance.

The installation of PICVs on the terminal units provide flow, temperature and pressure control in variable flow systems. Combined with an Automatic Balancing Valve as the end of line by–pass, this ensures the necessary flow passes through the system avoiding dead legs and ensuring a good temperature response. Figure 3

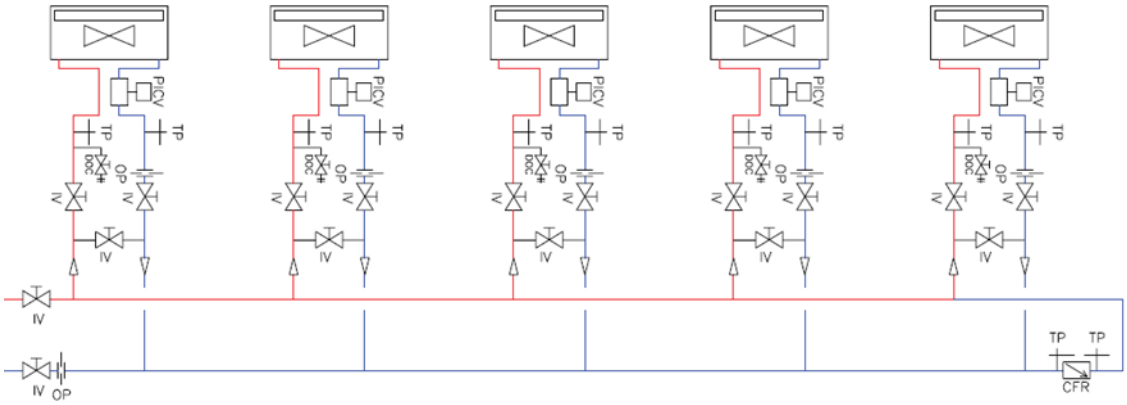

Figure 3: Branch with all PICV Control and End of Line Automatic Balancing Valve or Constant Flow Regulator (CFR) By-Pass (BSRIA BG2/210)

A correctly sized and located externally adjustable Automatic Balancing Valve as an End of Line Bypass Valve on each branch of terminal units will provide sufficient flow through the branch to maintain branch temperature when all the terminal unit valves have closed down. Set the valve to 2% of the flow rate of the branch. This flow rate setting should be kept to a minimum to avoid energy waste.

Stay tuned – we will be publishing our recommended strategy for dead leg prevention and low flow pump protection next or call our office to book an appointment with one of our experts.