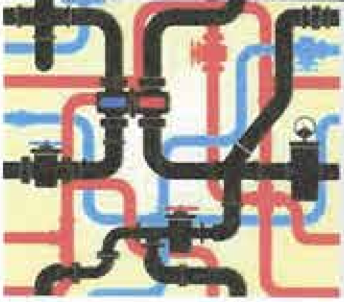

The provision of heating and air conditioning in many buildings relies on extensive systems of pipework to convey hot and chilled water. Unless the network of pipes is well designed, carefully installed and fully commissioned, the services installation will be perceived as inefficient and ineffective.

Going with the flow

Variable-flow systems have the potential to reduce pumping energy significantly, but only with the right kind of balancing valves — properly used. **Martyn Neil** of Danfoss explores the role of differential-pressure control valves in the energy performance of commercial HVAC systems.

When considering energy saving through the use of differential-pressure control valves (DPCVs) it's worth reflecting on the reasons for the rise in pressure controls in modern hydronic systems. The continuing trend towards more energy-efficient variable-flow systems has certainly played its part. One of the advantages of variable-flow over constant-flow systems is the potential to reduce pump speed and, therefore, its energy usage; reducing pump speed by 20% cuts energy consumption by 50%, and a speed reduction of 50% results in an 80% drop in energy usage.

So how does this relate to differential-pressure controls?

To answer that, let's first look at how the constant-flow system worked. This system provided a constant speed from the pump, constant flow and constant pressure. It used 3-port valves, which either delivered flow to the coils they were controlling, or bypassed an equal amount around the third port and back to the main system. A commissioning set was used to set the required flow rate. The constant flow system relied upon the kV (the size of the orifice, defined as the flow rate in m³/h at 1 bar differential pressure) and the differential pressure being constant. The commissioning sets were set to deliver a fixed kV, while the control valves were supplied with an in-built kV. At no point did the pressure change, creating a constant flow to the coil.

In early variable-flow systems, the 3-port valve was often just replaced by 2-port valves to make the pump reduce speed based on a differential-pressure sensor. The problem was that this created an issue for the balancing and control valves, because the fixed kV valves were now experiencing a variable differential pressure. So there was a constant kV and a variable differential pressure, which delivered a variable flow to the coil.

This was an issue with early solutions because what we are trying to achieve is a variable flow across the pump to reduce the energy used, but a constant flow across the coil that supplies heating or cooling to end-users. A variable flow to the outlet results in swings in temperature and a lack of control for building occupants. This was the challenge that valve manufacturers like Danfoss had to resolve; fortunately we already had a solution with the differential pressure control valve.

The DPCV keeps differential-pressure variations within reasonable limits and also makes circuits independent of one another. This enables accurate and stable modulating control, minimises noise from control valves and simplifies balancing and commissioning. The DPCV utilises a diaphragm and a spring within the valve to modulate the flow through the valve. An impulse tube is connected on the flow pipe (or before the control valve) and another impulse tube is connected to the return. An increase in pressure pushes down on the diaphragm, which throttles the valve to maintain balance.

Evidence suggests that reducing pump speed should be a primary focus in the design of current and future HVAC systems if we are to achieve further improvements in energy performance

The positioning of these valves means that whilst we create a constant flow and balance across the coil or circuit we are controlling, the pump pressure sensor is free from their influence and can reduce the energy the system uses to an even greater extent than a 2-port and commissioning-set system.

The energy saving potential of different systems was quantified in modelling by BSRIA in 'BG12/2011 energy efficient pumping systems'. A number of systems were modelled utilising differential-pressure control, pressure-independent control and reverse-return systems. When comparing a constant-flow single flow-return layout feeding valve modules, the energy used when utilising DPCVs and a remote-control sensor pump was 43% of the same system with a traditional constant speed pump, 3- or 4-port system.

The modelling also showed that a combined differential-pressure control valve, commonly called a pressure-independent control valve, with remote sensor, in a single branch flow and return layout, used 31% of the energy required by the equivalent constant-flow system. I believe these results are a clear demonstration of how a variable-flow system with differential-pressure controls can deliver significant savings for building owners, whilst providing improved comfort for occupants.

Evidence suggests that reducing pump speed should be a primary focus in the design of current and future HVAC systems if we are to achieve further improvements in energy performance. Differential-pressure control valves also have an important role to play, not only to provide balance in all load conditions and better control authority but also as energy-saving devices in their own right.

Martyn Neil is commercial product sales manager at Danfoss.