The Importance of Balancing Valves in HVAC Systems

Balancing valves are a must for constant flow water systems, but are they really needed in variable flow water systems? Read on !

By Amrish Chopra
CEO - Anergy Instruments Pvt. Ltd., Faridabad

Part 2
(Part 1 appeared in the July - Sept. '09 Issue)

My article in the last issue of July-September 2009 was about balancing constant volume water systems which were common till the energy crisis changed the thinking. To use energy efficiently, today, most HVAC projects use 2-way control valves that provide variable flow chilled water to the loads with pump-head-pressure controlled by a variable frequency pump motor drive.

This transition from constant flow to variable flow water systems, has made proportional balancing redundant. In variable flow water systems, proportional balancing satisfies the design conditions only in theory, at full-load, with all the control valves fully open, which may rarely be the case. In a dynamic system - it is out of balance the moment control valves start operating. The proponents of dynamic balancing valves (DBV) claim that whenever the change of rate of flow in one circuit disturbs the balancing, these valves in other circuits adjust their orifice to attain rebalance.

However, most of these arguments are made in isolation, and the simultaneous action of control valve and DBV is not considered. For better appreciation, it is necessary to understand the water flow control process and take a careful look at the water flows through loads in constant flow as well as variable flow systems.

The flow in any circuit or through any device can be defined by the equation :

$Q = Kv \sqrt{\Delta P}$

Q = Water flow rate - m^3/hr

ΔP = Pressure drop - bar

K_v = Flow coefficient

Kv being characteristic of the circuit or device is a constant and the equation can be simplified.

The flow in a circuit can be changed by varying the pressure drop and in a control valve, resistance to flow can be increased or decreased by changing its orifice-pass-area.

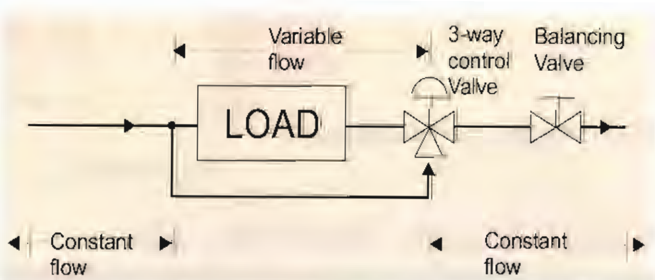

Figure 1 : Schematic of a control valve and a balancing valve in a constant flow system

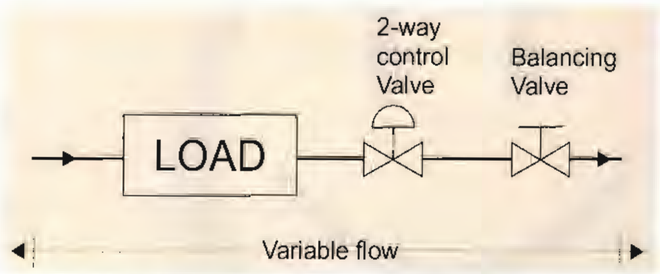

Figure 2 : Schematic of a valve installation in a variable flow system

Figure 1 shows a schematic installation of a control valve and a balancing valve near a load in a constant flow water system. In such systems, a 3-way control valve is used, and water flow through the load is varied to meet the load requirement. The remaining water flow is diverted through the bypass circuit, thus keeping the water flow rate through the balancing valve and the main circuit constant.

Figure 2 shows a schematic of a valve installation in a variable flow water system, where the control valve and balancing valves are installed in series. For any change in load, water flow changes through the whole circuit i.e.; load, control valve, balancing valve and even the pump.

A control valve is designed to vary the flow rate in a circuit by changing the flow resistance across it, whereas a dynamic balancing valve is designed to keep the flow constant, again by changing the flow resistance across it. It should not be very difficult to imagine what will happen when two such devices are connected in series.

As per the catalogue of a leading manufacturer of DBVs, "If the valve is being installed in a variable flow application, (used in series with a modulating control valve), simply select the flow rate, from the above mentioned chart, closest to the designed maximum flow rate of the circuit. The DBV will then limit the flow to that specific maximum rate. Below the maximum flow rate, the valve will act as a fixed orifice device adding minimal pressure loss to the system".

How many people can understand this technical jargon is debatable, since a lot which should have been written between the above lines is missing.

In simple layman's language what it means is that the dynamic balancing valve works only till the time the control valve is fully open, i.e., when the load is 100%. And it is well known that plants do not operate at full capacity for more than 3% - 5% of the total time.

continued on page 128

Control Nuggets *continued from page 122*

The Importance of Balancing Valves...

Assume a system with multiple loads, which has just been started. All control valves are fully open and dynamic balancing valves are controlling the maximum flow rate through each circuit. After some time, after overcoming the initial load, a control valve starts closing down to reduce water flow rate through it by increasing the pressure drop. The DBV being connected in series detects this reduction in flow and immediately opens up its orifice to bring the water flow rate back to its designed value. Over to the control valve, which again tries to reduce the water flow rate by closing its own orifice but the DBV counter acts by opening its orifice, and this struggle continues till the DBV reaches its full open position - only then does the control valve get authority over the flow rate, but by then it may have used up a lot of its stroke, leaving very little effective stroke. Reduced effective stroke results in poor rangeability/turn-down-ratio and erratic control. In some cases, the control valve may, in fact, start behaving as an ON/OFF control instead of modulating control.

To summarise, in variable volume water systems, static balancing valves have little use, and dynamic balancing valves create more problems than they solve.

To overcome the shortcomings of DBV, many manufacturers have come up with dynamic balancing-cum-control valves, also known as pressure independent control valves or Δp control valves. But, are these valves really helpful and worth their cost? More on that in the next issue. ❖