FloControl knows

VALVE AUTHORITY
DEFINITION AND RELEVANCE

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What is Control Valve Authority?

Valve authority is a term used to describe the basis on which a Control Valve is selected.

The term describes the correlation between the Control Valve resistance and the remaining circuit resistance. The basic principle is: as higher the resistance (pressure drop) of the Control Valve, as more impact (authority) the Control Valve has on the flow rates and vice versa.

To calculate the authority, the pressure drop across the Control Valve in fully open position has to be considered, as the pressure drop across the valve is at its minimum in the fully open position. This value is represented as (ΔPv).

When the Control Valve is closing, it will gradually overtake the pressure drop of other devices installed in the circuit. Only when the pressure drop of the circuit, including the Control Valve, is increased, the flow across the circuit will decrease. When the flow reaches 0, the full pressure drop of the system is transferred to the Control Valve – this value is defined as ($\Delta Pv + \Delta Pc$).

The conventional definition of Control Valve Authority (N) is a measure of how much of the systems pressure drop is provided by the Control Valve and is generally defined as the ratio of the pressure drop across the fully open Control Valve (ΔPv) and pressure drop across the rest of the circuit (ΔPc) plus the fully open control valve (ΔPv).

Mathematically Control Valve Authority can be represented as follows:

N = Valve fully open/Valve fully closed = $\Delta Pv/(\Delta Pc + \Delta Pv)$

ΔPv = Control Valve pressure drop in fully open position ($\Delta Pv=(Q/Kvs)^2$)

ΔPc = pressure drop across the remaining circuit, including pipes, fittings, strainer, isolation valve, DPCV and DRV

Why is Control Valve Authority important?

Authority is important to correctly size a Control Valve. It is usual practice to express this ratio in terms of a percentage which can help to understand the level of control the valve will exert within the system.

Oversized Control Valves will result in a low pressure drop, which is beneficial for the energy consumption but will adversely impact the flow control. Hence, oversized Control Valves tend to operate near to the closed position most of the time to provide any form of acceptable control.

If the Control Valve is undersized, the pressure drop across the Control Valve (ΔPv) is increased. Any movement of the Control Valve will strongly impact on the flow, providing very good control. Undersized Control Valves are generally good for control and occupant comfort but will adversely impact on the energy consumption.

Clearly, a trade off exists between the consideration of Control Valve control and pressure drop. Practical Control Valve sizing requires a balance between the two dynamics.

It is generally considered that:

- 0 – 25% Valve authority provides unstable to fair control with a low pressure drop
- 25 -50% Valve authority provides fair to good control with reasonable pressure drop
- 50%-100% Valve authority provides good to excellent control but with a high pressure drop

For practical purposes Control Valves are selected to have an authority of 35 -75% providing a fair compromise between control and pressure drop, but both should be considered together to avoid a high unacceptable pressure drop. Normally a 50% authority is targeted, which will vary depending on the availability of the Control Valve Kvs values.

Variable flow Control Valve sizing Considerations

With the emergence of the variable flow system and the Pressure Independent Control Valve (PICV Valve) authority calculations are almost a thing of the past because the PICV Valve has 100% valve authority with a constant minimum differential pressure requirement to make them function.

Despite the high authority, a Pressure Independent Control Valve is highly energy efficient. A PICV Valve combines the control, balancing & differential pressure control functions in one valve housing, eliminating the need for DPCVs and DRVs in the system.

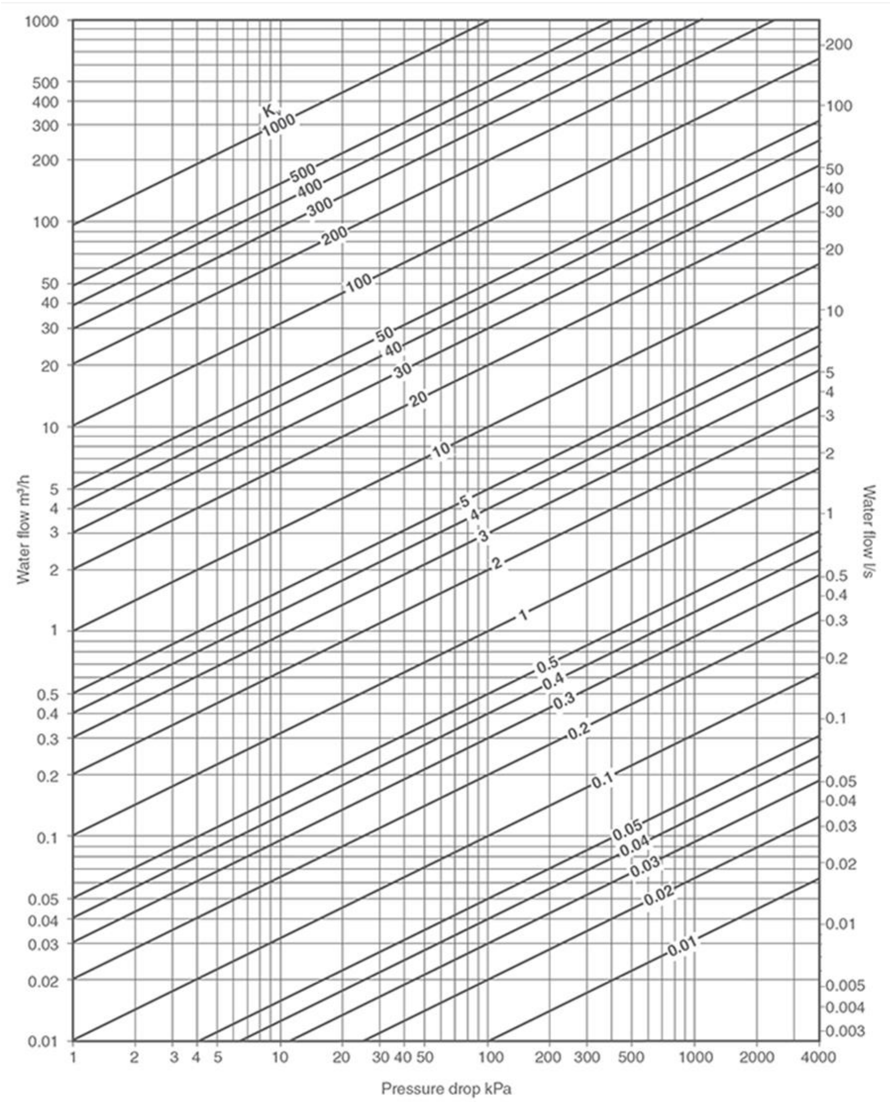
PICV Valve selection is relatively simple, only requiring the design flow rate.

However, in a variable flow system with PICVs valve authority calculations are relevant when sizing 3-Port and 4-Port Valves, for say, end of line Control Valves to provide terminal unit control plus dead leg and low flow pump protection. To correctly size a 3-Port and 4-Port Control Valve, circuit flow rate (Qc) and circuit pressure drop (ΔPc) information is required for the circuit or terminal unit to be controlled. The above information will be used to establish the required valve flow coefficient (Kvr) value for the Control Valve to size it correctly.

This can be carried out by calculation using the following formula:

Kvr [m³/h] = 36xQc [l/s] / √ΔPc [kPaD]

Or by using a graph relating flowrate, pressure drop and valve flow coefficient [Kv]:



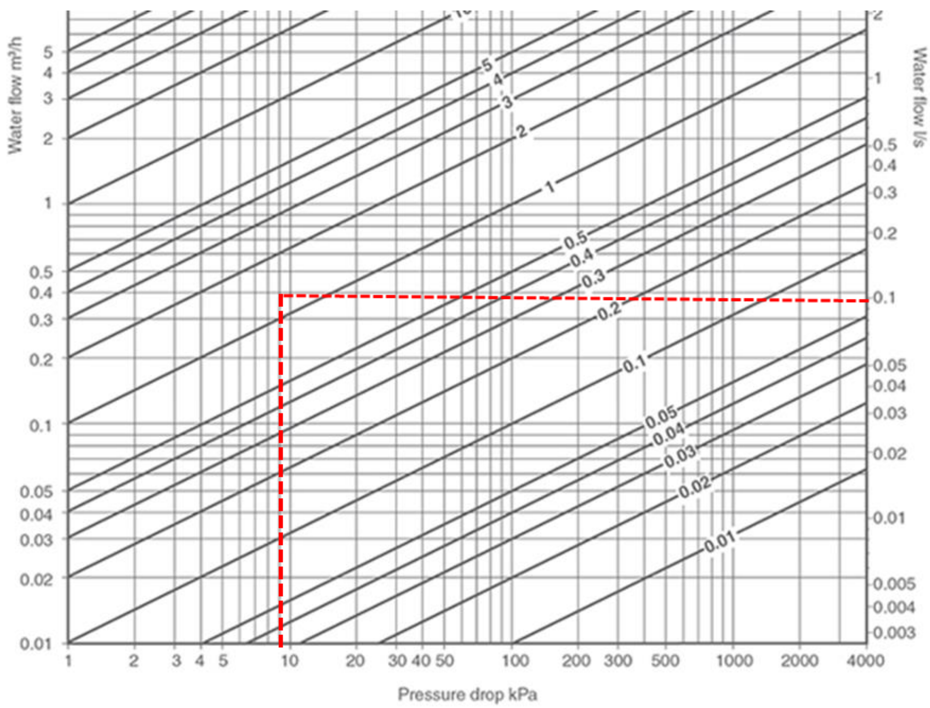
To better understand how we use the Control Valve authority calculation we will consider a relevant worked example for a 4-Port Valve to be fitted to a FCU, assuming:

- Circuit or FCU flowrate (Qc) = 0.1 l/s
- Circuit or FCU pressure drop (ΔPc) = 9kPa

By calculation:

Kvr = 36xQc/√ΔPc
Kvr = 36x0.1/√9
Kvr = 3.6/3.00 = 1.2

Or by using the graph, it can be confirmed that we require a Control Valve with a Kv value of 1.2.



However, Control Valves are only available with Kvs values, which increase in a geometric progression, called generally, a Reynard series:

Kvs: 0.25, 0.63, 1.00, 1.60, 2.5, 4.00, 6.30, 10, 16

We therefore have a choice of selecting a Control Valve with a Kvs value of either 1.00 or 1.60.

To help make the decision we can use the Valve Authority calculation.

We must first calculate the (ΔPv) for the two Control Valve options:

$$\Delta Pv = ((36xQc)/Kvs)^2$$

Option 1 with Control Valve Kvs 1.0 $\Delta Pv = ((36x0.1)/1.0)^2 = 12.96$ kPa
Option 2 with Control Valve Kvs 1.6 $\Delta Pv = ((36x0.1)/1.6)^2 = 5.06$ kPa

Corresponding Control Valve authority calculation:

$$N = \Delta Pv/(\Delta Pc + \Delta Pv)$$

Option 1 with Control Valve Kvs 1.0 Valve authority = 12.9/(9+12.9) = 58.9%
Option 2 with Control Valve Kvs 1.6 Valve authority = 5.06/(9+5.06) = 35.9%

In this instance Option 1 the 4-Port with a Kvs of 1.00 would be selected because the authority of 58.9% is in the good to excellent selection range and the pressure drop of 12.96 kPa is comparable to the circuit/FCU pressure drop.

Other Control Valve selection considerations

Valve authority is clearly an important consideration and is useful for defining the suitability of a Control Valve selection. Hopefully this article has provided an insight into this topic.

There are, however, other equally important considerations:
- Control Valve Characteristic
- Rangeability
- Turndown ratio

These will be the subject of further articles.

If you have any hydronics questions, need technical PICV know-how or want to know more about the UK's largest range of valve sets please get in touch.