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FlowCon Topic Letter

Rangeability and Turn Down Ratio

Rangeability

Rangeability is not clearly defined in regard to PICVs as PICVs hold a pre-setting element as well as a pressure independent element. The pre-setting element is often identical to the regulation element.

Controllability in control valves is related to the pre-setting and regulation element only as the control curves are created under constant differential pressure providing below mathematical reasoning:

$$Q = K_v * \sqrt{\Delta P} \rightarrow Q = K_v * \sqrt{\text{constant}} \rightarrow Q = K_v$$

Both the FlowCon Essentia, FlowCon Green, FlowCon GreEQ and FlowCon SM ranges hold a 100% linear pre-setting and regulation unit and are – according to IEC 60534 standard – considered holding high control range giving a **control range** of 1:1000.

Another definition of rangeability, which is more suitable to PICVs as it includes the pressure regulating element, is to consider the rangeability as being the ratio between the highest to the lowest flow that the valve can control without exceeding the specified limits. These limits are defined as a total tolerance, which includes both the mechanical

¹ The minimum flow rate is defined as being the smallest flow the valve can control without exceeding the specified limits. For FlowCon SM and FlowCon Essentia.0 valves, this value is defined by the mechanical tolerances and not the minimum flow the actuator can modulate to.

tolerances as well as the valve's pressure independency and hysteresis and their tolerances.

Removing the pressure related tolerances, by reviewing the valve at a specific ΔP , significantly improves the tolerances. The tolerances based on mechanical tolerances alone are defined as 5% of the minimum adjusted flow rate for the FlowCon Essentia, FlowCon Green and FlowCon GreEQ valves and 2% for the FlowCon SM range.

Another parameter to consider, upon discussing minimum controllable flow, is the actuator **resolution** as this defines how accurate the valve can be controlled by the actuator. The actuators used for the proposed valves hold a resolution of 1:100 for FN / FNP, FH and FNR actuators used for FlowCon Essentia, FlowCon Green and FlowCon GreEQ ranges and 1:1000 for SM actuators used for FlowCon SM range when using a 0-10V signal. Based on the above, the values in table 1 are interpolated.

The rangeability in table 1, has been calculated as per below example for FlowCon SM.4.2:

Maximum flow: 51.000 l/h
Minimum flow¹: 340 l/h

$$\text{Rangeability} = \frac{\text{Maximum flow}}{\text{Minimum flow}}$$

$$\text{Rangeability} = \frac{51.000 \text{ l/hr}}{340 \text{ l/hr}} = 150$$

For FlowCon Essentia.1/.2, FlowCon Green and FlowCon GreEQ, the lowest value is defined by the actuator and not the mechanical tolerance.

Model	Highest Settable Max. Flow	Lowest Settable Max. Flow	Minimum Controlled Flow	Mechanical Tolerance at Lowest Setting	Rangeability ²
	[l/hr]	[l/hr]	[l/hr]	[l/hr]	[x:1]
FlowCon Essentia.0	465	35	30	2	15
FlowCon Essentia.1	1.000	105	10	5	100
FlowCon Essentia.2	1.700	150	17	7	100
FlowCon Green.0	575	37	6	2	100
FlowCon Green.1	1.110	64	11	3	100
FlowCon Green.1HF	2.650	620	27	31	100
FlowCon Green.2	4.630	865	46	43	100
FlowCon Green.3	13.647	1.900	136	95	100
FlowCon GreEQ.0	454	17	5	1	100
FlowCon GreEQ.1	805	27	8	1	100
FlowCon GreEQ.2	2.160	850	22	43	100
FlowCon SM.1.1	2.470	633	3	13	190
FlowCon SM.2.1	8.420	1.850	9	37	228
FlowCon SM.3.0	15.000	5.310	15	106	141
FlowCon SM.3.1	27.500	9.240	28	185	149
FlowCon SM.3.2	35.600	12.800	36	256	139
FlowCon SM.4.1	33.800	12.600	34	252	134
FlowCon SM.4.2	51.000	17.000	51	340	150
FlowCon SM.4.3	72.700	13.300	73	266	273
FlowCon SM.5.1	83.800	23.300	84	466	180
FlowCon SM.5.2	106.000	25.600	106	512	207
FlowCon SM.6.2	277.000	33.100	277	662	418

Turn Down Ratio

Turn down ratio is used to describe the ratio between the maximum and minimum controllable flow in a given system. A product holding a spindle height limitation will result in limitation to its available resources and therefore have a lower turn down ratio than rangeability. E.g., a valve holding a 100:1 rangeability and sized for a specific system to utilize only 40% of its capacity, results in a 40:1 turn down ratio.

The FlowCon Essentia, FlowCon Green and FlowCon GreEQ valves – unlike most other PICVs – do not have any stroke limitation regardless of setpoint as these valves always utilize 100% of its capacity. The turn down ratio is therefore 100:1.

The FlowCon SM range is controlled by rotary actuator motion and holds a very high rangeability. When calculating the FlowCon SM's turn down ratio, actual degree rotation is divided by the maximum degree rotation. As an example, FlowCon SM.3.1 has a rotation limitation to 1.080° when selected for a max. flow of 11.600 l/hr compared to 2.160° in highest maximum flow settings. This effectively means that the valve's turn down ratio is 50%³ of its specified rangeability or full capacity or in other words 50:1 for this selected lower flow setting. If lower flow rates are required, it is recommended to select a SM.3.0 instead in order to keep turn down ratio up.

² The flow rates used to calculate the turn down ratio may contain additional decimals compared to the rounded numbers listed in the table.

³ $1.080^\circ / 2.160^\circ = 50\%$