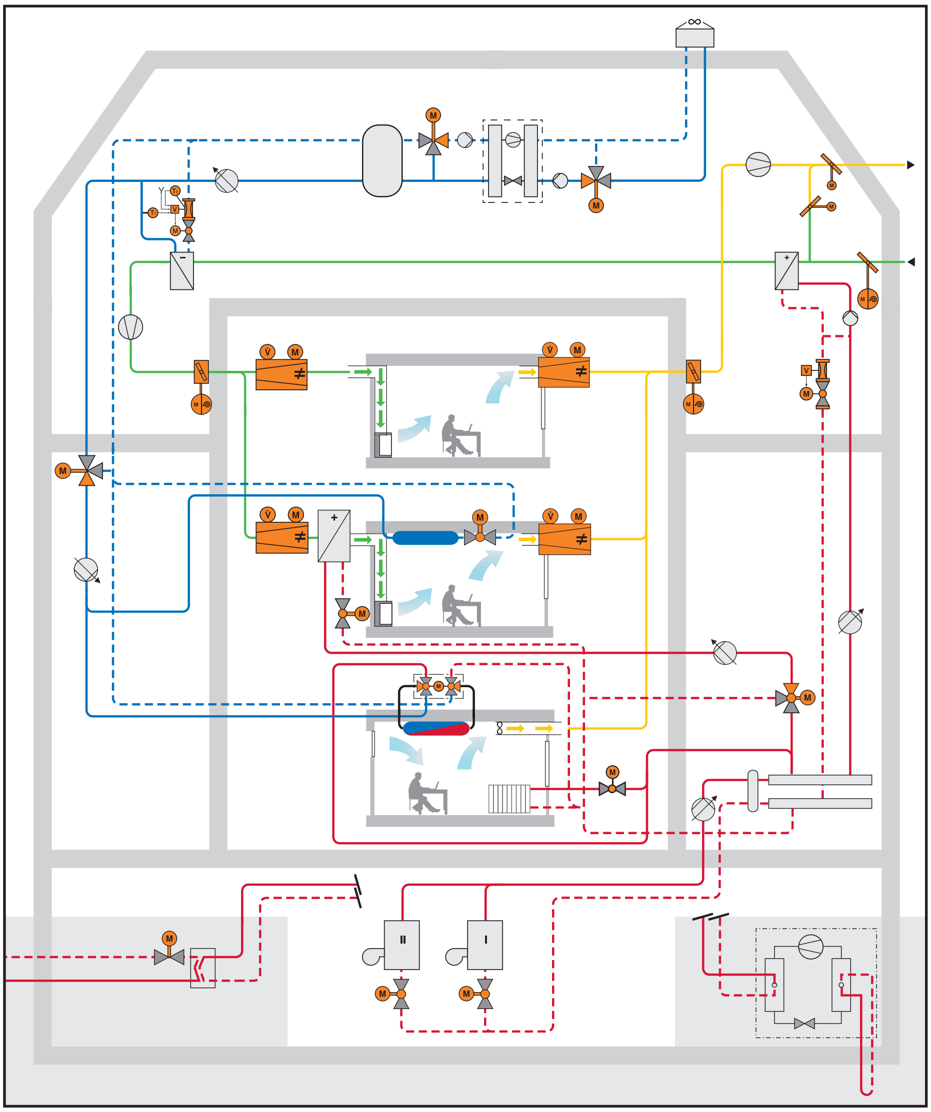


Dimensioning open-close, control and pressure-independent valves

Table of contents

Introduction

Relevant information on project planning

These notes for project planning serve as aids for the selection and projecting planning of Belimo valves.
The data, information and limit values listed on the data sheets and in the further notes for project planning for the respective valves are to be taken into account and/or complied with, respectively.
Belimo valves are suitable as open-close or control valves in heating, ventilation and air conditioning systems. It is not permitted to use Belimo valves for applications outside the specified field of application.
For project planning involving open-close and control valves, it is recommended that sufficient numbers of shut-off devices be provided for in order to simplify later revisions, e.g. of heat exchangers.

Ordering forms

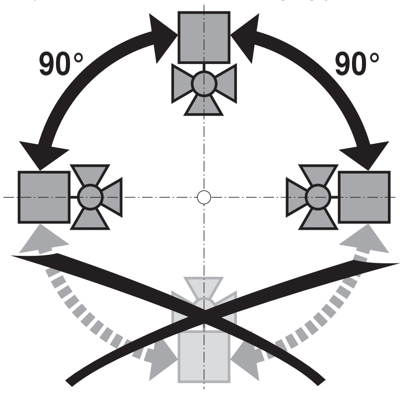
Depending on the ordering form, valves and actuators are supplied either pre-assembled or as separate items. Ordering examples of these can be found in the current Belimo Product and Price Catalogue.

Installation of the actuator on the valve

The assembling of actuator and valve can be performed without difficulty onsite in accordance with the installation instructions enclosed with the actuator.

Installation instructions

The actuators (valve-actuator combinations) may be mounted upright to horizontal. The actuator may not be installed in a hanging position, i.e. with the spindle pointing downwards.



Commissioning

Commissioning may not be carried out until after assembly and installation of the valve and actuator have been completed.

Maintenance

Belimo water final control elements are maintenance-free. Before service work is carried out on the actuator, it is essential to isolate the actuator from the power supply (by disconnecting the electrical cable). Any pumps in the part of the pipeline element concerned must also be switched off and the appropriate slide valves closed (allow everything to cool down first if necessary and reduce the system pressure to ambient pressure level). The system must not be returned to service until the valve with actuator have been mounted properly in accordance with the instructions and the pipelines have been refilled in the proper manner.

Subsequent expansion of valves

In the case of applications requiring later expansion, it is recommended that appropriate precautions be taken, e.g. the use of additional detachable pipe connectors.

Disposal

In the event of disposal, the actuator must be broken down into its different materials and disposed of in accordance with national and local regulations.

General

Dimensions
The dimension of the valve-actuator combination used is dependent not only the nominal diameter of the valve but also on the actuator used. The dimensions are listed on the respective data sheets.

Pipeline clearances
The minimum clearances between the pipelines and the walls and ceilings required for project planning depend not only on the valve dimensions but also on the selected actuator. The dimensions can be found on the respective data sheets.

Water quality requirements
The water quality requirements specified in VDI 2035 must be adhered to.

Dirt filter recommended
We recommend that a centrally installed dirt filter always be used in order that Belimo water final control elements will also be able to provide reliable control for long periods.

Dimensioning steps Open-close valves

1. Determining the k_{vs} value

- Prerequisite: Nominal diameter of the pipeline is known
- Selection of a possible valve on the basis of the nominal diameter of the pipeline (nominal diameter of valve ≤ nominal diameter of pipeline)
- The respective k_{vs} values can be found in the Belimo data sheets in accordance with the desired nominal diameter

2. Determining volumetric flow $\dot{V}_{100}$

If the thermal rating of a consumer and the associated temperature difference between supply and return are known, then the volumetric flow can be calculated with the following formula. The density and the thermal capacity of the water are taken into account as constant values with 0.86 as the factor.

$$\dot{V}_{100} = 0.86 \cdot \frac{Q_{100}}{\Delta T}$$

$\dot{V}_{100}$ [m³/h]
Q_{100} [kW]
ΔT [K]

3. Calculation of the differential pressure Δp_{v100}

$$\Delta p_{v100} = \left(\frac{\dot{V}_{100}}{k_{vs}}\right)^2 \cdot 100$$

Δp_{v100} [kPa]
$\dot{V}_{100}$ [m³/h]
k_{vs} [m³/h]

4. Selecting the suitable valve

The appropriate valve can be selected with the information from Steps 1 – 3. The following overview shows the Belimo open-close valves and references further documentation.

k_{vs} [m³/h]	0.4 ... 8	15 ... 49	8.6 ... 49	15 ... 49	0.63 ... 40	0.4 ... 320	630 ... 1000	45 ... 42800
Valve type	Zone valve	Open-close ball valves			Globe valves			Butterfly valves
Designation	QCV	Open-close ball valves	Open-close ball valves	Open-close ball valves	Globe valve	Globe valve	Large globe valve	Butterfly valve
Pipe connection	Internal thread	Internal thread	External thread	Flange	External thread	Flange	Flange	Flange
2-way	C2..Q-..	R2..	R4..	R6..R	H4..B	H6..R [1] H6..N [2] H6..S / H6..SP [2] H6..X.. [3]	H6..W..	D6..N D6..NL
3-way	C3..Q-..	R3..	R5..	R7..R	H5..B	H7..R [1] H7..N [2] H7..X.. / H7..Y.. [3] [4]	H7..W..	
DN	15 ... 20	15 ... 50	15 ... 50	15 ... 50	15 ... 50	15 ... 150	200 ... 250	25 ... 700
PN	16	16	16	6	16	6 / 16 25 / 40	16	6 / 10 / 16 [5]
Medium temperature	2 ... 90°C	–10 ... 120°C	6 ... 100°C	–10 ... 100°C	5 ... 120°C	[6]	5 ... 120°C	–20 ... 120°C
Further notes for project planning	2-way and 3-way zone valve QCV	2-way and 3-way characterised control valves			Globe valves			Butterfly valves

1) PN 6
2) PN 16
3) PN 25
4) PN 40
5) D6..N: DN 25…200: Flange PN 6/10/16;
DN 250…350: Flange PN 10/16;
DN 400…700: Flange PN 16
D6..NL: DN 50…150: Flange PN 10/16;
DN 200…700: Flange PN 16
6) 5…120°C: H6..R, H7..R, H6..N, H7..N, H6..W.., H7..W..;
5…150°C: H6..S, H6..SP, H6..X..;
5...200°C: H7..X.., H7..Y..

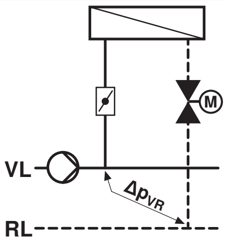
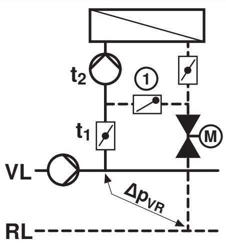
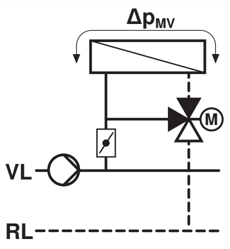
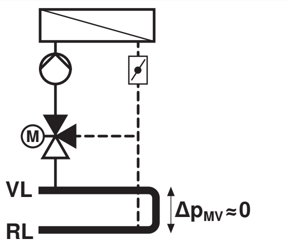
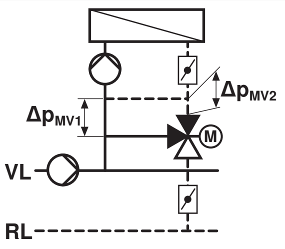
Dimensioning steps Standard control valves

The correct valve design

In order to ensure that a valve achieves good control characteristics, thus making it possible to ensure a long service life for the final controlling element, proper configuration of the valve with the correct valve authority is required.
The valve authority is the measure of the control characteristics of the valve in conjunction with the hydraulic network. The valve authority is the nominal load ratio between the differential pressure of the completely opened valve (Δp_{v100}) at the nominal flow rate and the maximum differential pressure occurring with the closed valve. The greater the valve authority, the better the control characteristics. The smaller the valve authority becomes, the more the operational behaviour of the valve will deviate from the valve characteristic, i.e. the poorer the behaviour of the volumetric flow control. A valve authority greater than >0.5 is strived for in everyday practice.
The dimensioning of a valve is explained in the following in six steps.

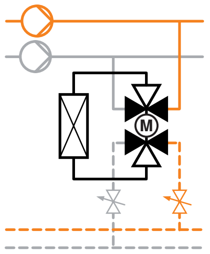
1. Determining basic hydraulic circuit arrangement and Δp_{v100}

The minimum clearances between the pipelines and the walls and ceilings required for project planning depend not only on the valve dimensions but also on the selected actuator. The dimensions can be found on the respective data sheets.

2-way control valves		3-way control valves		
Belimo 2-way control valves are to be provided in the return as throttling devices. This ensures lower thermal loads on the sealing elements in the valve. The prescribed flow direction can be obtained from the additional notes for project planning for characterised control valves and globe valves.		Belimo 3-way control valves are mixing devices. The flow direction must be observed for all pressure levels. Whether or not installation is in the supply or return is dependent on the selected hydraulic circuit. The prescribed flow direction can be obtained from the additional notes for project planning for characterised control valves and globe valves.		
Throttling circuit	**Injection circuit with throttling device**	**Diverting circuit**	**Mixing circuit**	**Injection circuit with 3-way characterised control valve**
$\Delta p_{v100} > \Delta p_{VR/2}$ Typical values: 15 kPa < Δp_{v100} < 200 kPa	$\Delta p_{v100} > \Delta p_{VR} / 2$ Typical values: 10 kPa < Δp_{v100} < 150 kPa	$\Delta p_{v100} > \Delta p_{MV}$ Typical values: 5 kPa < Δp_{v100} < 50 kPa	$\Delta p_{v100} > \Delta p_{MV}$ Typical values: $\Delta pv100$ > 3 kPa (with depressurised distributor) Other mixing circuits: 3 kPa < Δp_{v100} < 30 kPa	$\Delta p_{MV1} + \Delta p_{MV2} \approx 0$ Typical values: Δp_{v100} > 3 kPa
				

Legend:

- Control valve, 2-way, with actuator
- Control valve, 3-way, with actuator
- Characterised control valve, 6-way, with actuator
- Pump
- Balancing valve
- Non-return valve
- VL — Supply
- RL - - - Return
- ΔpVR — Differential pressure at the respective branching (supply / return) at nominal load
- ΔpMV — Differential pressure in quantity-variable part with nominal load (e.g. exchanger)
- ① In some counties is $t_2 < t_1$ specified.

6-way characterised control valves
Belimo 6-way characterised control valves were specially developed for utilisation with combined heating and cooling elements. In order to accomplish this, a 6-way characterised control valve assumes the function of four through valves or two through valves and one change-over valve. The following configuration is carried out with 6-way characterised control valves for each sequence (heating and cooling)
Typical values: $\Delta p_{v100} \leq$ 100 kPa For low-noise operation: $\Delta p_{v100} \leq$ 50 kPa


Dimensioning steps Standard control valves

2. Determining volumetric flow $\dot{V}_{100}$

If the thermal rating of a consumer and the associated temperature difference between supply and return are known, then the volumetric flow can be calculated with the following formula. The density and the thermal capacity of the water are taken into account as constant values with 0.86 as the factor.

$$\dot{V}_{100} = 0.86 \cdot \frac{Q_{100}}{\Delta T}$$

$\dot{V}_{100}$ [m³/h]
Q_{100} [kW]
ΔT [K]

3. Determining the k_{vs} value mathematically

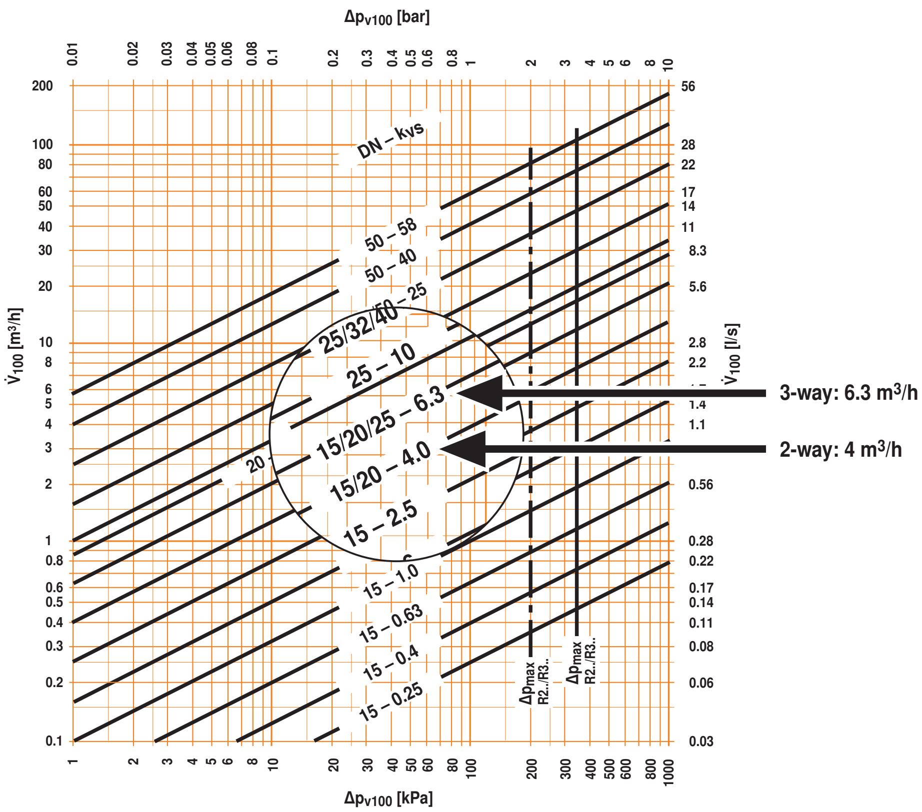
Once the volumetric flow has been calculated, the flow rate factor k_v can be determined at a differential pressure of 100 kPa.

$$k_v = \frac{\dot{V}_{100}}{\sqrt{\frac{\Delta p_{v100}}{100}}}$$

Δp_{v100} [kPa]
$\dot{V}_{100}$ [m³/h]
k_v [m³/h]

4. Selecting the suitable valve (selecting the k_{vs}- value)

The k_v value from Step 3 can be used to determine a k_{vs} value in the flow diagram (see further notes for project planning for characterised control valve, globe valve, butterfly valve or QCV).
If the k_v value is between two k_v lines in the flow diagram:
– Calculated k_v value is closer to the lower k_v line, select the lower k_{vs} value
– Calculated k_v value is closer to the upper k_v line, select the larger k_{vs} value
– If the k_v value is exactly between two k_v lines, then select the smaller k_{vs} value for a 2-way control valve and the larger k_{vs} value for a 3-way control valve.
If the k_v value is above the highest k_v line, select the largest possible k_{vs} value.
If the k_v value is below the lowest k_v line, select the smallest possible k_{vs} value.
In this connection an example with calculated k_v = 5.15 m³/h:



Dimensioning steps Standard control valves

5. Checking resulting differential pressure Δp_{v100}

Once a valve has been selected, the resulting differential pressure Δp_{v100} can be checked. The resulting differential pressure Δp_{v100} is relevant for the calculation of the valve authority P_v:

$$\Delta p_{v100} = \left(\frac{\dot{V}_{100}}{k_{vs}}\right)^2 \cdot 100$$

Δp_{v100} [kPa]
$\dot{V}_{100}$ [m³/h]
k_{vs} [m³/h]

6. Checking valve authority P_v (regulation stability)

Check P_v with the resulting differential pressure Δp_{v100}. A valve authority of ≥0.5 is strived for:

– Pressured distributor with variable volume flow rate (2-way control valves)

$$P_v = \frac{\Delta p_{v100}}{\Delta p_{VR}}$$

– Pressured distributor with constant volume flow rate or low-pressure distributor with variable volume flow rate (3-way control valves)

$$P_v = \frac{\Delta p_{v100}}{\Delta p_{v100} + \Delta p_{MV}}$$

k_{vs} [m³/h]	0.4 ... 8	0.25 ... 2.5	0.25 ... 58	0.25 ... 40	0.63 ... 320	0.63 ... 40	0.4 ... 320	630 ... 1000	45 ... 42800
Valve type	Zone valve	Characterised control valves				Globe valves			Butterfly valves
Designation	QCV	6-way characterised control valve	Characterised control valve	Characterised control valve	Characterised control valve	Globe valve	Globe valve	Large globe valve	Butterfly valve
Pipe connection	Internal thread	Internal thread	Internal thread	External thread	Flange	External thread	Flange	Flange	Flange
2-way	C2..Q-..		R2..	R4.. R4..K	R6..R 1) R6..W 2)	H4..B	H6..R 1) H6..N 2) H6..S / H6..SP 2) H6..X.. 3)	H6..W..	D6..N D6..NL
3-way			R3..	R5.. R5..K	R7..R 1)	H5..B	H7..R 1) H7..N 2) H7..X.. / H7..Y.. 3) 4)	H7..W..	
6-way		R30..-..-B2							
DN	15 ... 20	15 ... 20	15 ... 50	10 ... 50	15 ... 150	15 ... 50	15 ... 150	200 ... 250	25 ... 700
PN	16	16	16	16	6 / 16	16	6 / 16 25 / 40	16	6 / 10 / 16 5)
Medium temperature	6 ... 80°C	6 ... 80°C	–10 ... 120°C	6 ... 100°C	–10 ... 100°C	5 ... 120°C	6)	5 ... 120°C	–20 ... 120°C
Further notes for project planning	2-way zone valve QCV	6-way characterised control valves	2-way and 3-way characterised control valves			Globe valves			Butterfly valves

1) PN 6
2) PN 16
3) PN 25
4) PN 40
5) D6..N: DN 25…200: Flange PN 6/10/16;
DN 250…350: Flange PN 10/16;
DN 400…700: Flange PN 16
D6..NL: DN 50…150: Flange PN 10/16;
DN 200…700: Flange PN 16
6) 5…120°C: H6..R, H7..R, H6..N, H7..N, H6..W.., H7..W..;
5…150°C: H6..S, H6..SP, H6..X..;
5...200°C: H7..X.., H7..Y..

Dimensioning steps Pressure-independent characterised control valves

Differential pressure Δp_{v100}

Fluctuating differential pressures with pressure-independent characterised control valves are compensated for automatically and have no influence on the flow. The differential pressure must be within a defined range in order to ensure perfect functioning. Specifications regarding minimum and maximum differential pressure can be found in the respective data sheets.

1. Determining volumetric flow $\dot{V}_{max}$

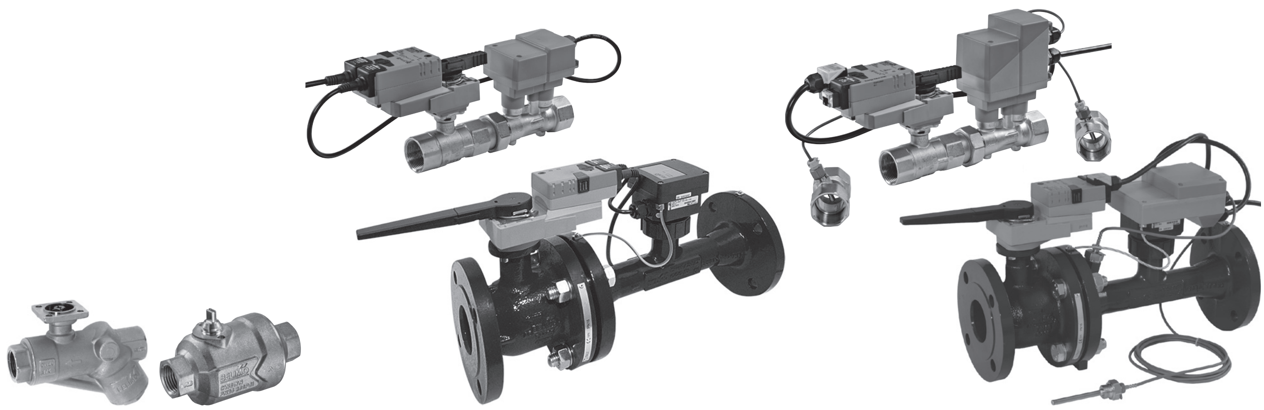
If the thermal rating of a consumer and the associated temperature difference between supply and return are known, then the volumetric flow can be calculated with the following formula. The density and the thermal capacity of the water are taken into account as constant values with 0.86 as the factor.

$$\dot{V}_{100} = 0.86 \cdot \frac{Q_{100}}{\Delta T}$$

$\dot{V}_{max}$ [m³/h]
Q_{100} [kW]
ΔT [K]

2. Selecting the suitable valve

The information from Step 1 is already sufficient for selecting the appropriate valve. The following overview shows the Belimo pressure-independent characterised control valves and references further documentation. The respective data sheets contain information regarding $\dot{V}_{nom}$. It should be noted that $\dot{V}_{max} \leq \dot{V}_{nom}$ is mandatory. The permissible setting range is specified in the respective data sheets.



$\dot{V}_{max}$ [l/s]	0.04 ... 5.5	0.005 ... 0.25	0.11 ... 4.8	3.6 ... 45	0.11 ... 4.8	3.6 ... 45
Designation	PICCV	PIQCV	EPIV	EPIV	Belimo Energy Valve™	Belimo Energy Valve™
Valve type	Mechanically pressure-independent characterised control valve		Electronic pressure-independent characterised control valve with sensor-operated flow control		Electronically pressure-independent characterised control valve with sensor-operated flow rate or power control and energy-monitoring function	
Pipe connection	Internal thread		Internal thread	Flange	Internal thread	Flange
2-way	R2..P-..	C2..QP(T)..	EP..R+MP	P6..W..E-MP	EV..R+BAC	P6..W..EV-BAC
DN	15 ... 50	15 ... 20	15 ... 50	65 ... 150	15 ... 50	65 ... 150
PN	16	25	16	16	16	16
Medium temperature	5 ... 100°C [1] 5 ... 80°C [2]	2 ... 90°C	–10 ... 120°C	–10 ... 120°C	–10 ... 120°C	–10 ... 120°C

[1] DN 15…20
[2] DN 25…50

Definitions

k_v	Flow rate factor or flow rate coefficient. The k_v value corresponds to the volumetric flow of water through a valve (in m^3/h or l/min) with a differential pressure of 100 kPa (1 bar), a water temperature of 5 ... 40°C and at a fixed delay angle
k_{vs}	k_v value of the valve at 100% degree of opening
$\Delta p_v 100$	Differential pressure with valve completely open
$\Delta p_v VR$	Differential pressure at the respective branching (supply / return) at nominal load
$\Delta p_v MV$	Differential pressure in quantity-variable part with nominal load (e.g. exchanger)
$\dot{V}_{100}$	Nominal flow rate with $\Delta p_v 100$
Q_{100}	Thermal rating of a consumer
ΔT	Temperature difference between supply and return
p_v	Valve authority: the measure of the control characteristics of the valve in conjunction with the hydraulic network. The valve authority is the ratio between the differential pressure of the completely opened valve ($\Delta p_v 100$) at the nominal flow rate and the maximum differential pressure occurring with the closed valve.
$\dot{V}_{max}$	Is the maximum flow rate of a pressure-independent valve which has been set with the greatest positioning signal, e.g. 10 V.
$\dot{V}_{nom}$	Greatest possible flow rate of a pressure-independent valve, catalogue value, status upon delivery

Further documentation

- Overview of Valve-actuator combinations
- Notes for project planning: Butterfly valves for open-close applications and control mode
- Notes for project planning: 2-way zone valve QCV™ / ZoneTight™
- Notes for project planning: 2-way and 3-way characterised control valves
- Notes for project planning: 6-way characterised control valves DN15 and DN 20

All-inclusive.

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