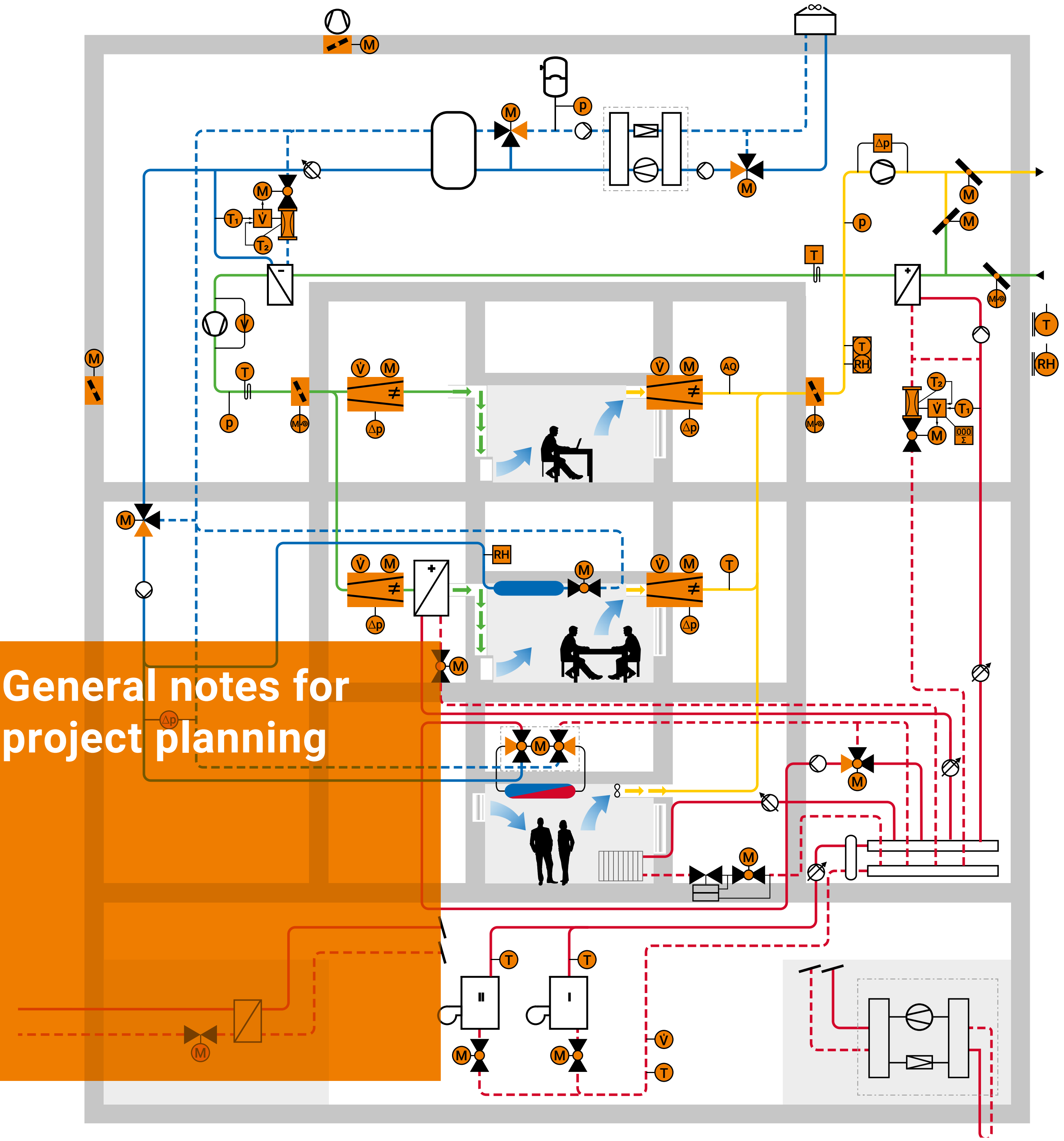

General notes for project planning

Dimensioning of open/close, control and pressure-independent valves

Edition 2021-07/A

BELIMO

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Introduction

Relevant information regarding project planning

These notes for project planning are an aid for the selection and project planning of Belimo valves. Also take into account the data, information and limit values in the data sheets and further notes for project planning of the respective valves. Belimo valves can be used as open/close or control valves in heating, ventilation and air-conditioning systems. It is not permitted to use Belimo valves outside of their specified field of application.
For the project planning of open/close and control valves, we recommend that provision be made for a sufficient number of isolation valves in order to facilitate later revisions, e.g. of heat exchangers.

Order forms

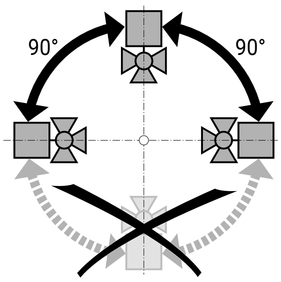
Depending on the order form, the valve and actuator are supplied either assembled together or separately. Examples of orders can be found in the current Belimo product and price catalogue.

Mounting the actuator on the valve

The actuator and the valve can be easily mounted on-site in accordance with the installation instructions enclosed with the actuator.

Installation regulations

The control devices (combination valve/actuator) can be installed upright to horizontal. It is not permitted to install control devices in a suspended position, i.e. with the spindle facing downwards.



Commissioning

The equipment may not be put into service until the valve and the actuator have been mounted and installed in accordance with regulations.

Maintenance

Belimo water final control elements are maintenance-free. When performing service work on the control device, switch off the power supply to the actuator (by unplugging the electrical cables if necessary). Switch off the pumps in the part of the affected piping system and close the appropriate slide valves (allow everything to cool down first if necessary and reduce the system pressure to ambient pressure level). Do not put into service again until the valve with actuator has been mounted in accordance with regulations and the pipelines have been filled by specialist technicians.

Later de-installation of valves

For applications which require later de-installation, we recommend implementing further measures accordingly, e.g. with additional detachable pipe connectors.

Disposal

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

General

Dimensions

The dimensions of the combination valve/actuator used are dependent not only on the nominal diameter of the valve but also on the actuator used. The dimensions can be found in the associated 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 in the associated data sheets.

Water quality

Adhere to the water quality requirements specified in VDI 2035.

Strainer

To ensure that Belimo water final control elements continue to provide reliable control well into the future, we always recommend the use of a centrally installed strainer.

Dimensioning steps for open/close valves

1. Determining the k_{VS} value

– Prerequisite: nominal pipeline diameter is known.
– Selection of a possible valve based on the nominal diameter of the pipeline (nominal diameter of valve ≤ nominal diameter of pipeline)
– The k_{VS} values for the desired nominal diameter can be found in the Belimo data sheets.

2. Determining volumetric flow V'_{100}

If the thermal output of a consumer and the associated differential temperature between the supply and return lines are known, then the following formula can be used to calculate the volumetric flow. The density and thermal capacity of the water are taken into account as constant values by a factor of 0.86.

$$V'_{100} = 0.86 \cdot \frac{Q_{100}}{\Delta T}$$

V'_{100} : [m³/h]
Q_{100} : [kW]
ΔT : [k]

3. Calculate differential pressure Δp_{v100}

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

Δp_{v100} : [kPa]
V'_{100} : [m³/h]
k_{vs} : [m³/h]

4. Selecting the correct valve

The correct valve can be selected using the results from Steps 1 to 3. In the case of open/close valves, the same nominal diameter is usually selected for both the valve and the pipe. The following overview shows the open/close valves from Belimo and references further documentation.





k_{VS} [m³/h]	**0.1...8**	**0.1...8**	**15...49**	**8.6...49**	**15...49**
Valve type	Zone valves		Open/close ball valves		
Designation	QCV	QCV	Open/close ball valve	Open/close ball valve	Open/close ball valve
Pipe connection	Internal thread	External thread	Internal thread	External thread	Flange
2-way	C2..Q-..	C4..Q-..	R2..	R4..	R6..R
3-way	C3..Q-..	C5..Q-..	R3..	R5..	R7..R
DN	15...25	15/20	15/20	15/20	15/20
PN	25	25	16	16	6
Permissible operating pressure p_S	1600 kPa	1600 kPa	1600 kPa	1600 kPa	600 kPa
Fluid temperature	2...90°C	2...90°C	−10...120°C	6...100°C	−10...100°C
Further notes for project planning	2-way and 3-way zone valve QCV		2 and 3-way characterised control valves		

Subject to technical modifications

					
k_{vs} [m^3/h]	**1.6...40**	**0.63...40**	**0.4...320**	**630...1000**	**45...42800**
Valve type	Globe valves				Butterfly valves
Designation	Globe valve	Globe valve	Globe valve	Large actuator valve	Shut-off damper
Pipe connection	Internal thread	External thread	Flange	Flange	Flange
2-way	H2..S-..	H4..B	H6..R [1] H6..N [2] H6..S/H6..SP [2] H6..X.. [3]	H6..W	D6..
3-way	H3..S-..	H5..B	H7..R [1] H7..N [2] H7..S/H7..SP [2]	H7..W	D7.. [4]
DN	15...50	15...50	15...150	200...250	25...700
PN	25	16	6/16/25	16	6/10/16 [5]
Permissible operating pressure p_s	2500/1600/600 kPa	1400 kPa	1600 kPa	2500 kPa	1600/1600 kPa
Fluid temperature	0...130°C	5...120°C	[6]	5...120°C	−20...120°C
Further notes for project planning	Globe valves				Butterfly valves

[1] PN 6
[2] PN 16
[3] PN 25
[4] available in DN 150...300
[5] D6..N, D6..W: DN 25...300: flange PN 6/10/16
DN 250...350: flange PN 10/16
DN 400...700: flange PN 16
D6..NL, D6..WL: DN 25...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.., H7..S
5...200°C: H7..X..

Dimensioning steps for standard control valves

1. Determining basic hydronic circuit and Δp_{v100}

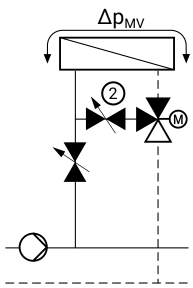
To ensure a valve achieves adequate control characteristics and thus a long service life for the HVAC performance device, it must be correctly designed with the correct valve authority P_V. The valve authority is the benchmark for the control characteristics of the valve in combination with the hydronic network. The valve authority is the relation at nominal load between the differential pressure of the fully open valve (Δp_{v100}) at nominal flow and the maximum differential pressure for the closed valve. The higher the valve authority, the better the control characteristics. The smaller the valve authority, the more the operational behaviour of the valve will deviate from the characteristic curve, i.e. the poorer the volumetric flow control will be. A valve authority of more than 0.5 is desired in everyday practice. Dimensioning of a valve is explained below in six steps.

3-way control valves

Belimo 3-way control valves are mixing devices. The direction of flow must be maintained under all loads. Whether installation is in the supply or return is dependent on the hydronic circuit selected. The specified direction of flow can be found in the further notes for project planning for characterised control valves and globe valves.

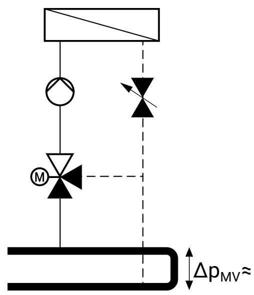
Diverting circuit

$\Delta p_{v100} > \Delta p_{MV}$
Typical values:
5 kPa < Δp_{v100} < 50 kPa



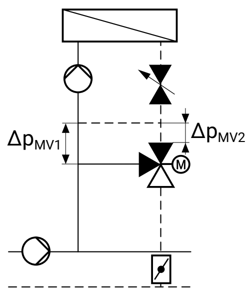
Mixing circuit

$\Delta p_{v100} > \Delta p_{MV}$
Typical values:
Δp_{v100} > 3 kPa
(With depressurised distributor)
Other mixing circuits:
3 kPa < Δp_{v100} < 30 kPa



Injection circuit with 3-way valve

$\Delta p_{MV1} + \Delta p_{MV2} = 0$
Typical values:
Δp_{v100} > 3 kPa

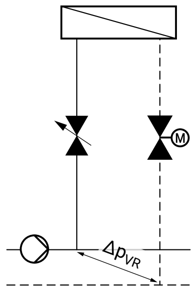


2-way control valves

Mount Belimo 2-way control valves as throttling devices in the return. This ensures lower thermal loads on the sealing elements in the valve. The specified direction of flow can be found in the further notes for project planning for characterised control valves and globe valves.

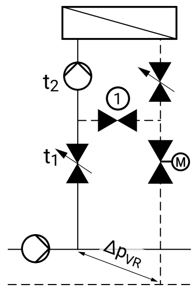
Throttling circuit

$\Delta p_{v100} > \Delta p_{VR}/2$
Typical values:
$10\ kPa < \Delta p_{v100} < 200\ kPa$



Injection circuit with 2-way valve

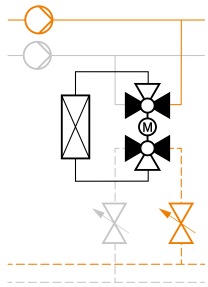
$\Delta p_{v100} > \Delta p_{VR}/2$
Typical values:
$10\ kPa < \Delta p_{v100} < 200\ kPa$



6-way characterised control valves

Belimo 6-way characterised control valves have been specially developed for use with combined heating and cooling elements. A 6-way characterised control valve performs the function of four 2-way valves or two 2-way valves and one changeover valve. The following design is performed with the 6-way characterised control valve for every sequence (heating and cooling).

Typical values:
$\Delta p_{v100} \leq 100\ kPa$
For low-noise operation:
$\Delta p_{v100} \leq 50\ kPa$



Legend:

	Control valve, 2-way, with actuator		Balancing valve
	Control valve, 3-way, with actuator		Non-return valve
	Characterised control valve, 6-way, with actuator		Supply
	Pump		Return
1	Specified in some countries, for which 2 < t1 will apply.	2	Thanks to the reduced flow in the bypass, the balancing valve is not required with the 3-way characterised control valve.

2. Determining volumetric flow V'_{100}

If the thermal output of a consumer and the associated differential temperature between the supply and return lines are known, then the following formula can be used to calculate the volumetric flow. The density and thermal capacity of the water are taken into account as constant values by a factor of 0.86.

$$V'_{100} = 0.86 \cdot \frac{Q_{100}}{\Delta T}$$

V'_{100} : [m³/h]
Q_{100} : [kW]
ΔT : [k]

3. Calculate k_V value

Once the volumetric flow has been calculated, the flow factor k_V can be determined for a differential pressure of 100 kPa.

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

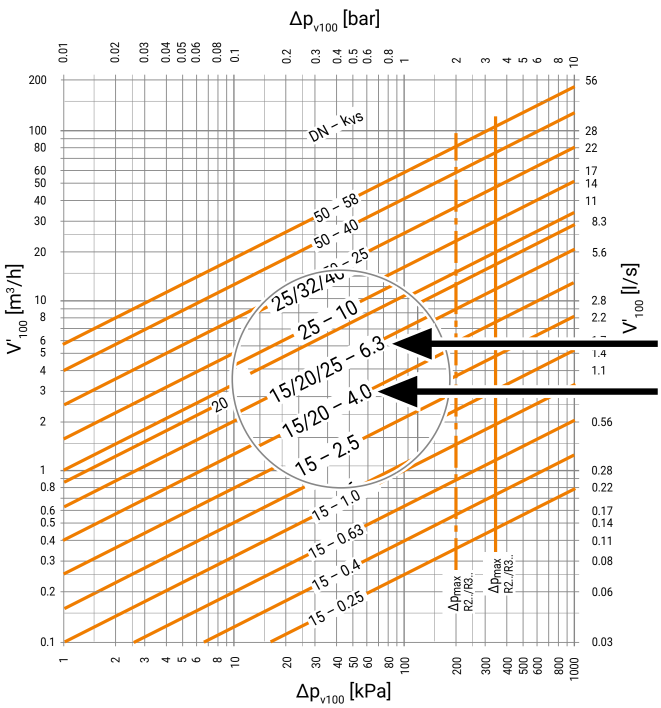
Δp_{v100} : [kPa]
V'_{100} : [m³/h]
k_v : [m³/h]

4. Selecting the correct valve (selecting the k_{VS} value)

The calculated k_V value from Step 3 can be used to determine a k_{VS} value in the flow chart (see further notes for project planning for characterised control valves, globe valve, butterfly valve or QCV) . If the k_V value lies between two k_V curves in the flow chart:

– If the calculated k_V value is closer to the lower k_V curve, then select the smaller k_{VS} value.
– If the calculated k_V value is closer to the higher k_V curve, then select the larger k_{VS} value.
– If the k_V value lies in the middle between two k_V lines, 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 curve, then select the largest possible k_{VS} value. If the k_V value is below the lowest k_V curve, then select the smallest possible k_{VS} value. Here an example with calculated k_V = 5.15 m³/h:



5. Check the 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:

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

Δp_{v100} : [kPa]
V'_{100} : [m³/h]
k_{vs} : [m³/h]

6. Checking valve authority P_v (control stability)

Check P_v with the differential pressure Δp_{v100} that results. A valve authority of ≥ 0.5 is desired:

– Pressurised distributor with variable volumetric flow (2-way control valves)

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

– Pressurised distributor with constant volumetric flow or low-pressure distributor with variable volumetric flow (3-way control valves)

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






k_{vs} [m³/h]	0.1...8	0.1...8	0.25...4	15...49	8.6...49	15...49
Valve type	Zone valves		Open/close ball valves			
Designation	QCV	QCV	6-way characterised control valve	Characterised control valve	Characterised control valve	Characterised control valve
Pipe connection	Internal thread	External thread	Internal thread	Internal thread	External thread	Flange
2-way	C2..Q-..	C4..Q-..		R2..	R4.. R4..K	R6..R [1] R6..W [2]
3-way				R3..	R5.. R5..K	R7..R [1]
6-way			R30..-..-B2/B3			
DN	15...25	15/20	15...25	15...50	10...50	15...150
PN	25	25	16	16	16	6/16
Permissible operating pressure p_s	1600 kPa	1600 kPa	1600 kPa	1600 kPa	1600 kPa	600 kPa
Fluid temperature	2...90°C	2...90°C	6...80°C	−10...120°C	6...100°C	[3]
Further notes for project planning	2-way and 3-way zone valve QCV		6-way characterised control valves	2 and 3-way characterised control valves		

[1] PN 6 [3] 5...110°C: R6..R, −10...120°C: R6..W, −10...100°C: R7..R
[2] PN 16

Subject to technical modifications

					
k_{VS} [m^3/h]	**1.6...40**	**0.63...40**	**0.4...320**	**630...1000**	**24...11760**
Valve type	Globe valves				Butterfly valves
Designation	Globe valve	Globe valve	Globe valve	Large actuator valve	Control butterfly valve
Pipe connection	Internal thread	External thread	Flange	Flange	Flange
2-way	H2..S-..	H4..B	H6..R [1] H6..N [2] H6..S/H6..SP [2] H6..X.. [3]	H6..W	D6..
3-way	H3..S-..	H5..B	H7..R [1] H7..N [2] H7..S/H7..SP [2]	H7..W	D7. [4]
DN	15...50	15...50	15...150	200...250	25...700
PN	25	16	6/16/25	16	6/10/16 [5]
Permissible operating pressure p_S	2500/1600/600 kPa	1400 kPa	1600 kPa	2500 kPa	1600/1600 kPa
Fluid temperature	0...130°C	5...120°C	[6]	5...120°C	−20...120°C
Further notes for project planning	Globe valves				Butterfly valves

[1] PN 6
[2] PN 16
[3] PN 25
[4] available in DN 150...300
[5] D6..N, D6..W: DN 25...300: flange PN 6/10/16
DN 250...350: flange PN 10/16
DN 400...700: flange PN 16
D6..NL, D6..WL: DN 25...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.., H7..S
5...200°C: H7..X..

Dimensioning steps for pressure-independent characterised control valves

Fluctuating differential pressures are compensated for automatically with pressure-independent characterised control valves and do not influence the flow. To ensure perfect function, the differential pressure must be within a defined range. Specifications regarding minimum and maximum differential pressure can be found in the respective data sheets.

1. Determining volumetric flow V'_{max}

If the thermal output of a consumer and the associated differential temperature between the supply and return lines are known, then the following formula can be used to calculate the volumetric flow. The density and thermal capacity of the water are taken into account as constant values by a factor of 0.86.

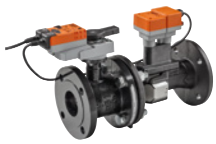
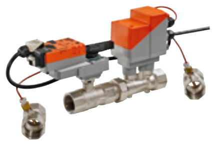
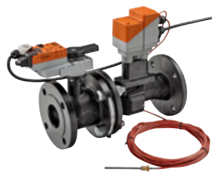
$$V'_{100} = 0.86 \cdot \frac{Q_{100}}{\Delta T}$$

V'_{100} : [m³/h]
Q_{100} : [kW]
ΔT : [k]

2. Selecting the correct valve

The correct valve can be selected using the results from Step 1. The following overview shows the pressure-independent characterised control valves from Belimo and references other documentation. Specifications regarding V'_{nom} can be found in the respective data sheets. Note that $V'_{max} \leq V'_{nom}$ must apply. The permissible setting range is specified in the respective data sheets.

V'_{max} l/s	0.08...1	0.006...0.583
Valve type	PIFLV	PIQCV
Pipe connection	Relief valve	Mechanical pressure-independent characterised control valve
2-way	C2..QFL-.. R225FL-..	C2..QP(T)..
DN	15...25	15...25
PN	25	25
Permissible operating pressure p_s	1600 kPa	1600 kPa
Fluid temperature	2...60°C	2...90°C

V'_{max} l/s	**0.018...0.65**	**0.11...4.8**	**3.6...45**	**0.11...4.8**	**3.6...45**
Designation	6-way EPIV	EPIV	EPIV	Belimo Energy Valve™	Belimo Energy Valve™
Valve type	Electronically pressure-independent 6-way characterised control valve	Electronic pressure-independent characterised control valves with sensor-operated flow control		Electronic 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	EP..R-R6+BAC	EP..R+(K)MP	EP..F+(K)MP	EV..R+BAC	EV..F+BAC
DN	15/20	15...50	65...150	15...50	65...150
PN	16	25	16	25	16
Permissible operating pressure p_s	1600 kPa	1600 kPa	1600 kPa	1600 kPa	1600 kPa
Fluid temperature	2...80°C	−10...120°C	−10...120°C	−10...120°C	−10...120°C

Definitions

Formula symbol

k_v	The flow coefficient k_v [m^3/h] is the specific volume flow of a valve with a defined delay angle with reference to 100 kPa (1 bar). The k_v value changes depending on the valve position. The flow coefficient is determined for a water temperature of 5…40°C.
k_{vs}	The k_v value in reference to the nominal delay angle is referred to as the k_{vs} value. The manufacturer specifies the maximum valve opening of the nominal delay angle. Characterised control valves (CCV): Flow coefficient at 100% valve opening (90° angle of rotation) Zone valve (QCV): Flow coefficient with corresponding position of the end stop clip (variable) Globe valves: Flow coefficient at 100% valve opening Butterfly valves: Flow coefficient at 60% valve opening for control application
Δp_{v100}	Differential pressure across the completely opened valve at V'_{100}
Δp_{VR}	Differential pressure at the respective branch (supply/return) with nominal load
Δp_{MV}	Differential pressure via the variable-flow part (e.g. an exchanger) at nominal load
p_s	Permissible operating pressure kPa
V'_{100}	Nominal flow rate with Vp_{v100}
Q_{100}	Thermal or cooling output of the consumer
ΔT	Temperature difference between supply and return
P_v	Valve authority: the benchmark for the control characteristics of the valve in combination with the hydronic network. The valve authority is the relation at nominal load between the differential pressure of the fully open valve (Δp_{v100}) at nominal flow and the maximum differential pressure for the closed valve.
V'_{max}	Set maximum flow of a pressure-independent valve with the greatest positioning signal, e.g. 10 V
V'_{nom}	Maximum possible flow rate of a pressure-independent valve, catalogue value, delivery condition

Further documentation

- Overview "Combination valve/actuator"
- Notes for project planning: butterfly valves for open/close applications and control mode
- Notes for project planning: 2-way zone valve QCVTM/ZoneTight™
- Notes for project planning: 2-way and 3-way characterised control valves
- Notes for project planning: 6-way characterised control valves DN 15 / DN 20

All inclusive.

Belimo as a global market leader develops innovative solutions for the controlling of heating, ventilation and air-conditioning systems. Actuators, valves and sensors represent our core business.

Always focusing on customer added value, we deliver more than only products. We offer you the complete product range for the regulation and control of HVAC systems from a single source. At the same time, we rely on tested Swiss quality with a 5-year guarantee. Our world-wide representatives in over 80 countries guarantee short delivery times and extensive support through the entire product life. Belimo does indeed include everything.

The "small" Belimo devices have a big impact on comfort, energy efficiency, safety, installation and maintenance.

In short: Small devices, big impact.

- 5-year warranty
- On-site around the globe
- Complete product range
- Tested quality
- Short delivery times
- Comprehensive support

EN – 2021-07/A – Subject to technical modifications

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