

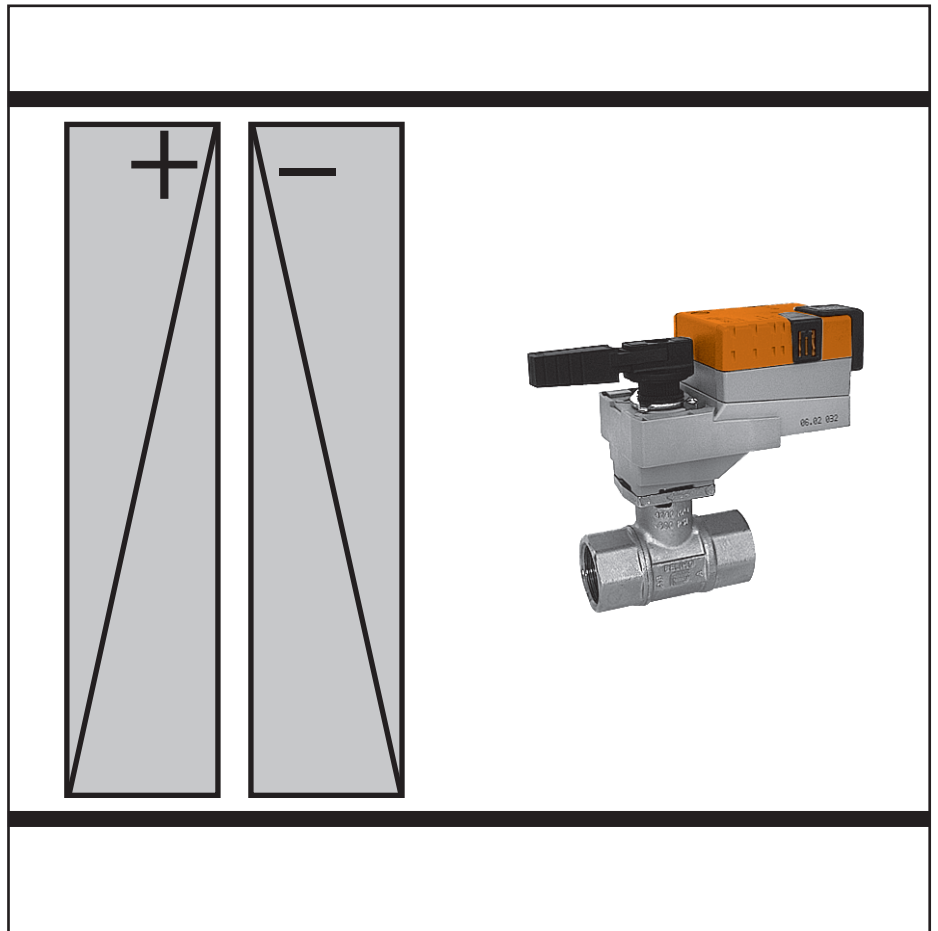
2-way and 3-way
characterised
control valves
Notes for project
planning

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2-way and 3-way characterised control valves

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Design and dimensioning

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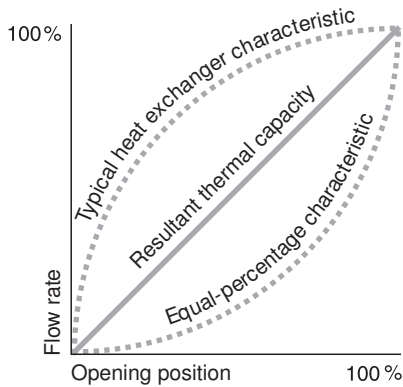
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The Belimo characterized control valve

Ordinary ball valves are unsuitable as control devices

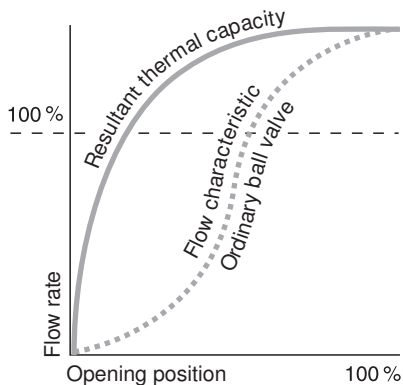
In order to ensure good stability of control, a hydraulic final controlling element must possess a flow characteristic that supplements the non-linear characteristic of the heat exchanger in the HVAC system.



Characteristics of an ideal hydraulic final controlling element

An equal-percentage valve characteristic is desirable in order to produce a linear relationship between the thermal output and the opening position of the final controlling element. This means that the flow rate increases very slowly as the final controlling element begins to open.

Unfortunately, this characteristic is severely distorted in ordinary ball valves.



Characteristic of an ordinary ball valve

The reason for this is that an ordinary ball valve has an extremely high flow coefficient (k_{VS} value) compared with its nominal size, several times that of a comparable globe valve.

Therefore, an ordinary ball valve is not very suitable for performing control functions:

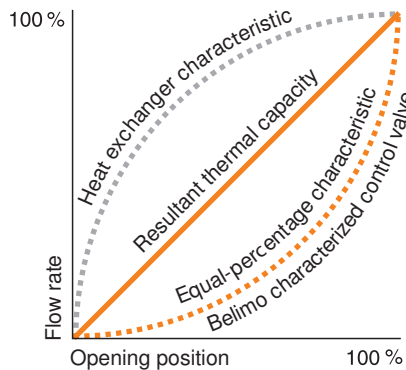
- Flow coefficient excessive due to the design
- Flow control inadequate in the part-load range

Belimo adds «characterized control» to ball valves

Belimo has succeeded in solving the problem of the distorted flow characteristic of ordinary ball valves.

A so-called «characterizing disc» in the inlet of the characterized control valve converts the valve's characteristic to the equal-percentage kind.

The side of the characterizing disc facing the ball is concave and in contact with the surface of the ball. Thus, the actual flow is regulated by the hole in the ball and by the V-shaped aperture in the characterizing disc.

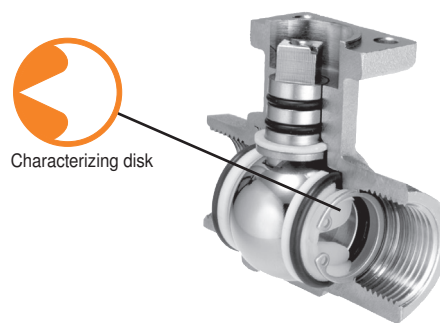


Characteristic of a Belimo characterized control valve

The k_{VS} value is reduced and corresponds approximately to that of a globe valve of comparable size. In order to avoid having to fit pipe reducers in the majority of cases, each valve size is also available with an appropriate choice of k_{VS} values.

Advantages of the Belimo characterized control valve

- Equal-percentage characteristic
- No initial jump in flow on opening
- Excellent stability of control thanks to the characterizing disk

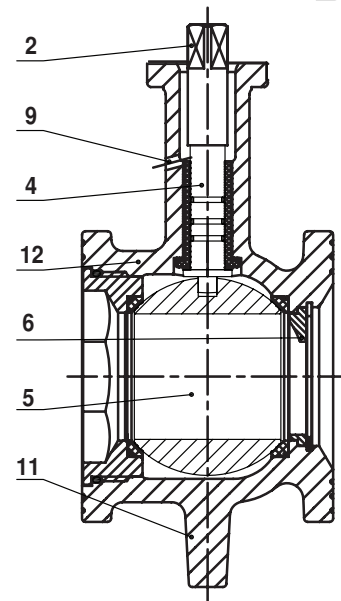
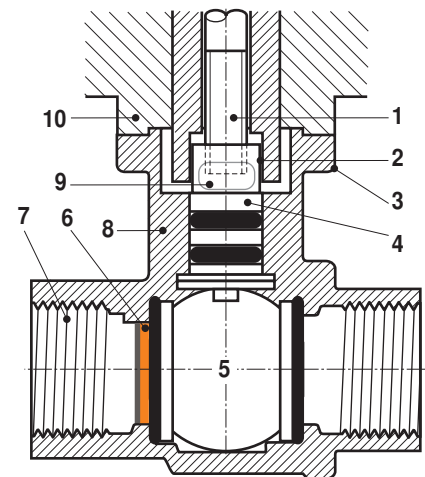


- k_{VS} values similar to those of globe valves of comparable size
- Fewer pipe reducers needed
- Better part-load characteristics and less prone to vibration, greater stability of control
- Tight-sealing (2-way)

Elements of the characterized control valve

- 1 Simple direct mounting using a central screw. The rotary actuator can be mounted in four different positions
- 2 Square stem head for form-fit attachment of the rotary actuator
- 3 Identical mounting flange for all sizes
- 4 Stem with two O-ring seals for a long service life
- 5 Ball and stem made of stainless steel or chrome-plated brass
- 6 Characterizing disc produces

- 7 Internal thread connection (ISO 7-1), external thread connection (ISO 228-1) and flange connection (ISO 7005-1/2)
- 8 Forged fitting, nickel-plated brass body
- 9 Vent window to prevent the accumulation of condensation
- 10 Thermal decoupling of the actuator from the ball valve
- 11 Flange (ISO 7005-2)
- 12 GG25, polyester coated body



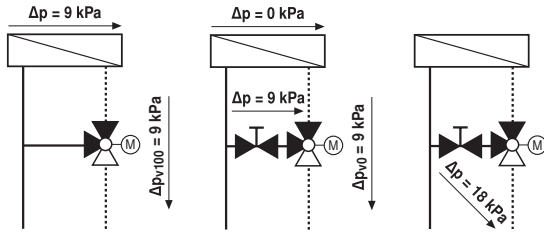
Optimum choice of k_{VS} valves of identical size

- Better controllability
- Lower installation costs

The Belimo range of characterized control valves includes 2-way and 3-way types. These are available in a variety of sizes and with a choice of k_{VS} values.

A characterized control valve is supplied as a unit complete with a suitable Belimo rotary actuator.

Project planning

Relevant information	The data, information and limit values listed on the "Characterised control valves" data sheets are to be taken into account and/or complied with, respectively.
Closing and differential pressures	The maximum permissible closing and differential pressures can be found in the 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 and can be found in the data sheets of the valves and actuators.
2-way characterised control valves	Characterised control valves are to be installed in the return as throttling devices. This leads to lower thermal loads on the sealing elements in the valve. The prescribed flow direction must be observed.
3-way characterised control valves	3-way characterised control valves are mixing devices. The flow direction must be observed for all pressure levels. Installation in the supply or return is dependent on the selected hydraulic circuit. The 3-way characterised control valve may not be used as a diverting valve
Diverting circuit	Thanks to the reduced flow rate in the bypass, no balancing valve in the bypass line is necessary with the diverting circuit.
Bypass 70% k_{VS}	<p>Full load Zero load with bypass throttle Zero load with reduced bypass k_{VS}</p>  $V = k_{VS} \cdot \sqrt{\Delta p_{v100}} = x \cdot k_{VS} \cdot \sqrt{2 \cdot \Delta p_{v100}}$ $\rightarrow x = \frac{1}{\sqrt{2}} = 0.7 \rightarrow 70\%$
Water quality	The water quality requirements specified in VDI 2035 must be adhered to.
Dirt filter	Characterised control valves are regulating devices. The use of dirt filters is recommended in order to prolong their service life as modulating instruments.
Shut-off devices	Care must be taken to ensure that sufficient numbers of shut-off devices are installed.

Design and dimensioning

Control characteristics	<p>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.</p> <p>The valve authority P_V is 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 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 P_V becomes, the more the operational behaviour of the valve will deviate from the linearity, i.e. the poorer the behaviour of the volumetric flow control. A valve authority of P_V of >0.5 is strived for in everyday practice.</p>
Design for use with glycol	<p>Salts were formerly added to the water to reduce its freezing point; this was referred to as brine applications. Nowadays, glycols are used and one speaks of refrigerant agents. Depending on the concentration of the refrigerant agent (type of glycol) used and the medium temperature, the density of the water/glycol mixture varies from 1% to 9%. The volumetric deviation which results from this process is less than the permitted quantity tolerance of the k_{VS} value of the valve (of $\pm 10\%$ in accordance with VDE 2178) and need not as a rule be taken into account, even if glycols require a slightly elevated k_V value.</p> <p>Depending on the type of glycol, tolerance with the valve materials used must be ensured and the permitted maximum concentration (50 percent) may not be exceeded.</p>

Flow characteristics

2-way characterised control valve

The characteristic curve is equal-percentage, with a characteristic curve factor $n(g) = 3.2$ or 3.9 . This guarantees stable control characteristics in the elevated partial load range. The curve is linear in the lower opening range between $0 \dots 30\%$ operating range. This ensures outstanding control characteristics, including in the lower partial load range. The operating range $0 \dots 100\%$ corresponds to an angle of rotation of $15 \dots 90^\circ$.

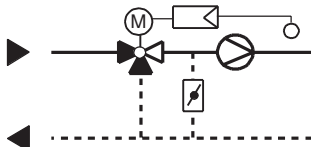
The characterised control valves function as tight-closing shut-off devices between angles of rotation of $0 \dots 15^\circ$.

3-way characterised control valve

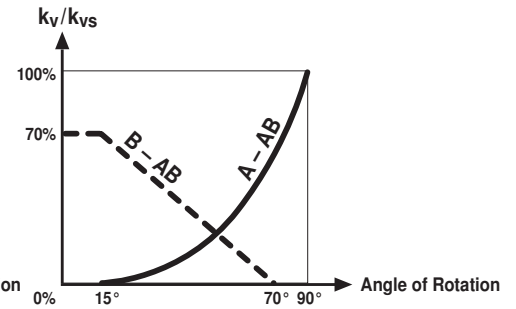
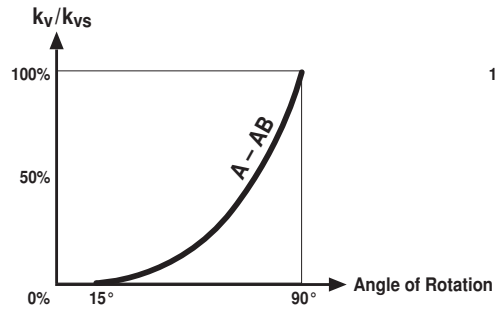
Same behaviour via the control path A – AB as with the 2-way characterised control valves. The flow rate in the bypass B – AB is designed to be 70% of the k_{VS} value of the control path (A – AB). The characteristic curve in the bypass is linear.

Note

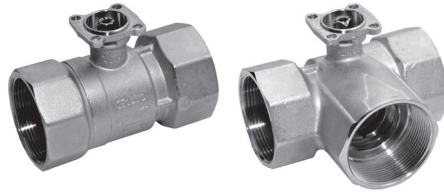
As a result of its ball construction, the 3-way characterised control valve is suitable only to a limited extent for conventional return line temperature controls. It is therefore recommended that return line temperature controls be implemented as double mixing circuits when these characterised control valves are used.



There are no restrictions with air heater mixing circuits or with injection circuits.



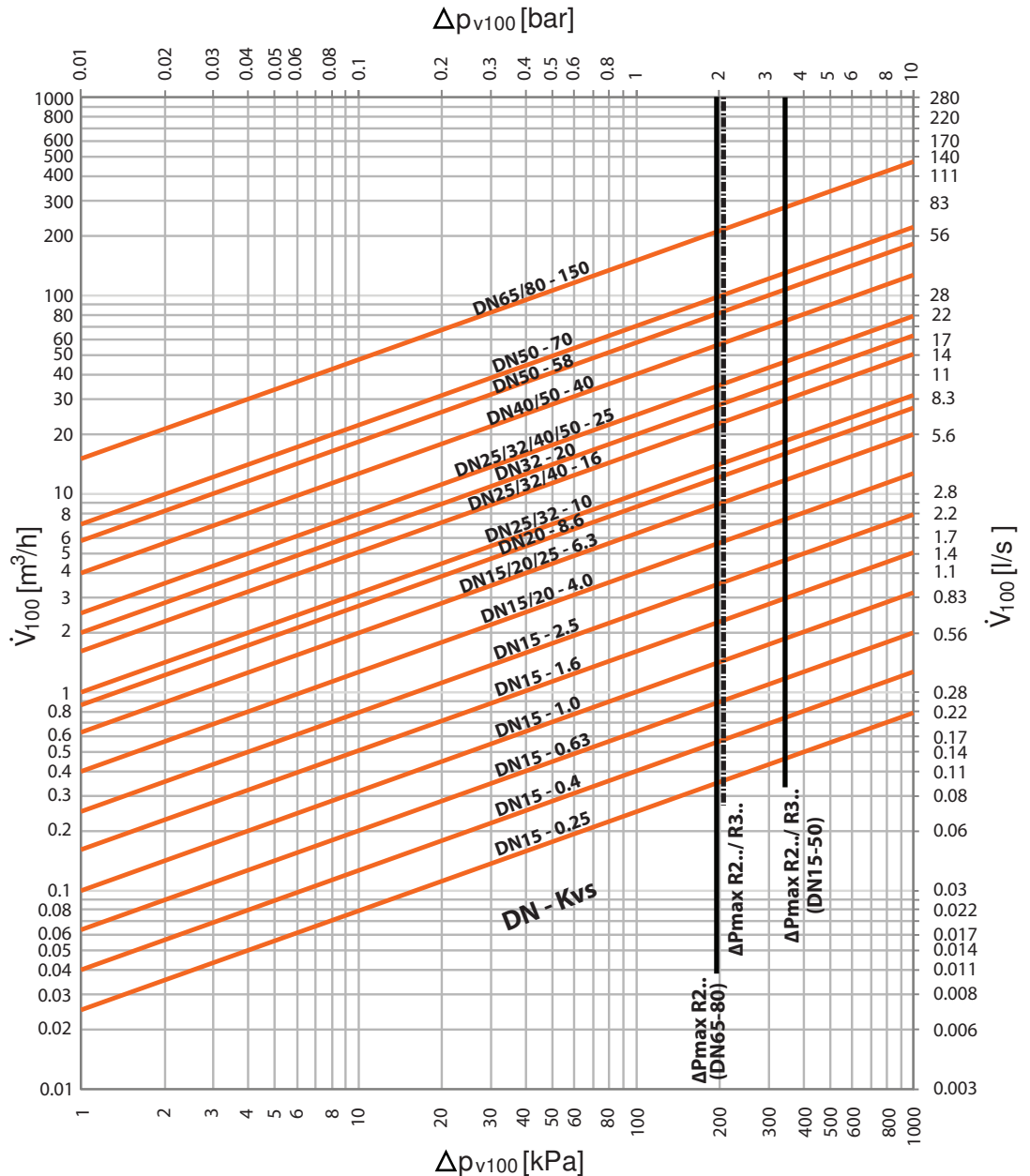
Calculation diagram for 2-way and 3-way characterised control valves R2.. / R3..



Application These characterised control valves are used in open and closed cold and hot water systems for modulating water-side control of air treatment and heating plants.

Media Cold and hot water, water with glycol up to max. 50% vol.

Medium temperatures The permissible medium temperatures can be found in the corresponding valve and actuator data sheets.



— Δp_{max}
Maximum permitted differential pressure for long service life across control path A – AB, with reference to the whole opening range.

----- Δp_{max}
For low-noise operation (R2../R3..)

Δp_{v100}
Differential pressure with ball valve full open.

\dot{V}_{100}
Nominal flow rate with Δp_{v100}

Formula k_{vs}

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

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

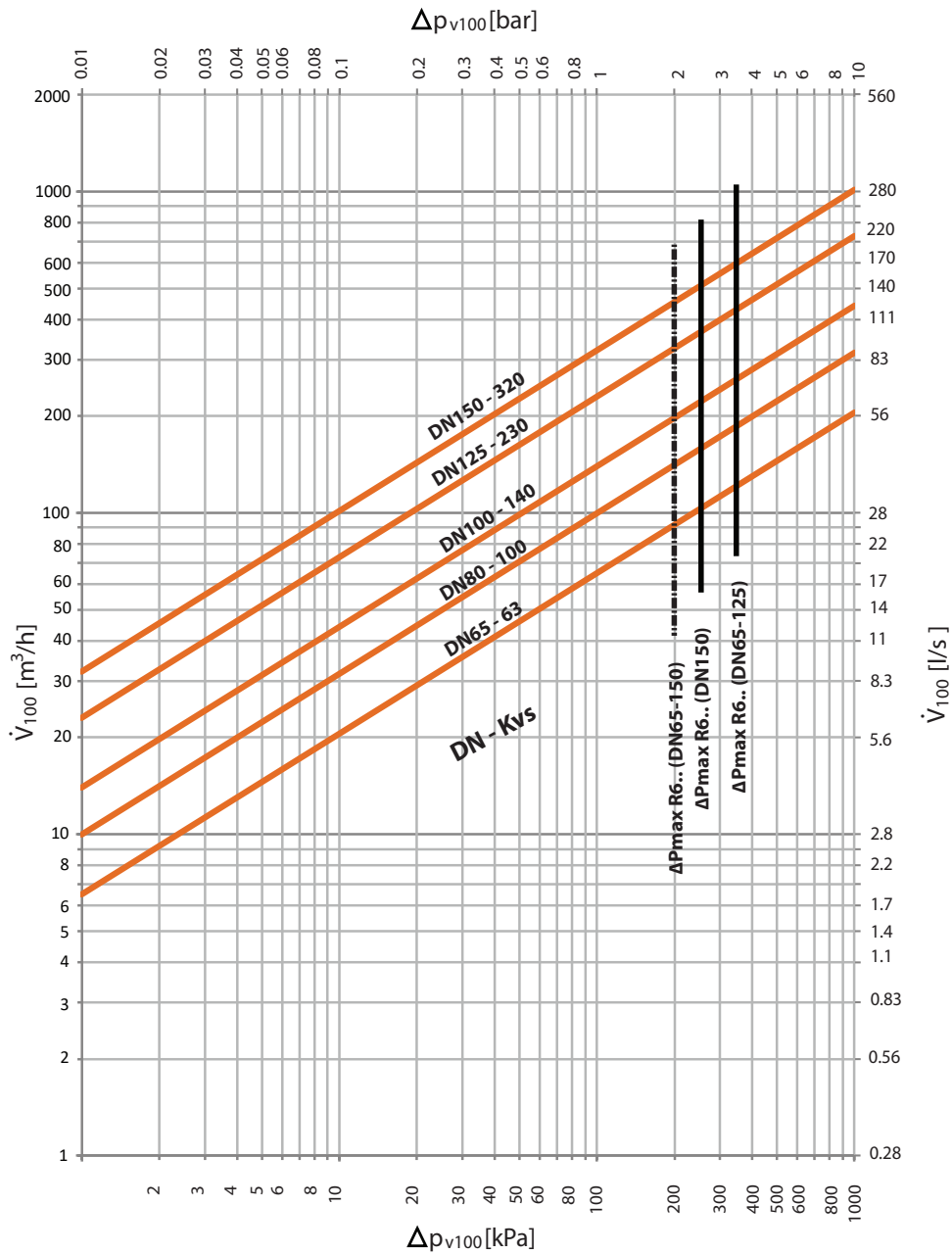
Calculation diagram for 2-way characterised control valves R6..AO



Application These characterised control valves are used in open and closed cold and hot water systems for modulating water-side control of air treatment and heating plants.

Media Cold and hot water, water with glycol up to max. 50% vol.

Medium temperatures -5...+100°C



— Δp_{max}
Maximum permitted differential pressure for long service life across control path A – AB, with reference to the whole opening range.

----- Δp_{max}
For low-noise operation (R6..AO)

Δp_{V100}
Differential pressure with ball valve full open.







\dot{V}_{100}
Nominal flow rate with Δp_{V100}

Formula k_{Vs}

$$k_{Vs} = \frac{\dot{V}_{100}}{\sqrt{\frac{\Delta p_{V100}}{100}}}$$

k_{Vs} [m³/h]
 \dot{V}_{100} [m³/h]
 Δp_{V100} [kPa]

Characterised control valve selection table

Rated pressure p_s [kPa] pressure class		2500 PN 25 (DN32...80)	4000 PN 40 (DN15...25)	1600 PN 16
Max. differential pressure Δp_{max} [kPa]		350 (DN15...50) 200 (DN65...80) (200 for low-noise operation)		350 (DN65...125) <250 (DN150) (200 for low-noise operation)
Valve design (2-way / 3-way)				
Internal thread (ISO 7-1)				
Flange (ISO 7005-2)				
Valve characteristic curve — Control path A–AB ----- Bypass B–AB				
Characterised control valves		R2..	R3..	R6..AO
k_{vs}	DN			
0.25	15	R2015-P25-S1	R3015-P25-S1	
0.4	15	R2015-P4-S1	R3015-P4-S1	
0.63	15	R2015-P63-S1	R3015-P63-S1	
1	15	R2015-1-S1	R3015-1-S1	
1.6	15	R2015-1P6-S1	R3015-1P6-S1	
2.5	15	R2015-2P5-S1	R3015-2P5-S1	
4	15	R2015-4-S1	R3015-4-S1	
	20	R2020-4-S1 / R2020-4-S2	R3020-4-S1 / R3020-4-S2	
6.3	15	R2015-6P3-S1		
	20	R2020-6P3-S1 / R2020-6P3-S2	R3020-6P3-S1 / R3020-6P3-S2	
	25	R2025-6P3-S2	R3025-6P3-S2	
8.6	20	R2020-8P6-S2		
10	25	R2025-10-S2	R3025-10-S2	
	32	R2032-10-S2	R3032-10-S2	
16	25	R2025-16-S2		
	32	R2032-16-S3	R3032-16-S3	
	40	R2040-16-S2 / R2040-16-S3	R3040-16-S3	
20	32	R2032-20-S2		
25	25	R2025-25-S2		
	32	R2032-25-S3	R3032-25-S3	
	40	R2040-25-S2 / R2040-25-S3	R3040-25-S4	
	50	R2050-25-S3 / R2050-25-S4	R3050-25-S4	
40	40	R2040-40-S4	R3040-40-S4	
	50	R2050-40-S3 / R2050-40-S4	R3050-40-S4	
58	50	R2050-58-S4	R3050-58-S4	
63	65			R664AO
70	50	R2050-70-S4		
100	80			R679AO
140	100			R6099AO
150	65	R2065-150-S4		
	80	R2080-150-S4		
230	125			R6124AO
320	150			R6149AO

Medium temperature

The permissible medium temperatures can be found in the corresponding valve and actuator data sheets.

Leakage rate



2-way: Leakage rate A, air bubble tight (EN 12266-1)

3-way: Control path A – AB leakage rate A, tight (EN 12266-1)

Bypass B – AB leakage rate class I (EN 1349 and EN 60534-4), 1...2% of k_{vs} value

- For all possible combinations with rotary actuators and their closing pressures and maximum permissible differential pressures, see the document "Overview Valve-actuator combinations"
- For detailed information concerning rotary actuators, see the data sheets for the rotary actuators

Dimensioning and selection table for 2-way and 3-way open-close ball valves

Differential pressure Δp_{\max} [kPa]	0.1	1.0	3.0	10.0	k_{vs} [m ³ /h]	DN [mm]		
Flow rate \dot{V}_{100} [m ³ /h]	0.38	1.2	2.1	3.8	12	15		R3020-S1
	0.47	1.5	2.6	4.7	15	15	R2015-S1	R3015-S1
						20	R2020-S1	
	0.57	1.8	3.1	5.7	18	32		R3032-S2
	0.82	2.6	4.5	8.2	26	25	R2025-S2	R3025-S2
	1.0	3.1	5.4	9.8	31	40	R2040-S2 / R2040-S3	R3040-S3
						20	R2020-S2	R3020-S2
	1.0	3.2	5.5	10.1	32	32	R2032-S2 / R2032-S3	R3032-S3
						50	R2050-S3 / R2050-S4	R3050-S4
	1.6	4.9	8.5	15.5	49	65	R665AO	
	3.8	12.0	20.8	37.9	120	80	R680AO	
	5.7	18.0	31.2	56.9	180	100	R6100AO	
	7.3	23.0	39.8	72.7	230	125	R6125AO	
12.3	39.0	67.5	123.3	390	150	R6150AO		
18.0	57.0	98.7	180.2	570				

$$\text{Formula } \dot{V}_{100} \dot{V}_{100} = k_{vs} \sqrt{\frac{\Delta p_{v100}}{100}}$$

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

Connections: **R2.. / R3..** Internal thread
R6..AO Flange

Standard direction of flow

<p>Characterised Control Valves</p>	<p>Open</p>	<p>Closed</p>	<p>2-way R2...-S..., R6...AO</p>
	<p>A-AB Open</p>	<p>A-AB Closed</p>	<p>3-way R3...-S..</p>
<p>Open/Close Ball Valves</p>	<p>Open</p>	<p>Closed</p>	<p>2-way R2...-S..., R6...AO</p>
	<p>A-AB Open</p>	<p>A-AB Closed</p>	<p>3-way R3...-S..</p>
<p>Spindle position for corresponding valve flow</p>			<p>For 2-way and 3-way Ball Valves</p>
<p>Actuator position corresponding to Ball Valve flow direction</p>			

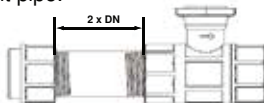
Mounting, installation and commissioning

Separate supply

When Ball Valve and Rotary Actuator are supplied separately, they can be assembled on-site.

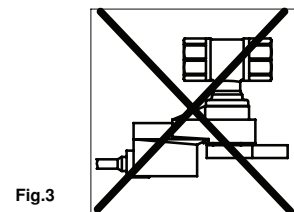
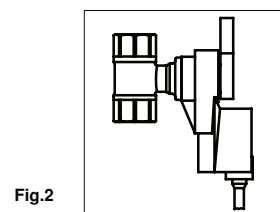
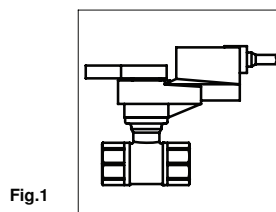
Recommended straight pipe installation

It is a general recommendation to keep minimum 2xDN of straight piping distance before the CCV installation in the pipe, to perform the best control function. For the outlet side of the CCV, there is no requirement to keep the minimum distance of straight pipe.



Recommended mounting positions

The Ball Valves can be mounted vertically (Fig. 1) or horizontally (Fig. 2). However, mounting the Ball Valves with the spindle pointing downwards, i.e. upside down (Fig. 3), is not recommended.



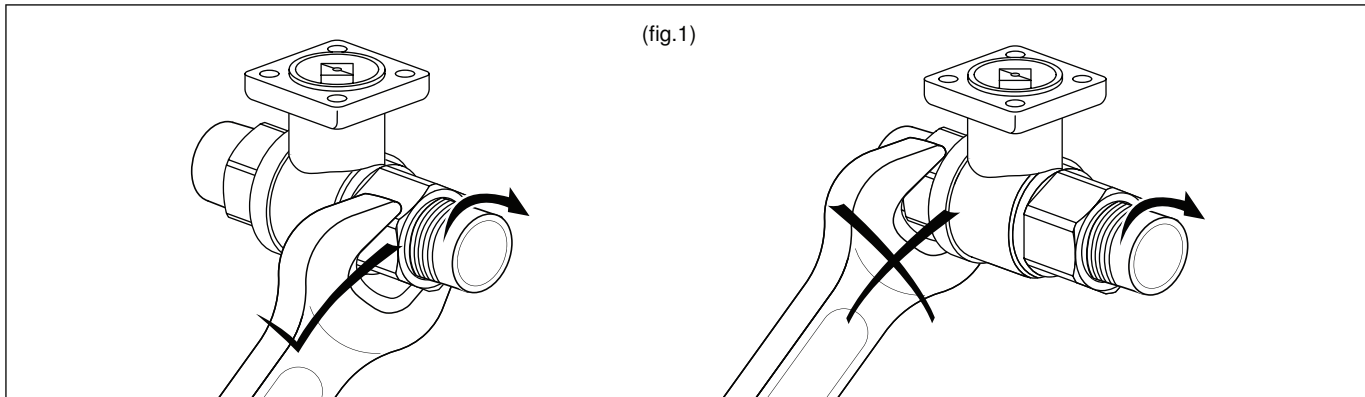
No special tools are needed for assembly. Instructions will be found packed with the valve and actuator.

Commissioning

Must not be carried out until the Ball Valve and Rotary Actuator have been assembled in accordance with the instructions.

DN15...50 CCV

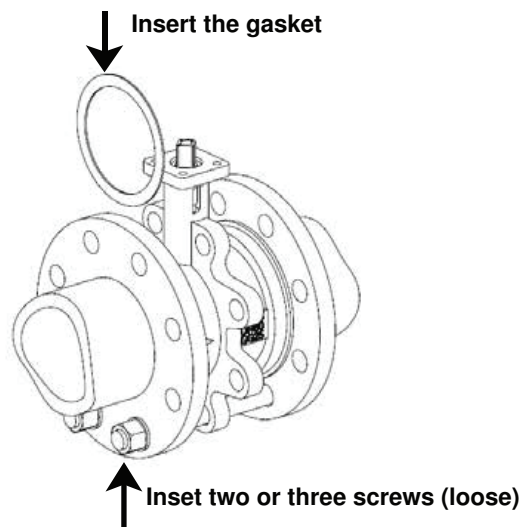
1. Clean pipe by compressed air or steam
2. Teflon tape or other sealing filler is recommended for pipe and valve thread end, pipe dope is not allowed on thread
3. Make sure the correct wrench position (fig.1)
4. Support pipeline to avoid pipe distortion



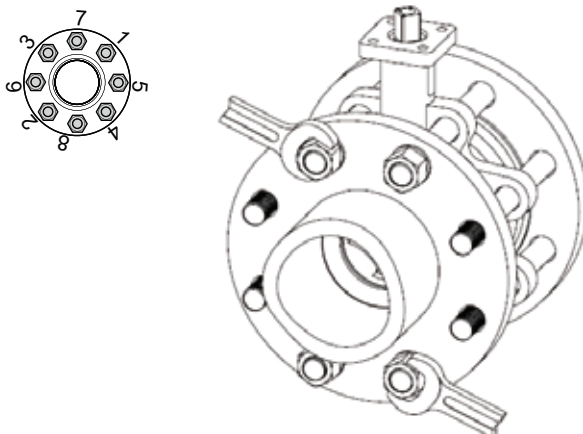
DN65...150 CCV

1. Clean the joint

2.



3. Insert the rest of the bolts, tighten all of the bolts evenly by the cross-over method to eliminate concentrated stresses.



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 five-year warranty. Our worldwide representatives in over 80 countries guarantee short delivery times and comprehensive 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

