2-way and 3-way globe valves

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Notes for project planning

Project planning

Relevant information
The data, information and limit values listed on the data sheets for the globe valves and linear actuators are to be taken into account and/or complied with, respectively.

Closing pressures
Maximum closing pressures $\Delta p$ are dependent on the valve size and the drive force. The values for all valve-actuator combinations are to be found in the closing pressure table «Overview Valve-actuator combinations».

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 are defined in the «Globe valves» data sheets.

2-way globe valves
2-way globe valves are to be provided as throttling devices in the return. This leads to lower thermal loads on the sealing elements in the valve. The prescribed flow direction must be observed.

3-way globe valves
3-way globe 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. In the case of the diverting circuit, it is recommended that a balancing drive be provided in the bypass line.

Dirt filter
Globe 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.

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

Flow characteristics

2-way globe valve
The characteristic curve is equal-percentage, with a characteristic curve factor $n(gl) = 3$. This guarantees stable control characteristics in the elevated partial load range. The curve is linear in the lower opening range between 0 … 30% stroke. This ensures outstanding control characteristics, including in the lower partial load range, see graph on the right.

3-way globe valve
Same behaviour via the control path A–AB as with the 2-way globe valves. The bypass B–AB exhibits the same $k_{vs}$ value as the control path. The characteristic curve in the bypass is linear, see graph on the right.

3-way globe valve with linear control path
(Valves ..W..<..S, H7..<..X..<..S, H7..<..Y..<..S)
Control path A–AB and bypass B–AB both exhibit a linear characteristic curve and the same $k_{vs}$ value, see graph on the right.

Note
The flow characteristics are achieved by the profiling/geometry of the valve cone.
Notes for project planning

Background

Principles of flow control

Direction of flow

The flow direction of the medium always runs against the cone which closes the control path.

2-way globe valve with closing point at bottom

![Diagram of 2-way globe valve with closing point at bottom]

Legend

1. Valve stem
2. Stem extension
3. Stem guide
4. Valve cone
5. Valve seat (A–AB)
6. Valve

3-way globe valve with closing point at top

![Diagram of 3-way globe valve with closing point at top]

Legend

1. Valve stem
2. Stem extensions
3. Valve seat (A–AB)
4. Valve cone
5. Valve seat Bypass (B–AB)
6. Axial fuse valve cone
7. Valve

Partial pressure-reduced 2-way globe valve with closing point at bottom

![Diagram of Partial pressure-reduced 2-way globe valve with closing point at bottom]

Legend

1. Valve stem
2. Stem guide
3. Piston guide
4. Valve cone
5. Valve seat (A–AB)
6. Valve

Function

The partial pressure reduction occurs as the result of the supply pressure of the medium (from Port A) also having an effect on the opposite side of the valve cone through the borehole in the valve cone. The actuator therefore only has to deliver the pressure force to ensure that the piston does not leak in its seat. As a result, much greater closing pressures can be achieved than is the case with non-partial pressure-reduced valves.
**Hydraulic circuits**

**Control characteristics**

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 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 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. An a_v of >0.5 is strived for in everyday practice.

**Differential pressures Δp_1/100 with globe valve completely open**

<table>
<thead>
<tr>
<th>Circuit</th>
<th>2-way globe valves: H4..B / H6..R / H6..N / H6..S / H6..SP / H6..W..S / H6..X..S</th>
<th>3-way globe valves: H5..B / H7..R / H7..N / H7..W..S / H7..X..S / H7..Y..S</th>
</tr>
</thead>
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<tr>
<td>Throttling circuit</td>
<td>Δp_1/100 &gt; Δp_{VR} / 2</td>
<td>Δp_1/100 &gt; Δp_{MV}</td>
</tr>
<tr>
<td>Typical values:</td>
<td>15 kPa &lt; Δp_1/100 &lt; 200 kPa</td>
<td>Typical values: 5 kPa &lt; Δp_1/100 &lt; 50 kPa</td>
</tr>
<tr>
<td>Injection circuit with</td>
<td>Δp_1/100 &gt; Δp_{VR} / 2</td>
<td>Δp_1/100 &gt; Δp_{MV}</td>
</tr>
<tr>
<td>throttling device</td>
<td>Typical values: 10 kPa &lt; Δp_1/100 &lt; 150 kPa</td>
<td>Typical values: 5 kPa &lt; Δp_1/100 &lt; 50 kPa</td>
</tr>
<tr>
<td>Diverting circuit</td>
<td>Δp_1/100 &gt; Δp_{MV}</td>
<td>Δp_1/100 &gt; Δp_{MV}</td>
</tr>
<tr>
<td>Typical values:</td>
<td>10 kPa &lt; Δp_1/100 &lt; 50 kPa</td>
<td>Typical values: 3 kPa &lt; Δp_1/100 &lt; 30 kPa</td>
</tr>
<tr>
<td>Mixing circuit</td>
<td>Δp_{MV1} + Δp_{MV2} = 0</td>
<td>Δp_1/100 &gt; Δp_{MV}</td>
</tr>
<tr>
<td>Injection circuit with</td>
<td>Δp_1/100 &gt; Δp_{MV}</td>
<td>Typical values: 3 kPa &lt; Δp_1/100 &lt; 30 kPa</td>
</tr>
<tr>
<td>3-way characterised control</td>
<td></td>
<td>Other mixing circuits: 3 kPa &lt; Δp_1/100 &lt; 30 kPa</td>
</tr>
<tr>
<td>valve</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legend:**
- © Globe valve, 2-way, with linear actuator
- © Globe valve, 3-way, with linear actuator
- Pump
- Non-return valve
- Balancing valve
- Differential pressure at the respective branching (supply / return) at nominal load
- Differential pressure in quantity-variable part with nominal load (e.g. exchanger)
Notes for project planning

Design and dimensioning

Design for use with glycol

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 … 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 ±10% in accordance with VDE 2173) and need not as a rule be taken into account, even if glycols require a slightly elevated \( k_v \) value. Depending on the type of glycol, tolerance with the valve materials used must be ensured and the permitted maximum concentration may not be exceeded.

**Rounding-off rules**

In practice, the desired \( k_v \) value never exactly matches the available \( k_{vs} \) value of a valve. It is therefore either the next largest or the next smallest valve which is selected when it comes to selecting the valve. This could lead to two situations:

1. The desired \( k_v \) value is not exactly between two \( k_{vs} \) values. Rounding is done then either up or down, accordingly.

   **Exemplary**
   A valve is needed with a \( k_v \) value of 4.8 m\(^3\)/h. The \( k_{vs} \) values 4 m\(^3\)/h and 6.3 m\(^3\)/h are available, and a \( k_{vs} \) value of 4 m\(^3\)/h is then selected.

2. The desired \( k_v \) value is exactly between two \( k_{vs} \) values. It is recommended that one select as follows:
   - 2-way valve – the smaller \( k_{vs} \) value
   - 3-way valve – the larger \( k_{vs} \) value

   **Exemplary**
   A valve is needed with a \( k_v \) value of 5.15 m\(^3\)/h. The \( k_{vs} \) values 4 m\(^3\)/h and 6.3 m\(^3\)/h are available. Accordingly, a \( k_{vs} \) value of 4 m\(^3\)/h is selected for the 2-way valve and a \( k_{vs} \) value of 6.3 m\(^3\)/h is selected for the 3-way valve.

Design in low-pressure steam applications

**Alignment and installation position**

Trouble-free operation in steam applications depends on the correct installation position and design of the control valve. The arrangement of the steam pipeline and the positioning of the condensation drain are also decisive.

**Restrictions**

Belimo control valves may only be used in steam applications which involve a subcritical steam-pressure ratio of between 0 and 0.4, and then only with equal percentage valve characteristic curves (medium speed \( v \) max. 50 m/s).

Installations with a resulting pressure ratio in the supercritical range between 0.4 and 1 are not permitted with Belimo valves.

**Steam ratio**

\[
\frac{p_1 - p_2}{p_1}
\]

Pressure specifications in absolute pressures
**Notes for project planning**

**Design and dimensioning**

**Dimensions diagram for 2-way and 3-way globe valves**

**Variables**

- $\Delta p_{v100}$ [bar]: Pressure difference with globe valve completely open.
- $\Delta p_{100}$: Closing pressure at which the linear actuator can still seal the fitting tightly, with reference to the particular leakage class.
- $\psi_{100}$ [m³/h]: Nominal flow rate with $\Delta p_{v100}$.
- $k_{v}$ [l/s]: Formula
  
  $$k_{v} = \frac{\psi_{100}}{\Delta p_{100}}$$

- $\Delta p_{\text{max}}$: Maximum permitted pressure difference for long service life across control path A – AB, with reference to the whole range of opening.

- $\Delta p_{100}$: Pressure difference with globe valve completely open.
### Selection of globe valves

<table>
<thead>
<tr>
<th>Pressure class / rated pressure $p_r$</th>
<th>PN6</th>
<th>PN16</th>
<th>PN25</th>
<th>PN40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. differential pressure $\Delta p_{max}$ [kpa]</td>
<td>400</td>
<td>400</td>
<td>1000</td>
<td>1000</td>
</tr>
</tbody>
</table>

**Valve design (2-way / 3-way)**

- H6..R
- H7..R
- H4..B
- H5..B
- H6..N
- H7..N
- H6..W..S
- H7..W..S
- H6..S
- H6..SP
- H7..X..S
- H7..X..SP
- H7..Y..S

**Flange (ISO 7005-2)**

- External thread (ISO228)

**Valve characteristic curve**

- Control path A–AB
- Bypass B–AB

<table>
<thead>
<tr>
<th>$k_v$</th>
<th>DN</th>
<th></th>
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<tbody>
<tr>
<td>0.4</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>0.63</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>1.6</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>2.5</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>6.3</td>
<td>65</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>125</td>
<td></td>
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<tr>
<td>40</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>58</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>63</td>
<td>250</td>
<td></td>
</tr>
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</table>

Max. closing pressures $\Delta p_c$

Depending on the drive force – values in the closing pressure table

"Overview Valve-actuator combinations"

### Selection of linear actuators

- For all possible combinations with linear actuators and the closing pressures they achieve, see "Overview Valve-actuator combinations"
- For detailed information concerning linear actuators, see the data sheets for the linear actuators
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