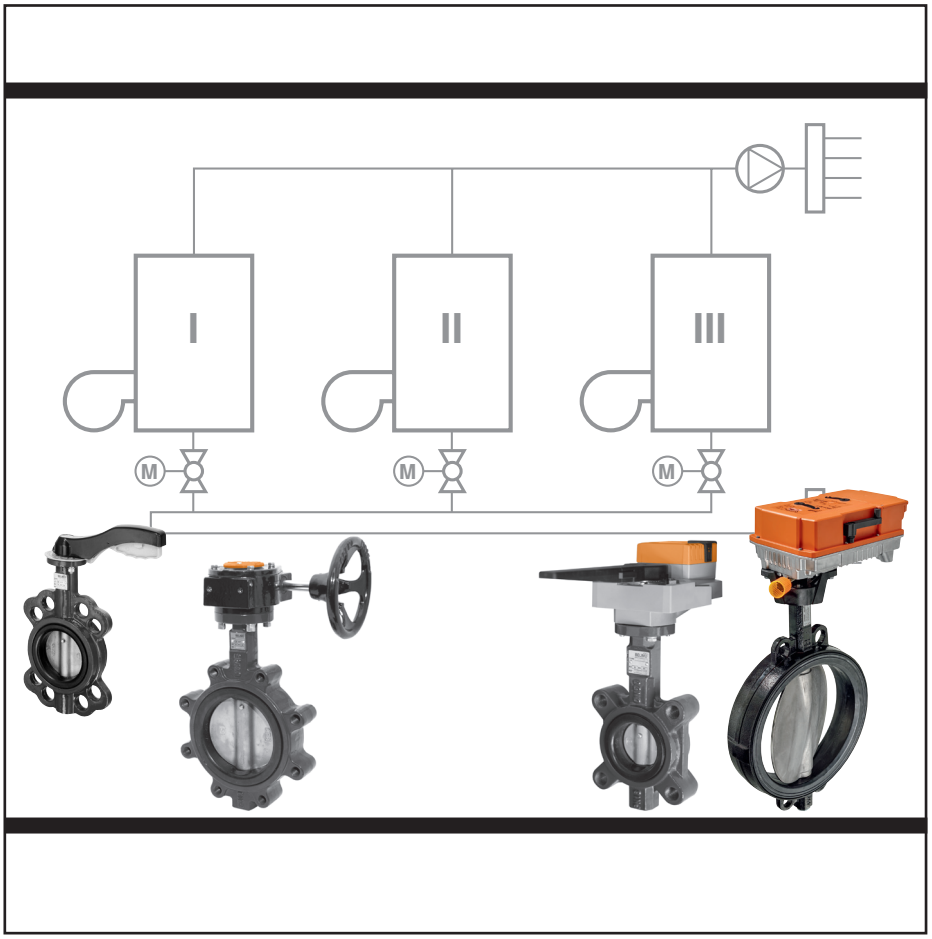


# Butterfly valves for open-close applications and control mode

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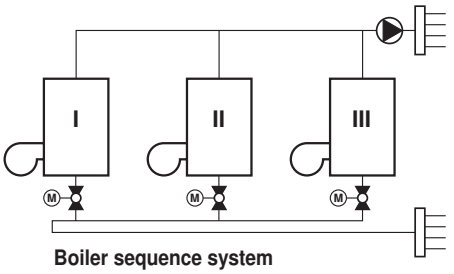
## Introduction

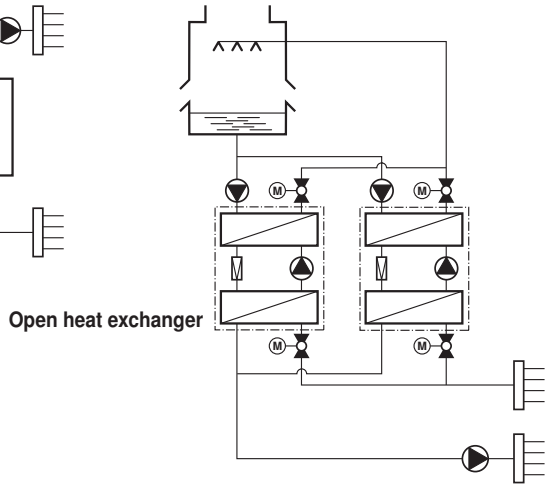
**Open-close applications**

Energy savings and the reduction of the leakage losses will become ever more important in the future. The generation outputs of boilers or chilling systems are divided up into different performance level categories. Depending on the decline in pressure, the generators will then be switched either on or off. The generators will be blocked in order to minimise performance loss. The leakage rate (shut-off seat) shall be kept as low as possible. The pressure loss shall also be low with the valves opened completely. These are prerequisites for minimising the electrical performance of the pumps and thus for lowering operating costs.

Typical applications




Boiler sequence system

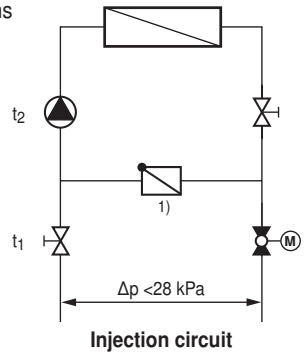



Open heat exchanger

**Control mode**

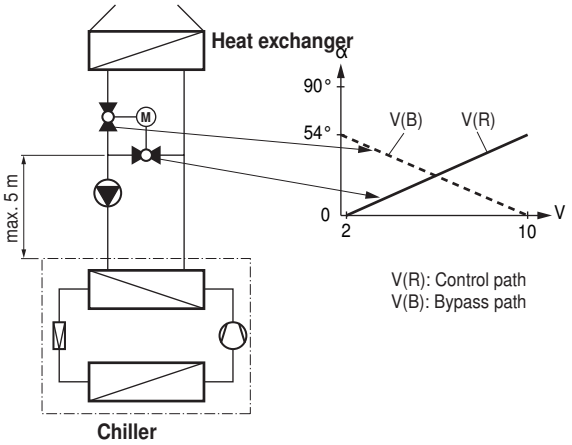
The BELIMO butterfly valves exhibit a nearly equal-percentage characteristic curve in accordance with VDI 2176 for opening angles between 0° and 54° and can also be installed in injection circuits or heat exchangers as an inexpensive final controlling element.

Typical applications




Injection circuit

1) with non-return valve will be $t_1 > t_2$




V(R): Control path
V(B): Bypass path

Chiller

**Valves and actuators product range**

24 V and 230 V rotary actuators with different functionalities, auxiliary switches and with emergency control function in a variety of torque classes ranging from 20 to 3500 Nm are available for selection for the motorisation of the BELIMO Wafer type and Lug type butterfly valves (DN 25 to 700) for indoor and outdoor applications: SR..A-5, SRF..A-5, SR..P, GR..A-5, DR..A-5, DR..-7,PR.. and SY.. .
The butterfly valves can be operated manually with a lever or a worm gear.

## Introduction *(continued)*

### Valves and actuators product range

Fig. Wafer type butterfly valve with hand lever

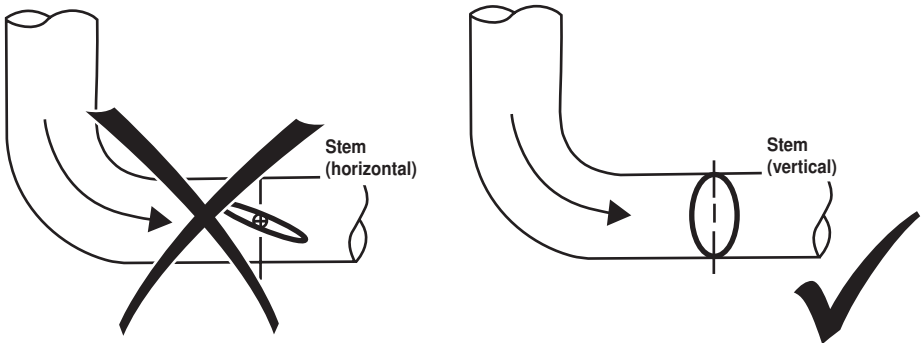
Fig. Lug type butterfly valve with worm gear

Fig. Lug type butterfly valve with SR..A-5 actuator

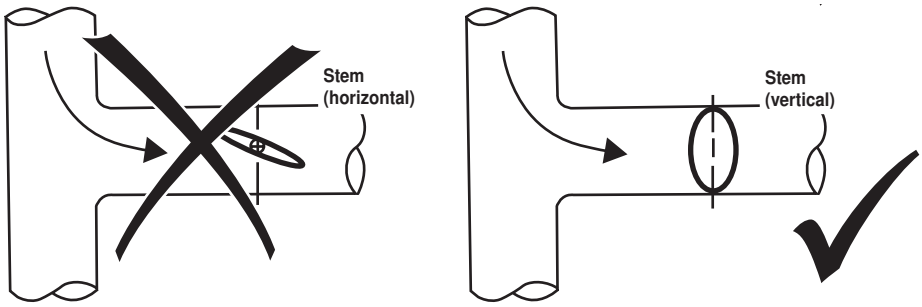
Fig. Wafer type butterfly valve with PR.. actuator

## Installation

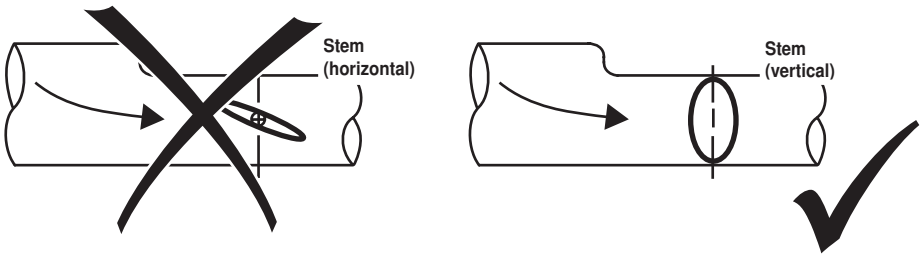
### Butterfly valve located after a bend



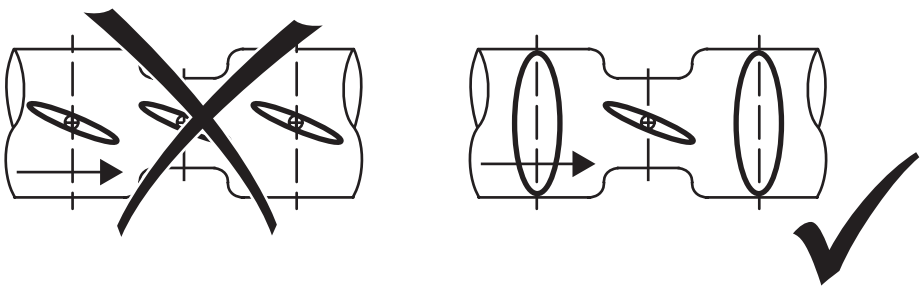

### Butterfly valve located after a T-piece




### Butterfly valve located after a pipe reducer



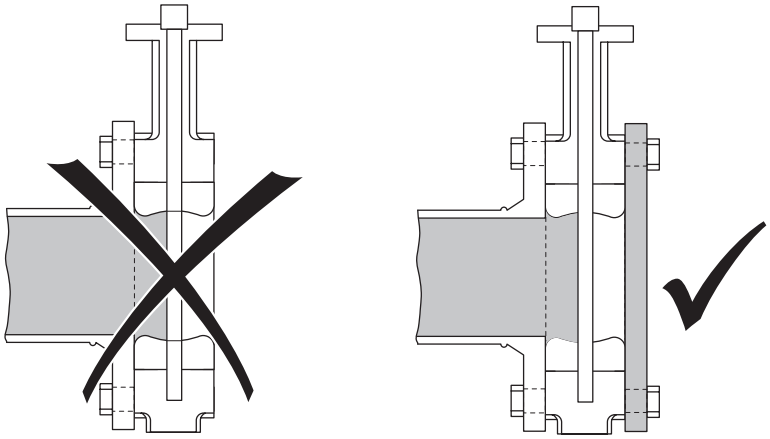

### Butterfly valves in combination for control / isolation applications



## Installation *(continued)*

**Installation of the butterfly valves**

as end fitting

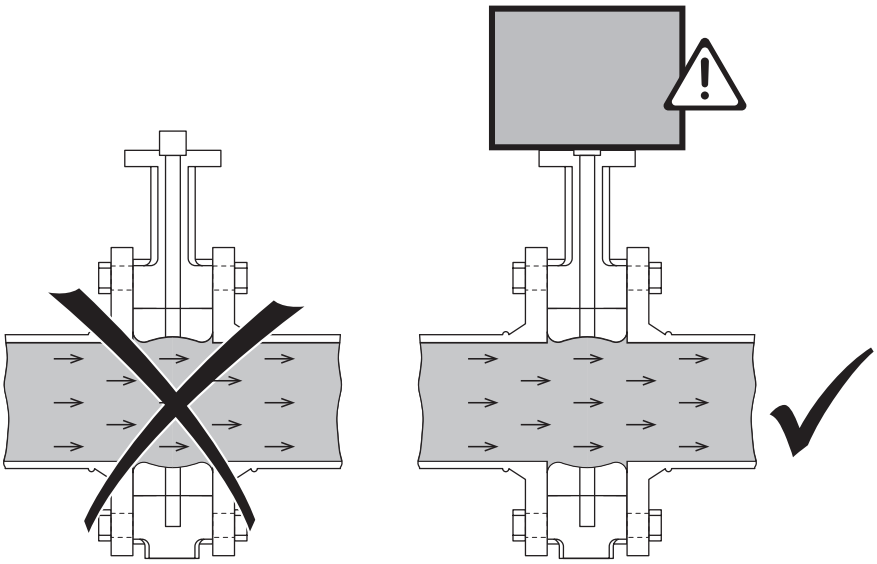


D6..N(L) butterfly valves must be mounted with counter flange in open systems. For D6..W(L) the counter flange must be closed.

Generally speaking D6.. butterfly valves must run through a full cycles at least once per month in order to reduce the breakaway torque.

**Important for butterfly valves D6..W(L)**

The butterfly valves D6..W und D6..WL may not be operated without an actuator or worm gear if there is flow in the line. In the absence of an actuator or worm gear, the butterfly valve might close and cause damage (water hammer).



## Project planning

**Design**

The data, information and limit values listed on the data sheets and mounting instructions D6.. are to be taken into account and/or complied with, respectively.

**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.

## Design and dimensioning

**General information**

The valves can be used when the following values for open-close applications are complied with:
– The maximum flow speed of 4 m/s may not be exceeded in the valve.
– The valve is to be selected in such a way that the nominal pipe width corresponds to = nominal valve width and the pressure drop off is kept as low as possible.

**D6..N(L) + ZD6N-.. combinations**

| Butterfly valve | | | Lever | Worm gear [2] |
|---|---|---|---|---|
| Type | DN [mm] | ζ Zeta value | | |
| **D625N(L)** | 25 | 0,32 | ZD6N-H100 | ZD6N-S100 |
| **D632N(L)** | 32 | 0,55 | ZD6N-H100 | ZD6N-S100 |
| **D640N(L)** | 40 | 0,83 | ZD6N-H100 | ZD6N-S100 |
| **D650N(L)** | 50 | 1,23 | ZD6N-H100 | ZD6N-S100 |
| **D665N(L)** | 65 | 0,88 | ZD6N-H100 | ZD6N-S100 |
| **D680N(L)** | 80 | 0,73 | ZD6N-H100 | ZD6N-S100 |
| **D6100N(L)** | 100 | 0,47 | ZD6N-H100 | ZD6N-S100 |
| **D6125N(L)** | 125 | 0,58 | ZD6N-H150 | ZD6N-S150 |
| **D6150N(L)** | 150 | 0,32 | ZD6N-H150 | ZD6N-S150 |
| **D6200W(L)** | 200 | 0,3 | | ZD6N-S150 |
| **D6250W(L)** | 250 | 0,32 | | ZD6N-S150 |
| **D6300W(L)** | 300 | 0,24 | | ZD6N-S150 |
| **D6350N(L)** | 350 | 0,2 | | ZD6N-S350 |
| **D6400N(L)** | 400 | 0,20 | | ZD6N-S400 |
| **D6450N(L)** | 450 | 0,19 | | ZD6N-S450 |
| **D6500N(L)** | 500 | 0,17 | | ZD6N-S500 |
| **D6600N(L)** | 600 | 0,17 | | ZD6N-S600 |
| **D6700N(L)** | 700 | 0,21 | | ZD6N-S700 |

$k_{V}max$ values and approved differential pressure $\Delta p_{V}100$ are illustrated in the table «Flow rate butterfly valves D6..» on page 5.

[2] Worm gears are not suitable for outdoor applications.

## Design and dimensioning *(continued)*

**Closing pressure D6..N / D6..NL DN 25 ... DN 150 D6..W / D6..WL DN 200 ... DN 300**

| Butterfly valve | | | Actuators | | | |
|---|---|---|---|---|---|---|
| | | | SR.. | GR.. | DR.. | PR.. |
| Typ | DN [mm] | $k_vmax$ [m³/h] | $\Delta p_s$ [kPa] | $\Delta p_s$ [kPa] | $\Delta p_s$ [kPa] | $\Delta p_s$ [kPa] |
| D625N(L) | 25 | 45 | 1200 | 1200 | | |
| D632N(L) | 32 | 55 | 1200 | 1200 | | |
| D640N(L) | 40 | 70 | 1200 | 1200 | | |
| D650N(L) | 50 | 90 | 1200 | 1200 | | |
| D665N(L) | 65 | 180 | 1200 | 1200 | | |
| D680N(L) | 80 | 300 | | 1200 | 1200 | |
| D6100N(L) | 100 | 580 | | | 1200 | 1200 [1] |
| D6125N(L) | 125 | 820 | | | 1200 | 1200 [2] |
| D6150N(L) | 150 | 1600 | | | | 1200 [2] |
| D6200W(L) | 200 | 2900 | | | | 1400 [2] |
| D6250W(L) | 250 | 4400 | | | | 1400 [2] |
| D6300W(L) | 300 | 7300 | | | | 800 [2] |

[1] ZPR03 Linkage
[2] ZPR01 Linkage

**Closing pressure D6..N / D6..NL DN 350 ... DN 700**

| Butterfly valve | | | Actuators | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | SY6 | SY7 | SY8 | SY9 | SY10 | SY12 |
| Typ | DN [mm] | $k_vmax$ [m³/h] | $\Delta p_s$ [kPa] | $\Delta p_s$ [kPa] | $\Delta p_s$ [kPa] | $\Delta p_s$ [kPa] | $\Delta p_s$ [kPa] | $\Delta p_s$ [kPa] |
| D6350N(L) | 350 | 10900 | 600 | 1200 [3] | | | | |
| D6400N(L) | 400 | 14200 | 600 [4] | 1000 [5] | | | | |
| D6450N(L) | 450 | 18800 | | 600 [6] | 1000 [6] | | | |
| D6500N(L) | 500 | 24100 | | | 600 [6] | 1000 [7] | | |
| D6600N(L) | 600 | 37300 | | | | | 600 [8] | 1000 [8] |
| D6700N(L) | 700 | 42800 | | | | | | 200 [9] |

[3] ZSY-703 Linkage
[4] ZSY-401 Linkage
[5] ZSY-701 Linkage
[6] ZSY-702 Linkage
[7] ZSY-901 Linkage
[8] ZSY-902 Linkage
[9] ZSY-903 Linkage

**Flow rate butterfly valves D6..N / D6..NL**

| Butterfly valve | | | Differential pressure $\Delta p_{v100}$ | | | | |
|---|---|---|---|---|---|---|---|
| Type | DN [mm] | $k_vmax$ [m³/h] | 0,01 [kPa] | 0,1 [kPa] | 1 [kPa] | 2 [kPa] | 3 [kPa] |
| D625N(L) | 25 | 45 | 0,5 | 1,4 | 4,5 | 6,4 | |
| D632N(L) | 32 | 55 | 0,6 | 1,7 | 5,5 | 7,8 | |
| D640N(L) | 40 | 70 | 0,7 | 2,2 | 7 | 9,9 | 12,1 |
| D650N(L) | 50 | 90 | 0,9 | 2,8 | 9 | 12,7 | 15,6 |
| D665N(L) | 65 | 180 | 1,8 | 5,7 | 18 | 25,5 | |
| D680N(L) | 80 | 300 | 3,0 | 9,5 | 30 | 42 | |
| D6100N(L) | 100 | 580 | 5,8 | 18,3 | 58 | 82 | |
| D6125N(L) | 125 | 820 | 8,2 | 26 | 82 | | |
| D6150N(L) | 150 | 1600 | 16 | 51 | 160 | | |
| D6200W(L) | 200 | 2900 | 29 | 92 | 290 | | |
| D6250W(L) | 250 | 4400 | 44 | 139 | 440 | | |
| D6300W(L) | 300 | 7300 | 73 | 231 | 730 | | |
| D6350N(L) | 350 | 10900 | 109 | 345 | 1090 | | |
| D6400N(L) | 400 | 14200 | 142 | 449 | 1420 | | |
| D6450N(L) | 450 | 18800 | 188 | 595 | 1880 | | |
| D6500N(L) | 500 | 24100 | 241 | 762 | 2410 | | |
| D6600N(L) | 600 | 37300 | 373 | 1179 | 3730 | | |
| D6700N(L) | 700 | 42800 | 428 | 1353 | 4280 | | |

Flow rate $\dot{V}_{100}$ [m³/h]

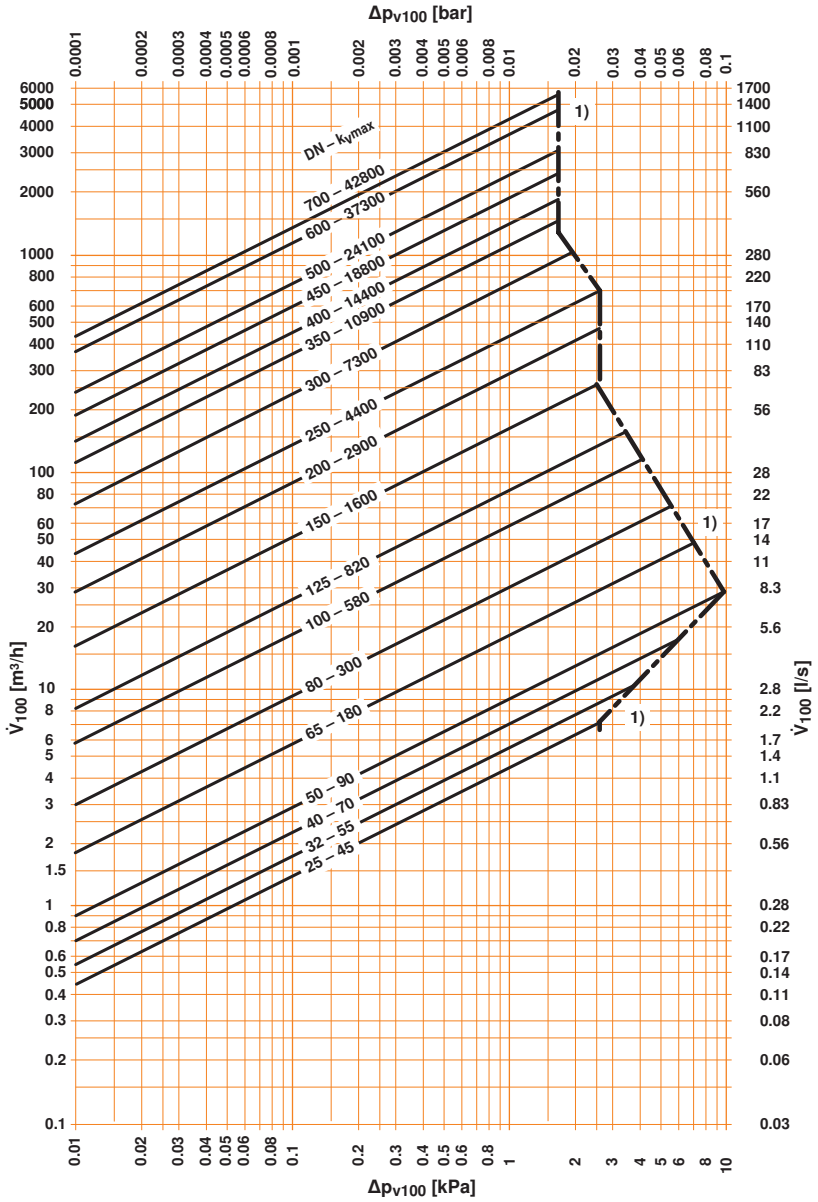
**Formula**

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

$\Delta p_{v100}$ [kPa]
$\dot{V}_{100}$ [m³/h]
$k_vmax$ [m³/h]

## Design and dimensioning *(continued)*

### Pressure drop




**Formula**

$$\frac{\Delta p_{v100}}{100} = \left(\frac{\dot{V}_{100}}{k_v max}\right)^2$$

| | |
|---|---|
| $\Delta p_{v100}$ | [kPa] |
| $\dot{V}_{100}$ | [m³/h] |
| $k_v max$ | [m³/h] |

**Legend**

| | |
|---|---|
| $\Delta p_{v100}$ | Differential pressure with valve completely open |
| $\dot{V}_{100}$ | Nominal flow rate with $\Delta p_{v100}$ |
| – · – · – | $\Delta p_{v100}$ |
| 1) | The maximum speed in the butterfly valves is 4 m/s |

## Project planning

**Design**

The data, information and limit values listed on the data sheets and mounting instructions D6.. are to be taken into account and/or complied with, respectively.

**Pipeline clearances**

The minimum clearances between the pipelines and the walls and ceilings required for project planning depend not only on the valve size but also on the selected actuator.

## Design and dimensioning

**General information**

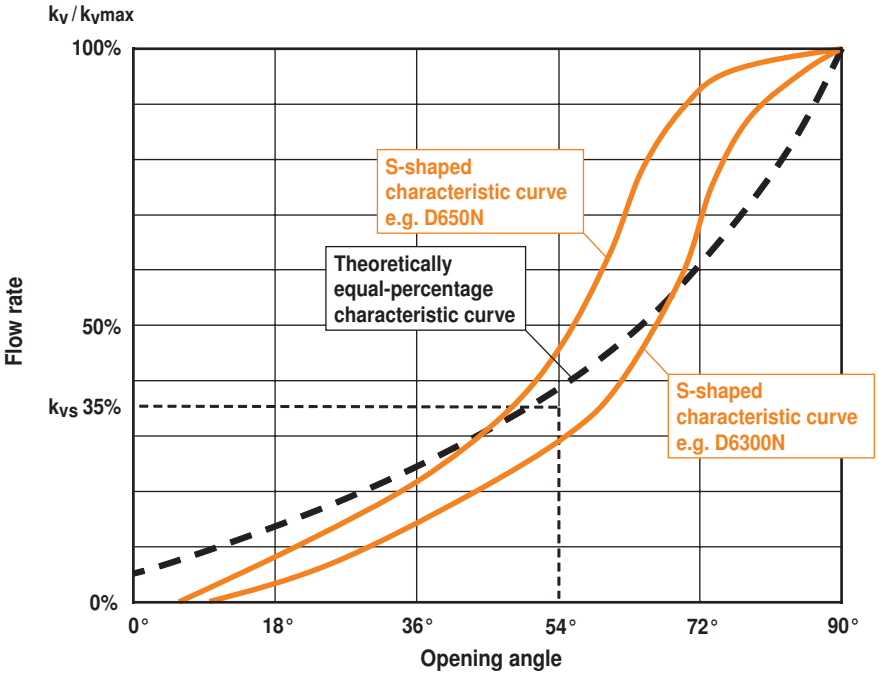
Butterfly valves can be used in control mode when the following values are complied with:
- The maximum flow speed of 4 m/s may not be exceeded in the butterfly valve.
- The butterfly valve is to be designed in such a way that the nominal pipe width corresponds to ≥ nominal butterfly valve width. The narrowing of the pipe must be designed in such a way thereby as to ensure optimum flow in order to ensure that the pressure drop is kept as low as possible.
- The maximum differential pressure for flow through the butterfly valve is 300 kPa (3 bar).

**Technical data for control mode**

| | |
|---|---|
| Differential pressure $\Delta p_{v0}$: | <300 kPa with valve cone opening (may not be exceeded) |
| Differential pressure $\Delta p_v$@54°: | The values listed in the Differential Pressure Table must be complied with |
| Valve authority: | >0.3 |
| Rangeability: | >30 |

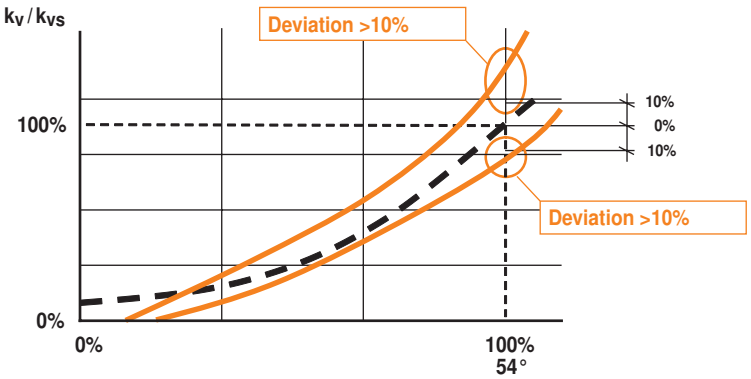
The S-shaped characteristic curve of the D6..N(L) butterfly valve (BFV) does not correspond to the equal percentage characteristic curve pursuant to VDI 2176. It is only in the angle of rotation range between 0° and 54° (60% of the full opening angle) that one can speak of an approximately equal percentage characteristic curve. For an opening angle of 54°, the $k_{vs}$ corresponds to approx. 35 percent of the $k_{vmax}$ value for a 90° opening angle.

**S-shaped characteristic curve**




**Definitions $k_{vmax}$ and $k_{vs}$**
The flow rate of $k_{vmax}$ will ensue when the disc is fully open (90°).
The $k_{vs}$ value refers to the flow rate at 54° opening angle, 1 bar pressure loss and medium temperature between 5 and 40°C.

Scaled characteristic curve range




The $k_{vs}$@54° listed in the differential pressure table deviates from the usual tolerance (±10%) for some nominal widths. The equivalence factor of the equal percentage characteristic curve is ~2.5.

## Design and dimensioning *(continued)*

Because of this fact, there is no configuration option available with the modulating actuators of limiting the angle of rotation range from 0° to 54°.
The angle of rotation range required can be adjusted accordingly afterwards with the MF and MP types using the PC-Tool MFT-P, Version 3.3 (not valid for SY actuators).

The differential pressure $\Delta p_v$@54° (marked in grey in the table «Flow rate») may not be exceeded. This will ensure that the maximum permissible medium speed of 4 m/s is maintained. Depending on the nominal width, the closing angle when in new condition lies between 2° and 16°.

### Flow rate

| Butterfly valve | | | | | |
|---|---|---|---|---|---|
| **Type** | **DN** [mm] | **$k_{vs}$@54°◁** [m³/h] | **$\dot{V}$@54°◁** [m³/h] | **$\Delta p_v$@54°◁** [kPa] | **Closing angle** New condition |
| **D625N(L)** | 25 | 16 | 5,8 | 13,4 | ~16°◁ |
| **D632N(L)** | 32 | 19 | 8,6 | 20,1 | ~16°◁ |
| **D640N(L)** | 40 | 25 | 13,0 | 28,0 | ~13°◁ |
| **D650N(L)** | 50 | 32 | 16,0 | 25,7 | ~13°◁ |
| **D665N(L)** | 65 | 63 | 27,7 | 19,3 | ~13°◁ |
| **D680N(L)** | 80 | 105 | 46,4 | 19,6 | ~13°◁ |
| **D6100N(L)** | 100 | 203 | 84 | 17,1 | ~10°◁ |
| **D6125N(L)** | 125 | 287 | 115 | 16,1 | ~10°◁ |
| **D6150N(L)** | 150 | 560 | 198 | 12,5 | ~10°◁ |
| **D6200W(L)** | 200 | 1015 | 350 | 11,9 | ~7°◁ |
| **D6250W(L)** | 250 | 1540 | 520 | 11,3 | ~7°◁ |
| **D6300W(L)** | 300 | 2555 | 790 | 9,6 | ~7°◁ |
| **D6350N(L)** | 350 | 3815 | 1000 | 6,8 | ~7°◁ |
| **D6400N(L)** | 400 | 4970 | 1435 | 8,3 | ~3°◁ |
| **D6450N(L)** | 450 | 6580 | 1750 | 7,1 | ~3°◁ |
| **D6500N(L)** | 500 | 8435 | 2020 | 5,7 | ~3°◁ |
| **D6600N(L)** | 600 | 13055 | 3200 | 6,0 | ~3°◁ |
| **D6700N(L)** | 700 | 14980 | 4360 | 8,5 | ~2°◁ |

**Formula**
The effective volumetric flow calculated for opening angle 54° is:

$$\dot{V}@54° = k_{vs}@54° \cdot \sqrt{\frac{\Delta p_v@54°}{100}}$$

$\dot{V}_{100}$@54° [m³/h]
$k_{vs}$@54° [m³/h]
$\Delta p$@54° [kPa]

### Closing pressure
**D6..N / D6..NL**
**DN 25 ... DN 150**
**D6..W / D6..WL**
**DN 200 ... DN 300**

| Butterfly valve | | | Actuators | | | |
|---|---|---|---|---|---|---|
| | | | **SR..** | **GR..** | **DR..** | **PR..** |
| **Typ** | **DN** [mm] | **$k_v$max** [m³/h] | **$\Delta p_s$** [kPa] | **$\Delta p_s$** [kPa] | **$\Delta p_s$** [kPa] | **$\Delta p_s$** [kPa] |
| **D625N(L)** | 25 | 45 | 1200 | 1200 | | |
| **D632N(L)** | 32 | 55 | 1200 | 1200 | | |
| **D640N(L)** | 40 | 70 | 1200 | 1200 | | |
| **D650N(L)** | 50 | 90 | 1200 | 1200 | | |
| **D665N(L)** | 65 | 180 | 1200 | 1200 | | |
| **D680N(L)** | 80 | 300 | | 1200 | 1200 | |
| **D6100N(L)** | 100 | 580 | | | 1200 | 1200 [1] |
| **D6125N(L)** | 125 | 820 | | | 1200 | 1200 [2] |
| **D6150N(L)** | 150 | 1600 | | | | 1200 [2] |
| **D6200W(L)** | 200 | 2900 | | | | 1400 [2] |
| **D6250W(L)** | 250 | 4400 | | | | 1400 [2] |
| **D6300W(L)** | 300 | 7300 | | | | 800 [2] |

[1] ZPR03 Linkage
[2] ZPR01 Linkage

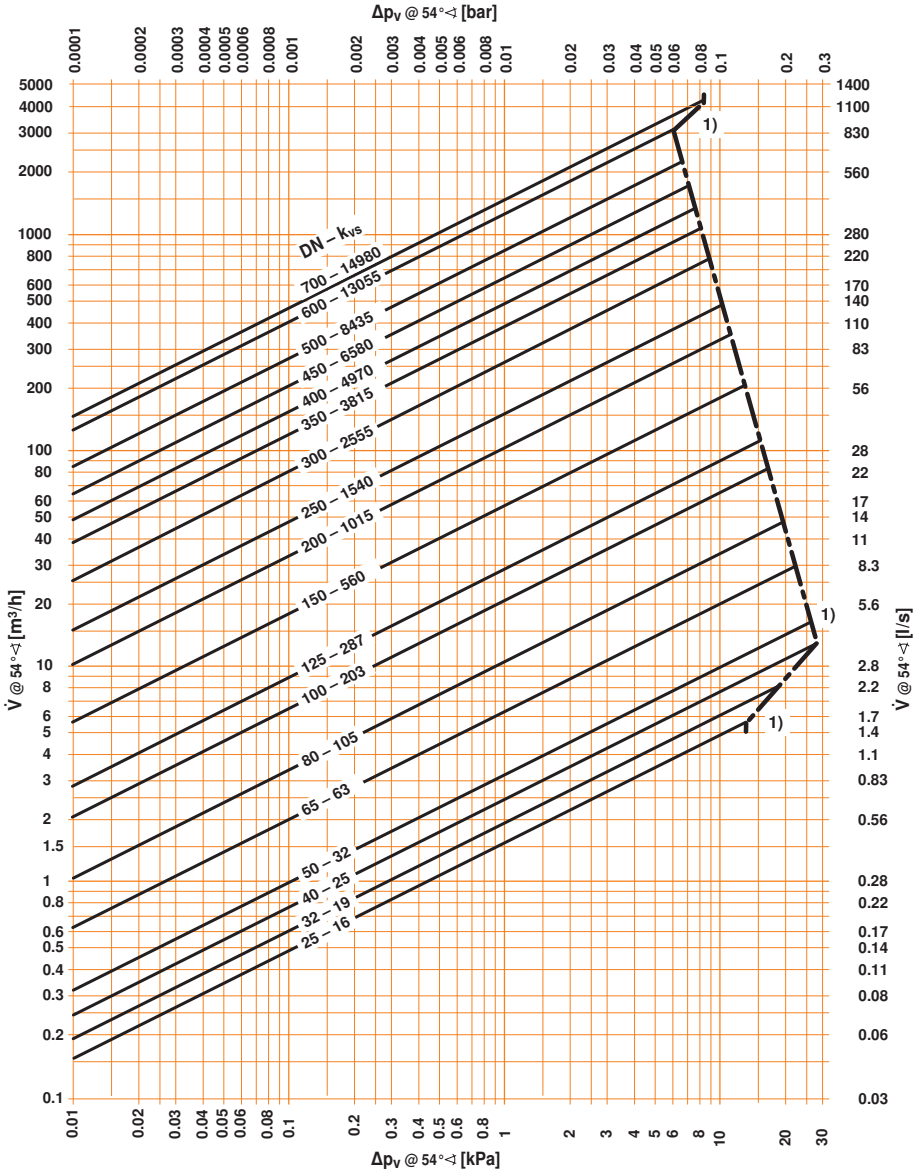
## Design and dimensioning *(continued)*

**Closing pressure D6..N / D6..NL DN 350 ... DN 700**

| Butterfly valve | | | Actuators | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | SY6 | SY7 | SY8 | SY9 | SY10 | SY12 |
| **Typ** | **DN** [mm] | **$k_v$max** [m³/h] | **$\Delta p_s$** [kPa] | **$\Delta p_s$** [kPa] | **$\Delta p_s$** [kPa] | **$\Delta p_s$** [kPa] | **$\Delta p_s$** [kPa] | **$\Delta p_s$** [kPa] |
| **D6350N(L)** | 350 | 10900 | 600 | 1200 3) | | | | |
| **D6400N(L)** | 400 | 14200 | 600 4) | 1000 5) | | | | |
| **D6450N(L)** | 450 | 18800 | | 600 6) | 1000 6) | | | |
| **D6500N(L)** | 500 | 24100 | | | 600 6) | 1000 7) | | |
| **D6600N(L)** | 600 | 37300 | | | | | 600 8) | 1000 8) |
| **D6700N(L)** | 700 | 42800 | | | | | | 200 9) |

3) ZSY-703 Linkage
4) ZSY-401 Linkage
5) ZSY-701 Linkage
6) ZSY-702 Linkage
7) ZSY-901 Linkage
8) ZSY-902 Linkage
9) ZSY-903 Linkage

**Pressure drop @ 54°◁ opening angle**




**Formula**

The effective volumetric flow calculated for opening angle 54° is:

$$\dot{V}@54° = k_{vs}@54° \cdot \sqrt{\frac{\Delta p_v@54°}{100}}$$

$\dot{V}_{100}@54°$ [m³/h]
$k_{vs}@54°$ [m³/h]
$\Delta p@54°$ [kPa]

**Legend**

| | |
|---|---|
| $\Delta p_v$ @ 54°◁ | Differential pressure at 54°◁ valve opening |
| $\dot{V}$ @ 54°◁ | Nominal flow rate with $\Delta p_v$ @ 54°◁ |
| ▬ ▪ ▬ | $\Delta p_v$ @ 54°◁ |
| 1) | The maximum speed in the butterfly valves is 4 m/s |

## Definitions

| | |
|---|---|
| **$k_v$max** | Marking (catalogue value) of butterfly valves: $k_v$ value when valve is completely open (90°) |
| **$k_v$** | 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 defined angle |
| **$k_{vs}$** | $k_v$ value of the valve at 100% degree of opening |
| **$\Delta p_s$** | Closing pressure at which the rotary actuator can still seal the butterfly valve tightly allowing for the appropriate leakage rate |
| **$\Delta p_v100$** | Differential pressure when valve is completely open |
| **$\Delta p_v$ @ 54°∢** | Maximum approved differential pressure. The flow velocity is 4 m/s at a valve opening angle of 54°∢ |
| **$\dot{V}_{100}$** | Nominal flow rate at $\Delta p_v100$ |
| **$\dot{V}$ @ 54°∢** | Nominal flow rate at $\Delta p_v$ @ 54°∢ |
| **ζ value** | Zeta ζ is the coefficient for the pressure loss through the fully opened valve (90°) |

**Further documentation**

- Overview «Valve-actuator combinations»
- Data sheets for valves and actuators
- Mounting instructions for valves and actuators
- General notes for project planning

# All-inclusive.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