

## Butterfly valves for open-close applications and control mode

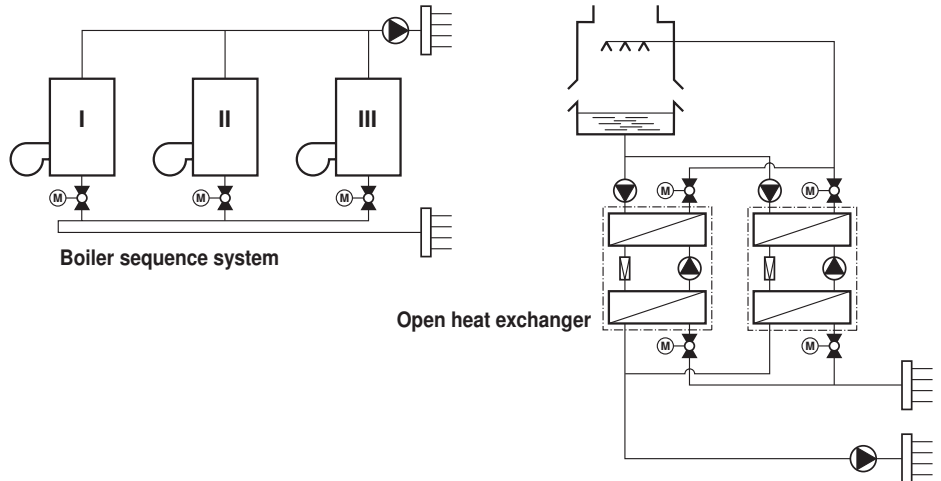
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Introduction

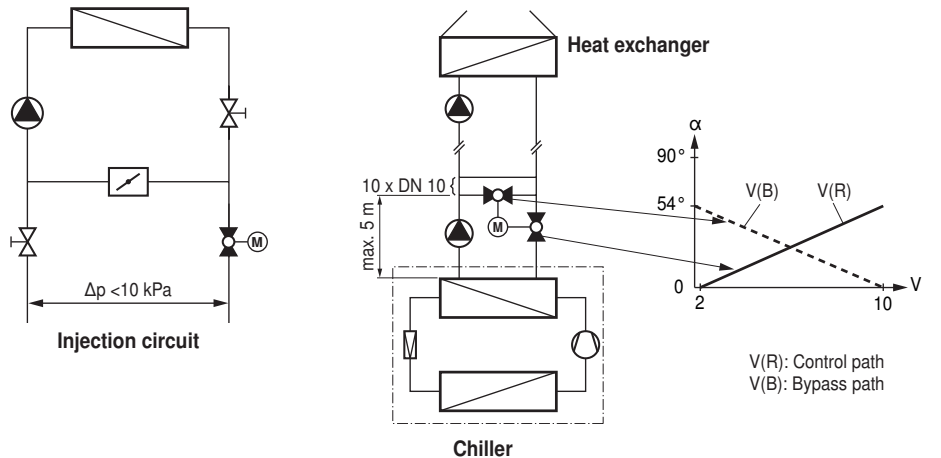
**Open-close applications** Energy savings and the reduction of the leakage losses will become ever more important in the future. The generation outputs of boilers or chilling systems are divided up into different performance level categories. Depending on the decline in pressure, the generators will 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



**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 with low differential pressures as an inexpensive final controlling element.

Typical applications



**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, GR..A-7, DGR..A-7, DR..-7 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 SY.. actuator



Body of the butterfly valves

Fig. Wafer type (with clips)

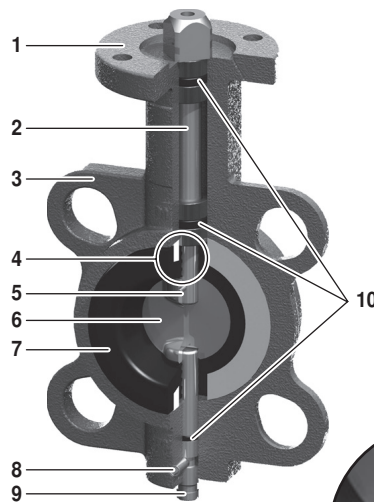
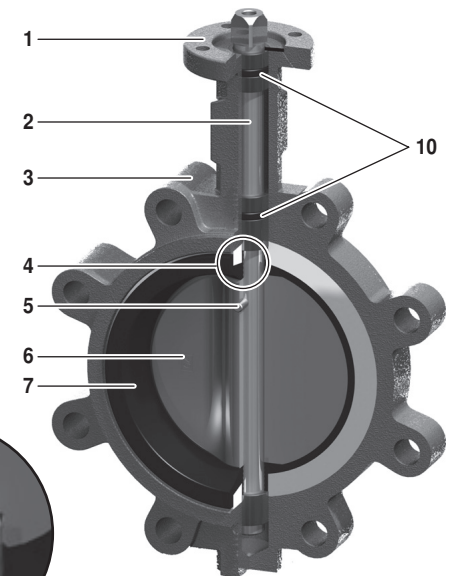


Fig. Lug type (with threads)

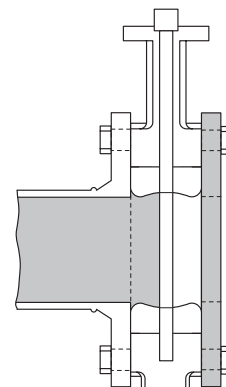
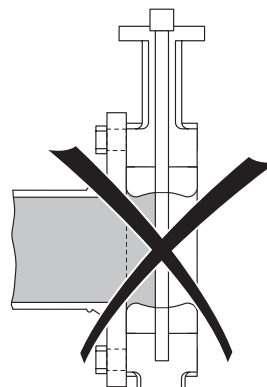


- 1 Flange in accordance with ISO 5211
- 2 Stainless stem, controlled in RPTFE bush bearing
- 3 Spheroidal cast iron housing (GGG 40)
- 4 EPDM seat with injected O-ring, seals against the exterior
- 5 Pin (to secure shaft, for a backlash-free rotation of the valve disc)
- 6 Stainless valve disc
- 7 EPDM seat primary seal, leak-proof pursuant to EN 12266-1, avoid leakage over the shaft (valve disc pol – seat)
- 8 Stainless spindle safety device
- 9 Stainless spindle short
- 10 EPDM O-ring tertiary seal against exterior contamination

**2-part stem**  
Wafer and lug type:  
DN 25 bis 40

**1-part stem**  
Wafer and lug type:  
DN 50 to 700

Installation of the butterfly valves in open systems



D6.. butterfly valves must be mounted with counter flange in open systems.

Generally speaking D6.. butterfly valves must run through a full cycles at least once per month in order to reduce the breakaway torque (applies to both open and closed systems).

## 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** 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.

## Closing pressure for manually operated butterfly valves D6..N(L) + ZD6N-..

Type	DN [mm]	Maximum permissible closing pressure [kPa]
D625N(L) ... D6350N(L)	25 ... 350	1200
D6400N(L) ... D6700N(L)	400 ... 700	1000

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

Butterfly valve			Lever	Worm gear <sup>2)</sup>
Type	DN [mm]	$\zeta$ 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
D6200N(L)	200	0,3		ZD6N-S200
D6250N(L)	250	0,32		ZD6N-S250
D6300N(L)	300	0,24		ZD6N-S350
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

$k_{Vmax}$  values and approved differential pressure  $\Delta p_{v100}$  are illustrated in the table «Flow rate butterfly valves D6..N / D6..NL» on page 5.

<sup>2)</sup> Worm gears are not suitable for outdoor applications.

## Design and dimensioning

(continued)

**Closing pressure butterfly valves**  
 D6..N / D6..NL  
 DN 25 ... DN 350

Butterfly valve			Actuators										
Type	DN [mm]	k <sub>v</sub> max [m <sup>3</sup> /h]	Δp <sub>s</sub> [kPa]	Δp <sub>s</sub> [kPa]	Δp <sub>s</sub> [kPa]	Δp <sub>s</sub> [kPa]	Δp <sub>s</sub> [kPa]	Δp <sub>s</sub> [kPa]	Δp <sub>s</sub> [kPa]	Δp <sub>s</sub> [kPa]	Δp <sub>s</sub> [kPa]	Δp <sub>s</sub> [kPa]	Δp <sub>s</sub> [kPa]
D625N(L)	25	45	1200	1200					1200				
D632N(L)	32	55	1200	1200					1200				
D640N(L)	40	70	1200	1200					1200				
D650N(L)	50	90	1200	1200					1200				
D665N(L)	65	180	1200	1200					1200				
D680N(L)	80	300	1200	1200					1200				
D6100N(L)	100	580	200	200	1200 <sup>1)</sup>				1200				
D6125N(L)	125	820			600 <sup>2)</sup>	1200	1200		1200				
D6150N(L)	150	1600				600	1200		1200				
D6200N(L)	200	2900								1200			
D6250N(L)	250	4400										1200	
D6300N(L)	300	7300										600	1200
D6350N(L)	350	10900											600

1) GR..A-5

2) GR..A-7

**Closing pressure butterfly valves**  
 D6..N / D6..NL  
 DN 400 ... DN 700

Butterfly valve			Actuators							
Type	DN [mm]	k <sub>v</sub> max [m <sup>3</sup> /h]	Δp <sub>s</sub> [kPa]	Δp <sub>s</sub> [kPa]	Δp <sub>s</sub> [kPa]	Δp <sub>s</sub> [kPa]	Δp <sub>s</sub> [kPa]	Δp <sub>s</sub> [kPa]	Δp <sub>s</sub> [kPa]	Δp <sub>s</sub> [kPa]
D6400N(L)	400	14200	200		600	1000				
D6450N(L)	450	18800		200		600	1000			
D6500N(L)	500	24100					600	1000		
D6600N(L)	600	37300						200	600	1000
D6700N(L)	700	42800								200

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

Butterfly valve			Differential pressure Δp <sub>v100</sub>				
Type	DN [mm]	k <sub>v</sub> max [m <sup>3</sup> /h]	0.01 [kPa]	0.1 [kPa]	1 [kPa]	2 [kPa]	3 [kPa]
D625N(L)	25	45	0.45	1.42	4.50	6.36	
D632N(L)	32	55	0.55	1.74	5.50	7.78	
D640N(L)	40	70	0.70	2.21	7.00	9.90	12.1
D650N(L)	50	90	0.90	2.8	9.0	12.7	15.6
D665N(L)	65	180	1.80	5.7	18.0	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		
D6200N(L)	200	2900	29	92	290		
D6250N(L)	250	4400	44	139	440		
D6300N(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		

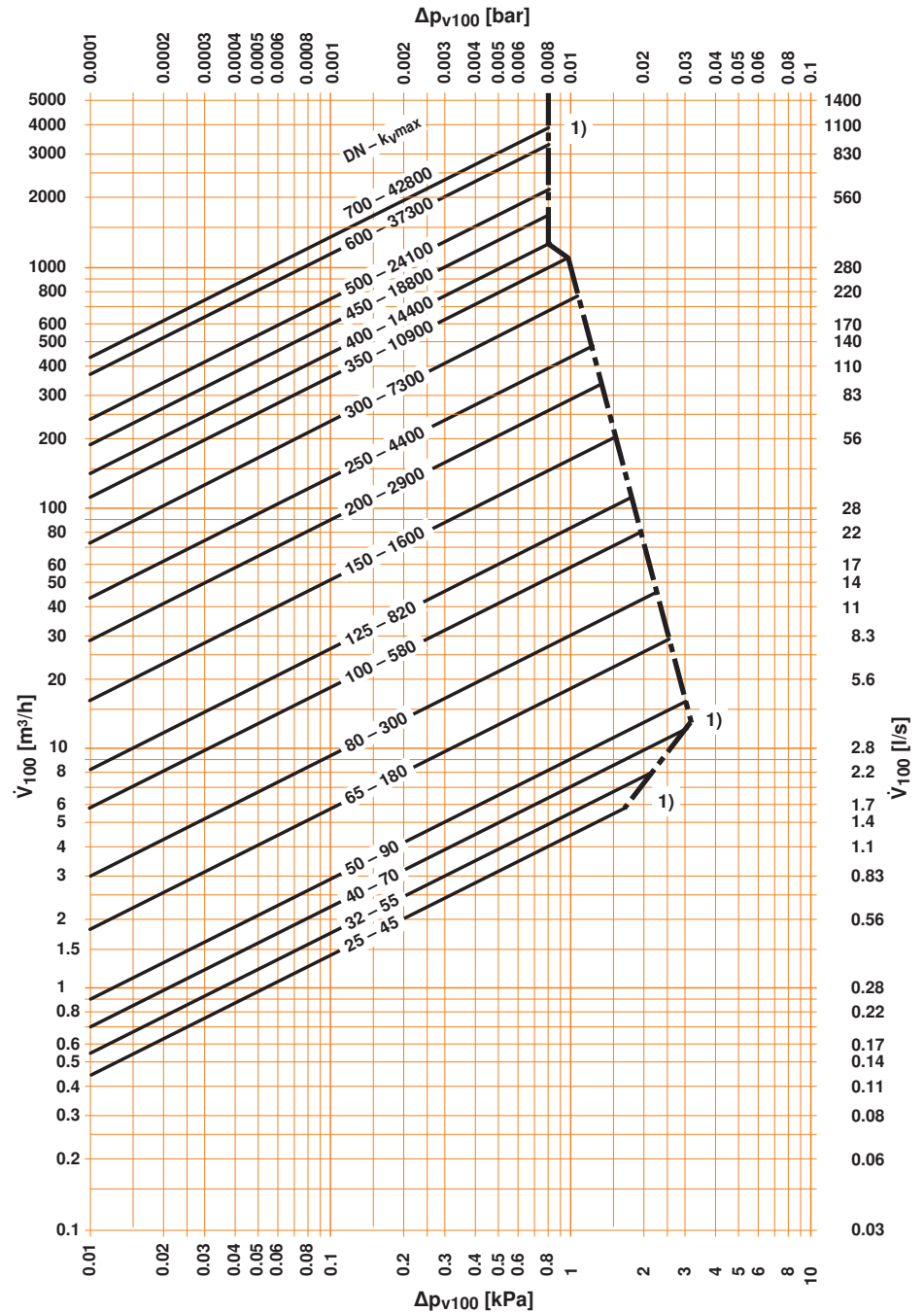
Flow rate V<sub>100</sub> [m<sup>3</sup>/h]

## Formula

$$\frac{\Delta p_{v100}}{100} = \left( \frac{V_{100}}{k_{vmax}} \right)^2$$

Δp<sub>v100</sub> [kPa]  
 V<sub>100</sub> [m<sup>3</sup>/h]  
 k<sub>v</sub>max [m<sup>3</sup>/h]

Pressure drop



Formula

$$\frac{\Delta p_{V100}}{100} = \left( \frac{\dot{V}_{100}}{K_{vmax}} \right)^2$$

$\Delta p_{V100}$  [kPa]  
 $\dot{V}_{100}$  [ $m^3/h$ ]  
 $K_{vmax}$  [ $m^3/h$ ]

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  $\geq$  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.

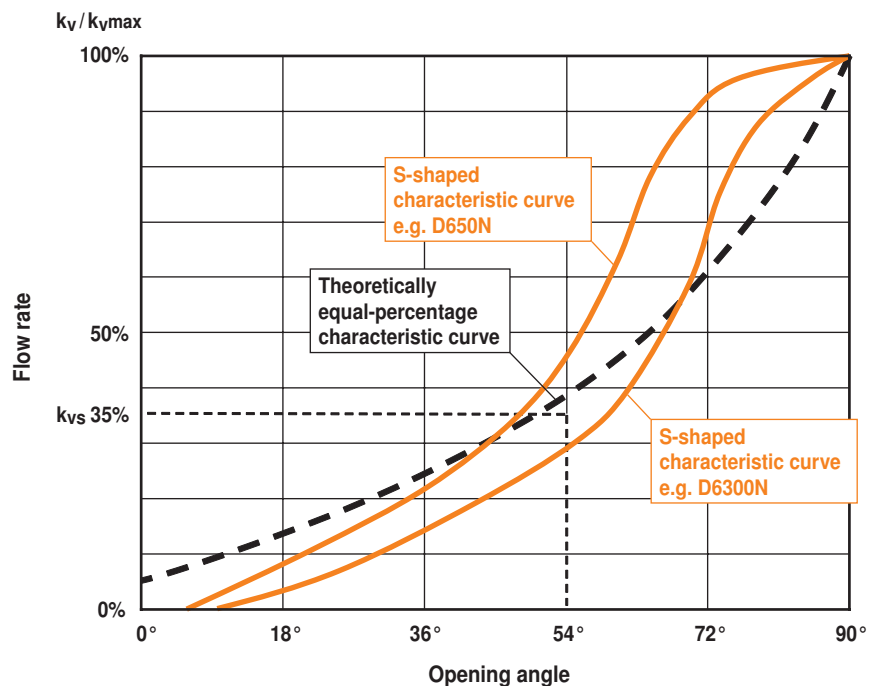
**Technical data for control mode**

Differential pressure  $\Delta p_{V0}$ : <25 kPa with valve cone opening (may not be exceeded)  
Differential pressure  $\Delta p_V @ 54^\circ$ : The values listed in the Differential Pressure Table must be complied with

Valve authority: >0.3  
Rangeability: >30

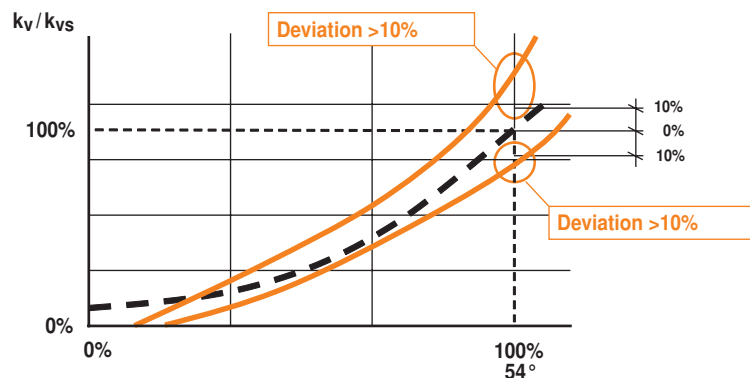
The S-shaped characteristic curve of the D6..N(L) butterfly valve (BFV) does not correspond to the equal percentage characteristic curve pursuant to VDI 2176. It is only in the angle of rotation range between  $0^\circ$  and  $54^\circ$  that one can speak of an approximately equal percentage characteristic curve. For an opening angle of  $54^\circ$ , the  $k_{VS}$  corresponds to approx. 35 percent of the  $k_{Vmax}$  value for a  $90^\circ$  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 ( $90^\circ$ ).  
The  $k_{VS}$  value refers to the flow rate at  $54^\circ$  opening angle, 1 bar pressure loss and medium temperature between 5 and  $40^\circ\text{C}$ .

## Scaled characteristic curve range



The  $k_{VS}@54^\circ$  listed in the differential pressure table deviates from the usual tolerance ( $\pm 10\%$ ) for some nominal widths. The equivalence factor of the equal percentage characteristic curve is  $\sim 2.5$ .

## 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.

The differential pressure  $\Delta p_v@54^\circ$  (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]	$k_{vs}@54^\circ$ [m³/h]	$\dot{V}@54^\circ$ [m³/h]	$\Delta p_v@54^\circ$ [kPa]	Closing angle New condition
D625N(L)	25	16	2.7	2.9	~16°↙
D632N(L)	32	19	4.3	5.0	~16°↙
D640N(L)	40	25	6.4	6.8	~13°↙
D650N(L)	50	32	9	8.2	~13°↙
D665N(L)	65	63	16	6.6	~13°↙
D680N(L)	80	105	24	5.1	~13°↙
D6100N(L)	100	203	45	4.8	~10°↙
D6125N(L)	125	287	65	5.1	~10°↙
D6150N(L)	150	560	105	3.5	~10°↙
D6200N(L)	200	1015	180	3.1	~7°↙
D6250N(L)	250	1540	281	3.3	~7°↙
D6300N(L)	300	2555	416	2.6	~7°↙
D6350N(L)	350	3815	511	1.8	~7°↙
D6400N(L)	400	4970	703	2.0	~3°↙
D6450N(L)	450	6580	907	1.9	~3°↙
D6500N(L)	500	8435	1132	1.8	~3°↙
D6600N(L)	600	13055	1651	1.6	~3°↙
D6700N(L)	700	14980	2272	2.3	~2°↙

## Formula

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

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

$\dot{V}_{100}@54^\circ$  [m³/h]

$k_{vs}@54^\circ$  [m³/h]

$\Delta p@54^\circ$  [kPa]

Closing pressure  
DN 25 ... DN 350

Butterfly valve		Actuators								
		SR..A	SR..P	GR..A	DGR..A	DR..	SY2	SY3	SY4	SY5
Type	DN [mm]	$\Delta p_s$ [kPa]	$\Delta p_s$ [kPa]	$\Delta p_s$ [kPa]	$\Delta p_s$ [kPa]	$\Delta p_s$ [kPa]	$\Delta p_s$ [kPa]	$\Delta p_s$ [kPa]	$\Delta p_s$ [kPa]	$\Delta p_s$ [kPa]
D625N(L)	25	1200	1200							
D632N(L)	32	1200	1200							
D640N(L)	40	1200	1200							
D650N(L)	50	1200	1200							
D665N(L)	65	1200	1200							
D680N(L)	80	1200	1200							
D6100N(L)	100	200		1200 <sup>1)</sup>						
D6125N(L)	125			600 <sup>2)</sup>	1200	1200	1200			
D6150N(L)	150				600	1200	1200			
D6200N(L)	200							1200		
D6250N(L)	250								1200	
D6300N(L)	300								600	1200
D6350N(L)	350									600

1) GR..A-5

2) GR..A-7

Closing pressure  
DN 400 ... DN 700

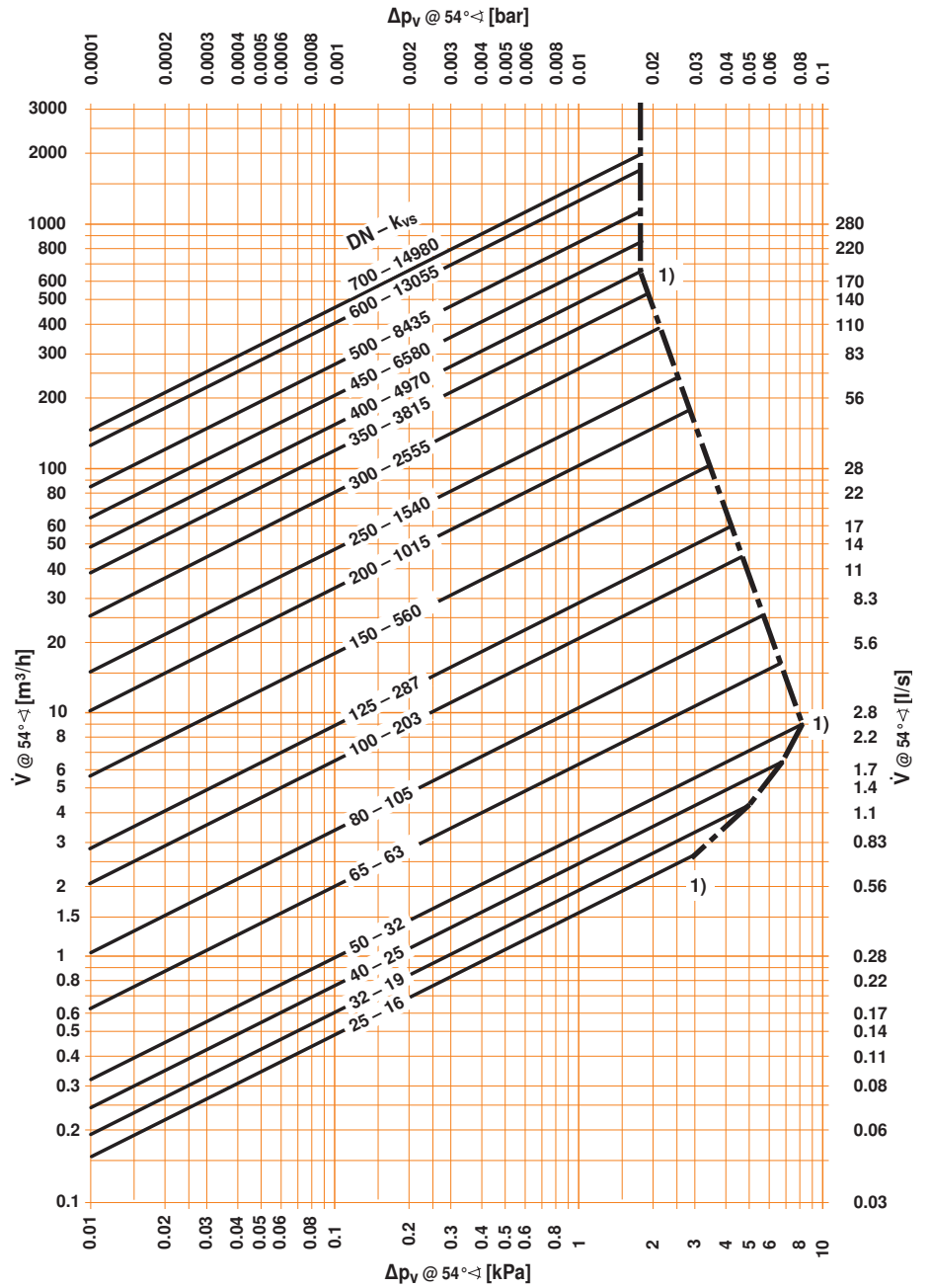
Butterfly valve			Actuators							
			SY4	SY5	SY6	SY7	SY8	SY9	SY10	SY12
Type	DN [mm]	$k_{vmax}$ [m³/h]	$\Delta p_s$ [kPa]	$\Delta p_s$ [kPa]	$\Delta p_s$ [kPa]	$\Delta p_s$ [kPa]	$\Delta p_s$ [kPa]	$\Delta p_s$ [kPa]	$\Delta p_s$ [kPa]	$\Delta p_s$ [kPa]
D6400N(L)	400	14200	200		600	1000				
D6450N(L)	450	18800		200		600	1000			
D6500N(L)	500	24100					600	1000		
D6600N(L)	600	37300						200	600	1000
D6700N(L)	700	42800								200



Design and dimensioning

(continued)

Pressure drop @ 54° opening angle



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

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

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

**Legend**

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

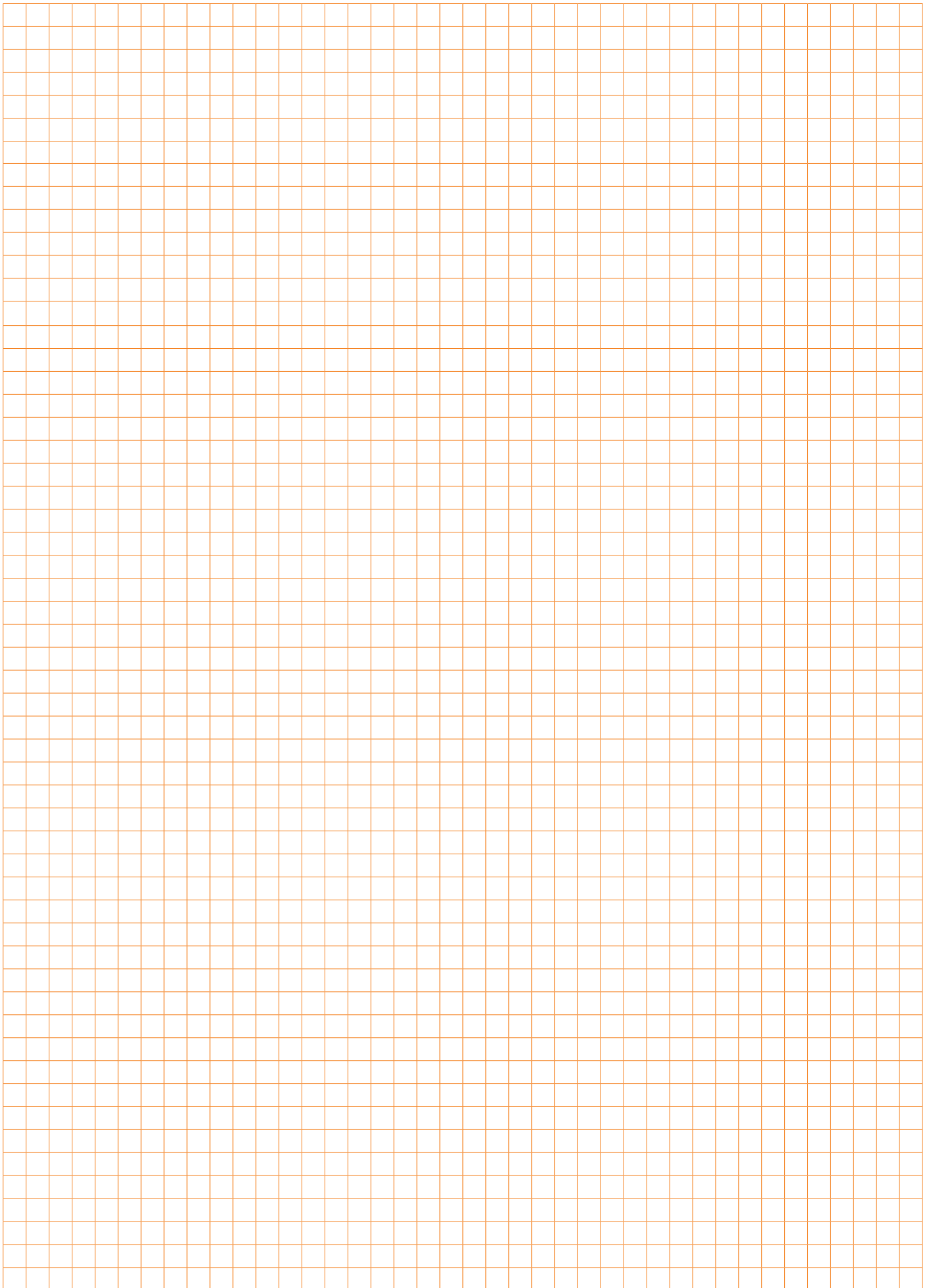
**Definitions**

<b><math>k_{vmax}</math></b>	Marking (catalogue value) of butterfly valves: $k_v$ value when valve is completely open (90°)
<b><math>k_v</math></b>	Flow rate factor or flow rate coefficient. The $k_v$ value corresponds to the volumetric flow of water through a valve (in m <sup>3</sup> /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
<b><math>k_{vs}</math></b>	$k_v$ value of the valve at 100% degree of opening
<b><math>\Delta p_s</math></b>	Closing pressure at which the rotary actuator can still seal the butterfly valve tightly allowing for the appropriate leakage rate
<b><math>\Delta p_{v100}</math></b>	Differential pressure when valve is completely open
<b><math>\Delta p_v @ 54^\circ \leftarrow</math></b>	Maximum approved differential pressure. The flow velocity is 4 m/s at a valve opening angle of 54° $\leftarrow$
<b><math>\dot{V}_{100}</math></b>	Nominal flow rate at $\Delta p_{v100}$
<b><math>\dot{V} @ 54^\circ \leftarrow</math></b>	Nominal flow rate at $\Delta p_v @ 54^\circ \leftarrow$
<b><math>\zeta</math> value</b>	Zeta $\zeta$ is the coefficient for the pressure loss through the fully opened valve (90°)

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**Further documentation**

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



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