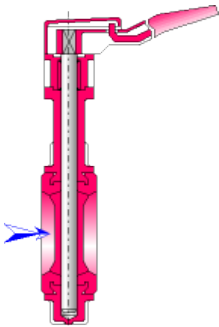




## Butterfly Valve (IDELCHIK)



### Model description:

This model of component calculates the minor head loss (pressure drop) generated by the flow in a butterfly valve installed in a straight pipe.

### Model formulation:

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Cross-sectional area (m<sup>2</sup>):

$$F = \pi \cdot \frac{D^2}{4}$$

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Mean velocity (m/s):

$$w = \frac{Q}{F}$$

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Mass flow rate (kg/s):

$$G = Q \cdot \rho$$

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Reynolds number:

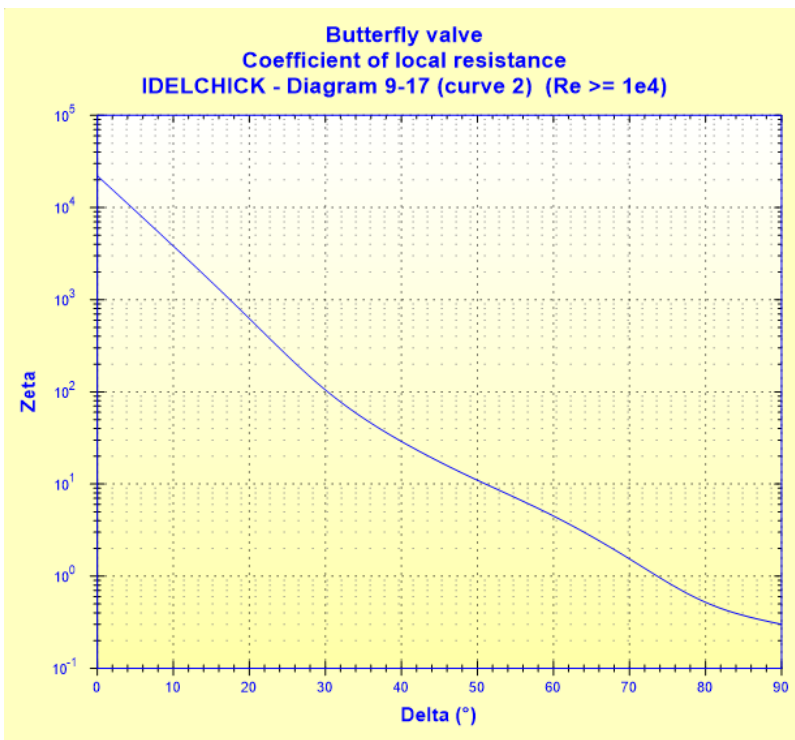
$$Re = \frac{w \cdot D}{\nu}$$

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Local resistance coefficient:

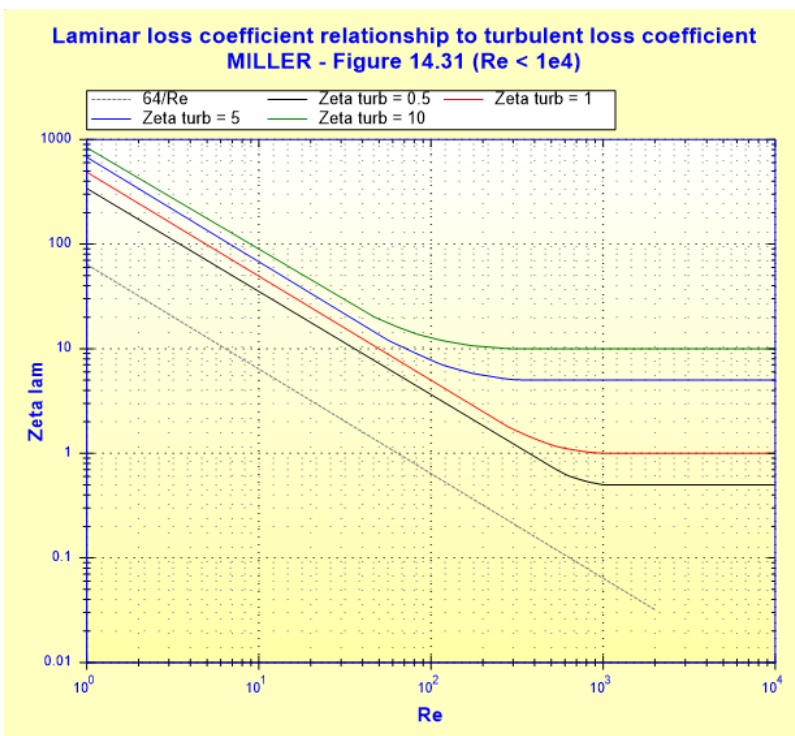
- $Re \geq 10^4$  (turbulent flow)

$$\zeta_{turb} = f(\delta) \quad ([1] \text{ diagram 9-16 curve 2})$$



■ Re < 10<sup>4</sup> (laminar flow)

$$\zeta_{lam} = f(\zeta_{turb}, Re) \quad ([2] \text{ figure 14.31})$$



Reynolds Number Correction (Re < 10<sup>4</sup>):

$$C_{Re} = \frac{\zeta_{lam}}{\zeta_{turb}}$$

Total pressure loss coefficient (based on mean velocity):

■ turbulent flow (Re ≥ 10<sup>4</sup>):

$$\zeta = \zeta_{turb}$$

- laminar flow ( $Re < 10^4$ ):

$$\zeta = \zeta_{lam}$$

Total pressure loss (Pa):

$$\Delta P = \zeta \cdot \frac{\rho \cdot w^2}{2}$$

Total head loss of fluid (m):

$$\Delta H = \zeta \cdot \frac{w^2}{2 \cdot g}$$

Hydraulic power loss (W):

$$Wh = \Delta P \cdot Q$$

**Symbols, Definitions, SI Units:**

D	Internal diameter (m)
F	Cross-sectional area (m <sup>2</sup> )
Q	Volume flow rate (m <sup>3</sup> /s)
G	Mass flow rate (kg/s)
w	Mean velocity (m/s)
Re	Reynolds number ( )
$\delta$	Opening angle (°)
$\zeta_{turb}$	Local resistance coefficient for $Re \geq 10^4$ ( )
$\zeta_{lam}$	Local resistance coefficient for $Re < 10^4$ ( )
$C_{Re}$	Reynolds number correction for $Re < 10^4$ ( )
$\zeta$	Pressure loss coefficient (based on the mean velocity) ( )
$\Delta P$	Total pressure loss (Pa)
$\Delta H$	Total head loss of fluid (m)
Wh	Hydraulic power loss (W)
$\rho$	Fluid density (kg/m <sup>3</sup> )
$\nu$	Fluid kinematic viscosity (m <sup>2</sup> /s)
g	Gravitational acceleration (m/s <sup>2</sup> )

**Validity range:**

- any flow regime: laminar and turbulent
  - note: for laminar flow regime ( $Re < 10^4$ ), the pressure loss coefficient " $\zeta_{lam}$ " is estimated

**Example of application:**

HydrauCalc 2020b - [Butterfly valve - IDELCHIK (3rd Ed.)]

File Edit Preferences Calculation method Database Tools Help

Fluid characteristics

Fluid : Water @ 1 atm [HC]  
Ref.: IAPWS IF97

Temperature : T 20 °C  
Pressure : P 1.013 bar

Density :  $\rho$  998.2061 kg/m<sup>3</sup>  
Dynamic Viscosity :  $\mu$  0.00100159 N.s/m<sup>2</sup>  
Kinematic Viscosity :  $\nu$  1.00340E-06 m<sup>2</sup>/s

Density  Dyn. Visc.  Kin. Visc.

Geometrical characteristics

Pressure loss  
 $\Delta P$  0.002484565 bar  
 $\Delta H$  0.0254 m of fluid

Opening angle 90 °

D 0.0703 m

G 4.9910 kg/s  
Q 0.005 m<sup>3</sup>/s  
1.288 m/s (Turbulent)  
w

Calculate  
Help  
Info

Complementary results

Designation	Symbol	Value	Unit
Pipe cross-section area	F	0.003881508	m <sup>2</sup>
Reynolds number	Re	90251	
<input checked="" type="checkbox"/> Coefficient of local resistance (Diagram 9-17)	$\zeta_{turb}$	0.3	
Pressure loss coefficient (based on the mean valve velocity)	$\zeta$	0.3	
Hydraulic power loss	Wh	1.242283	W

## References:

- [1] Handbook of Hydraulic Resistance, 3rd Edition, I.E. Idelchik  
[2] Internal Flow System, Second Edition, D.S. Miller