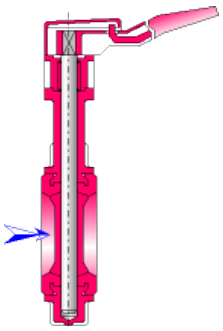
Butterfly Valve (IDELCHIK)



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:

Cross-sectional area (m^2):

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

Mean velocity (m/s):

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

Mass flow rate (kg/s):

$$G = Q \cdot \rho$$

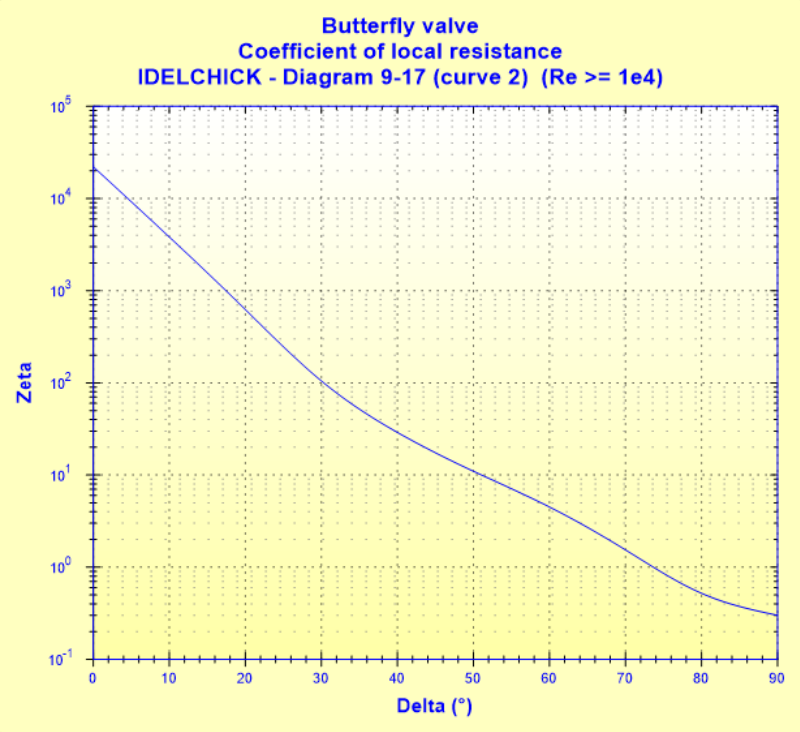
Reynolds number:

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

Local resistance coefficient:

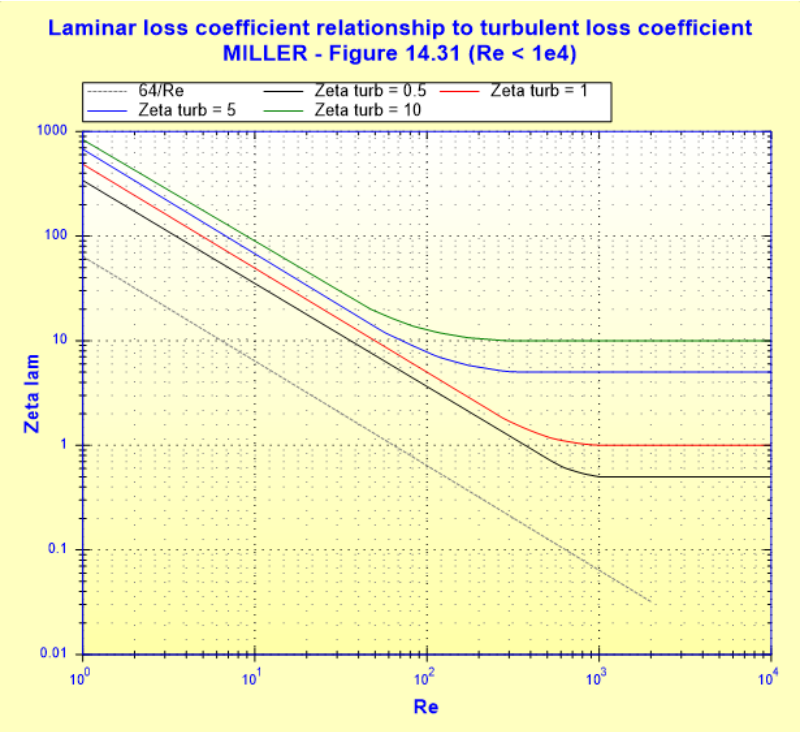
- $\mathrm{Re} \geq 10^4$ (turbulent flow)

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



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

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



Reynolds Number Correction ($Re < 10^4$):

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

Total pressure loss coefficient (based on mean velocity):

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

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

- 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^2)
Q	Volume flow rate (m^3/s)
G	Mass flow rate (kg/s)
w	Mean velocity (m/s)
Re	Reynolds number ()
δ	Opening angle (°)
ζ_{turb}	Local resistance coefficient for $Re \geq 10^4$ ()
ζ_{lam}	Local resistance coefficient for $Re < 10^4$ ()
C_{Re}	Reynolds number correction for $Re < 10^4$ ()
ζ	Pressure loss coefficient (based on the mean velocity) ()
ΔP	Total pressure loss (Pa)
ΔH	Total head loss of fluid (m)
Wh	Hydraulic power loss (W)
ρ	Fluid density (kg/m^3)
ν	Fluid kinematic viscosity (m^2/s)
g	Gravitational acceleration (m/s^2)

Validity range:

- any flow regime: laminar and turbulent

  note: for laminar flow regime ($Re < 10^4$), the pressure loss coefficient "ζ_{lam}" is estimated

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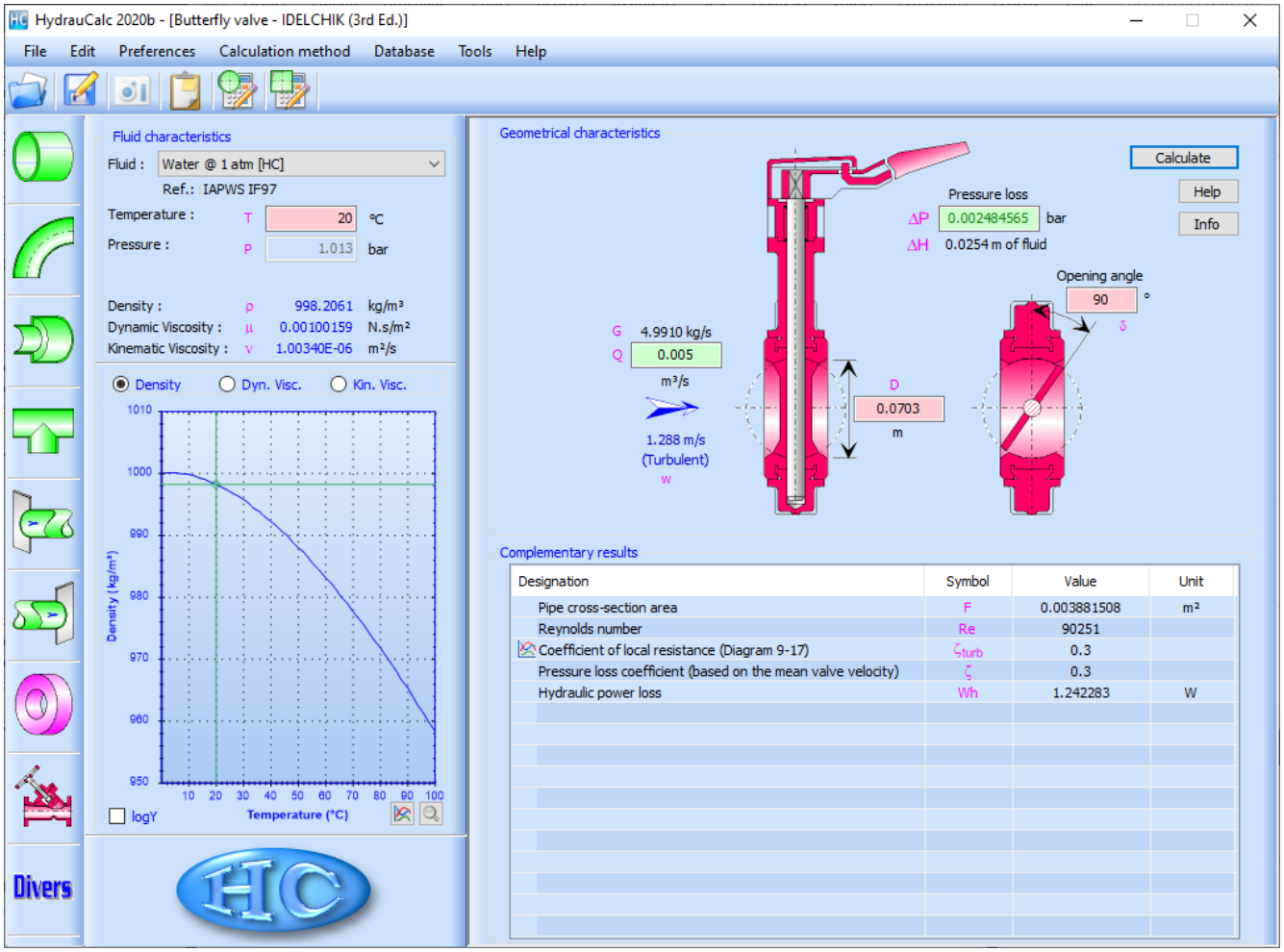
Example of application:



References:

[1] Handbook of Hydraulic Resistance, 3rd Edition, I.E. Idelchik

[2] Internal Flow System, Second Edition, D.S. Miller