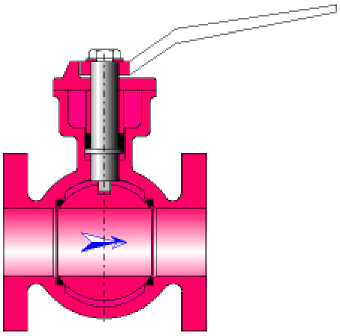
Ball valve
(MILLER)



Model description:

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

Model formulation:

Cross-sectional area (m^2):

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

Mean velocity (m/s):

$$U = \frac{Q}{A}$$

Mass flow rate (kg/s):

$$G = Q \cdot \rho$$

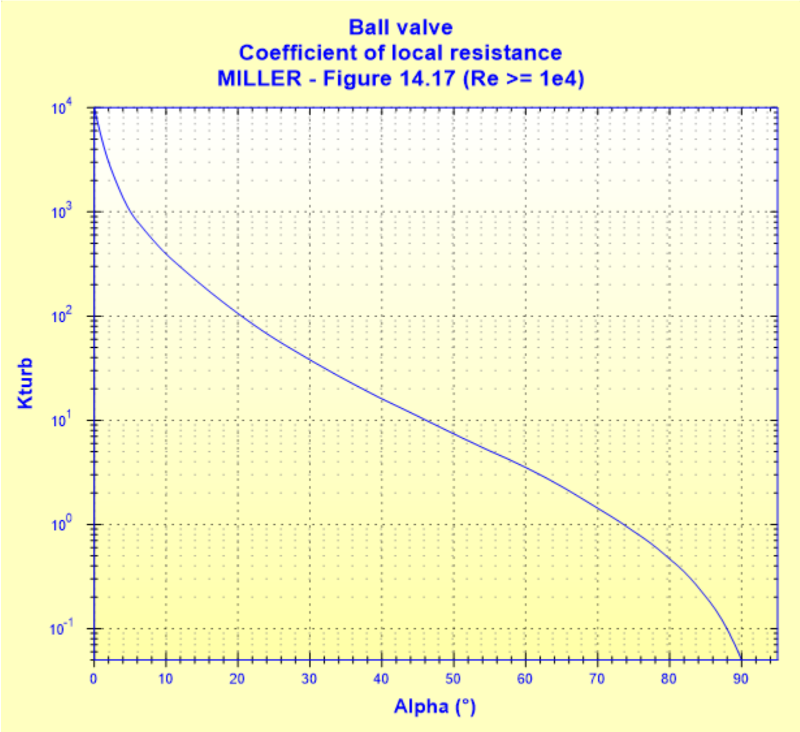
Reynolds number:

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

Local resistance coefficient:

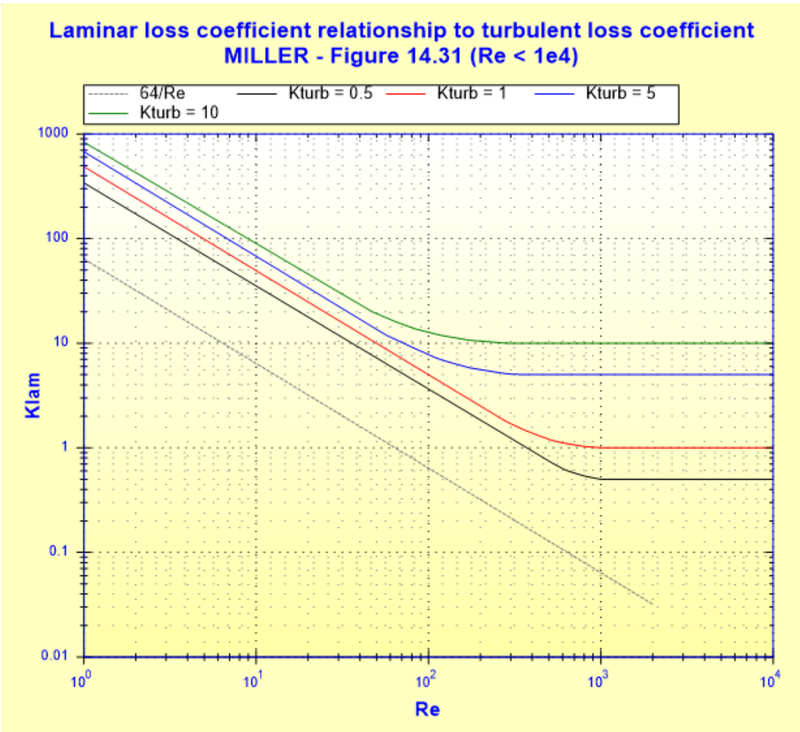
- $Re \geq 10^4$ (turbulent flow)

$$K_{turb} = f(\alpha)$$ ([1] figure 14.17)



■ Re < 10^4 (laminar flow)

$$K_{lam} = f(K_{turb}, \text{Re})$$ ([1] figure 14.31)



Reynolds Number Correction (Re < 10^4):

$$C_{\text{Re}} = \frac{K_{lam}}{K_{turb}}$$

Total pressure loss coefficient (based on mean velocity):

■ turbulent flow (Re ≥ 10^4):

$$K = K_{turb}$$

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

$$K = K_{lam}$$

Total pressure loss (Pa):

$$\Delta P = K \cdot \frac{\rho \cdot U^2}{2}$$

Total head loss of fluid (m):

$$\Delta H = K \cdot \frac{U^2}{2 \cdot g}$$

Hydraulic power loss (W):

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

Symbols, Definitions, SI Units:

D	Internal diameter (m)
A	Cross-sectional area (m^2)
Q	Volume flow rate (m^3/s)
G	Mass flow rate (kg/s)
U	Mean velocity (m/s)
Re	Reynolds number ()
α	Opening angle (°)
K_{turb}	Local resistance coefficient for $Re \geq 10^4$ ()
K_{lam}	Local resistance coefficient for $Re < 10^4$ ()
C_{Re}	Reynolds number correction for $Re < 10^4$ ()
K	Total pressure loss coefficient (based on 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)

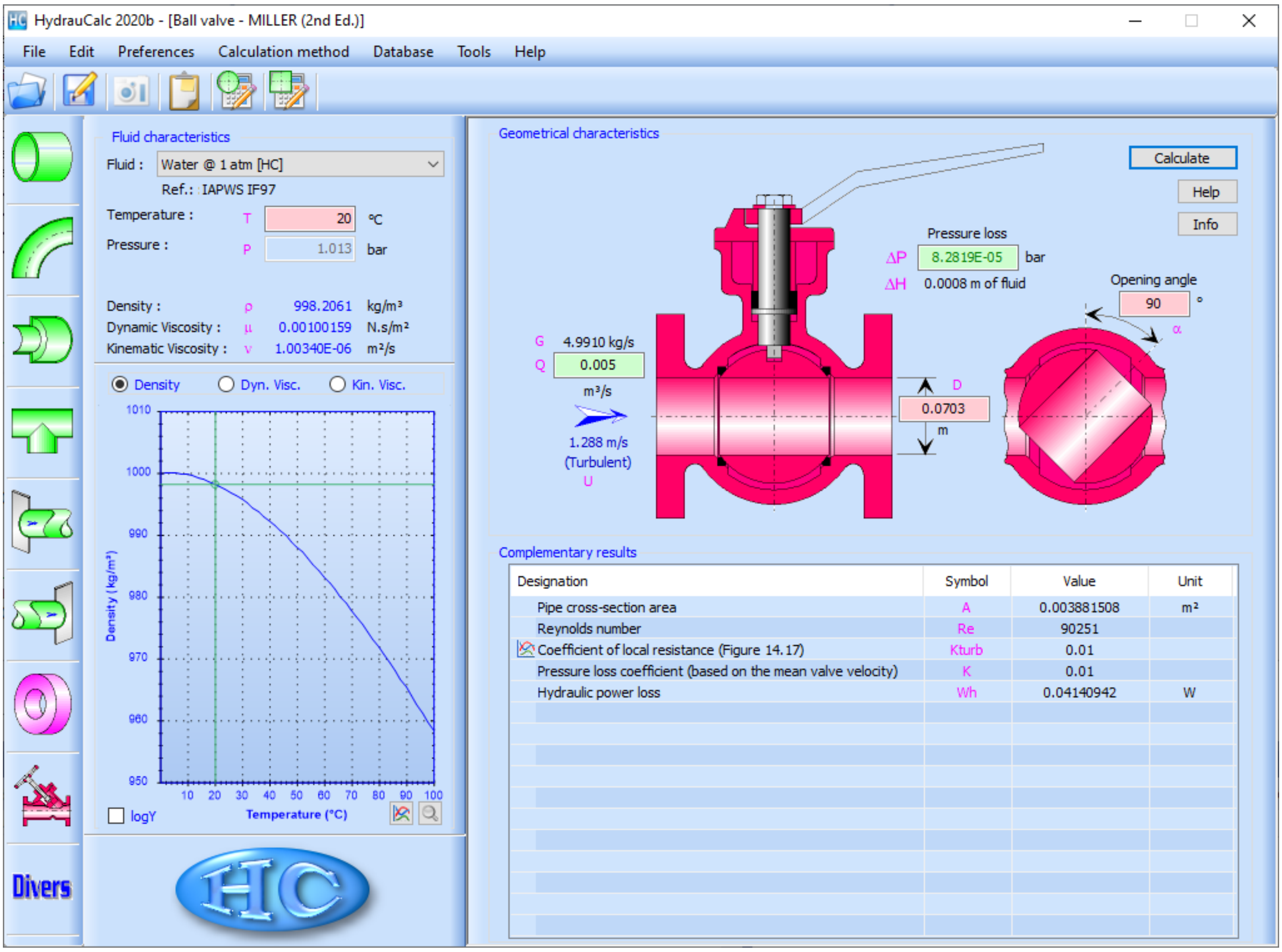
Validity range:

- any flow regime: laminar and turbulent

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

---

Example of application:



Designation	Symbol	Value	Unit
Pipe cross-section area	A	0.003881508	m²
Reynolds number	Re	90251	
Coefficient of local resistance (Figure 14.17)	Kturb	0.01	
Pressure loss coefficient (based on the mean valve velocity)	K	0.01	
Hydraulic power loss	Wh	0.04140942	W

References:

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