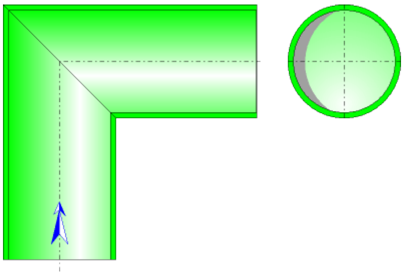
Miter Bend
Circular Cross-Section
(CRANE)



Model description:

This model of component calculates the head loss (pressure drop) of a miter bend whose cross-section is circular and constant. In addition, the flow is assumed fully developed and stabilized upstream of the bend.

Model formulation:

Cross-section area (m^2):

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

Mean velocity (m/s):

$$V = \frac{q}{A}$$

Mass flow rate (kg/s):

$$w = q \cdot \rho$$

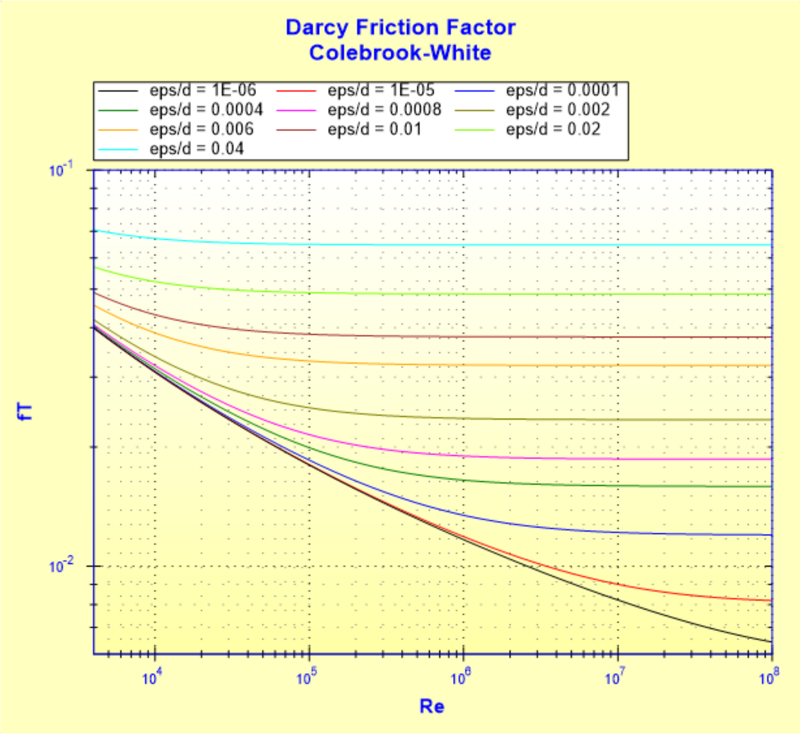
Reynolds number:

$$\mathrm{Re} = \frac{V \cdot d}{\nu}$$

Darcy friction factor:

$$f_T = \frac{1}{\left[2 \cdot \log\left(\frac{\varepsilon}{3.7 \cdot d} + \frac{2.51}{\mathrm{Re} \cdot \sqrt{f_T}}\right)\right]^2}$$

Colebrook-White equation

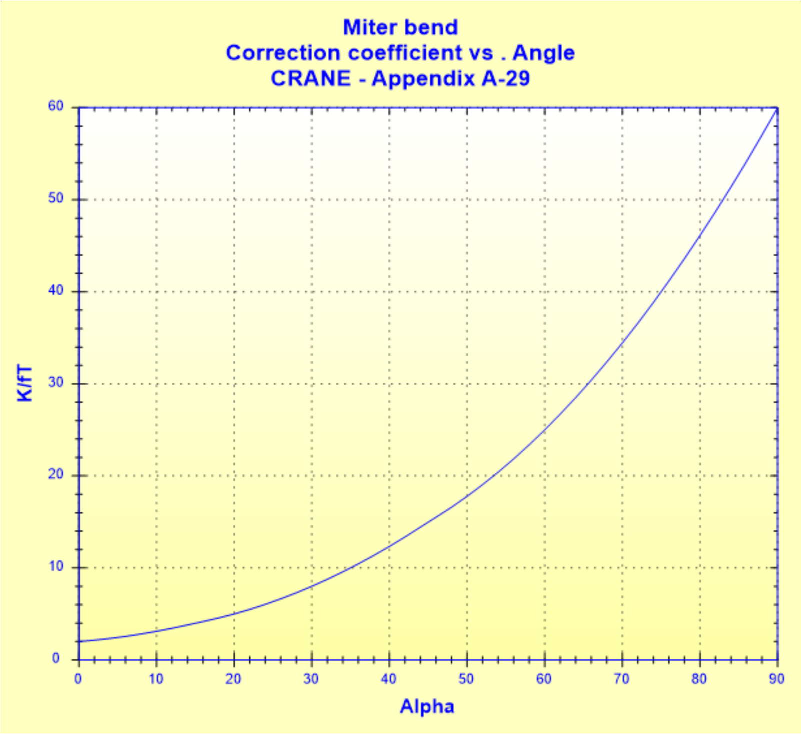


Resistance coefficient for a miter bend:

$$K = f(\alpha, f_T)$$

([1] Appendix A-29)

α	K	K/f_T
0	$2\ f_T$	2
15	$4\ f_T$	4
30	$8\ f_T$	8
45	$15\ f_T$	15
60	$25\ f_T$	25
75	$40\ f_T$	40
90	$60\ f_T$	60



Total pressure loss coefficient (based on mean velocity in bend):

$$K_B = K$$

Total pressure loss (Pa):

$$\Delta P = K_B \cdot \frac{\rho \cdot v^2}{2}$$

Total head loss of fluid (m):

$$\Delta H = K_B \cdot \frac{v^2}{2 \cdot g}$$

Hydraulic power loss (W):

$$Wh = \Delta P \cdot q$$

Straight length of equivalent pressure loss (m):

$$L_{eq} = K_B \cdot \frac{d}{f_T}$$

Symbols, Definitions, SI Units:

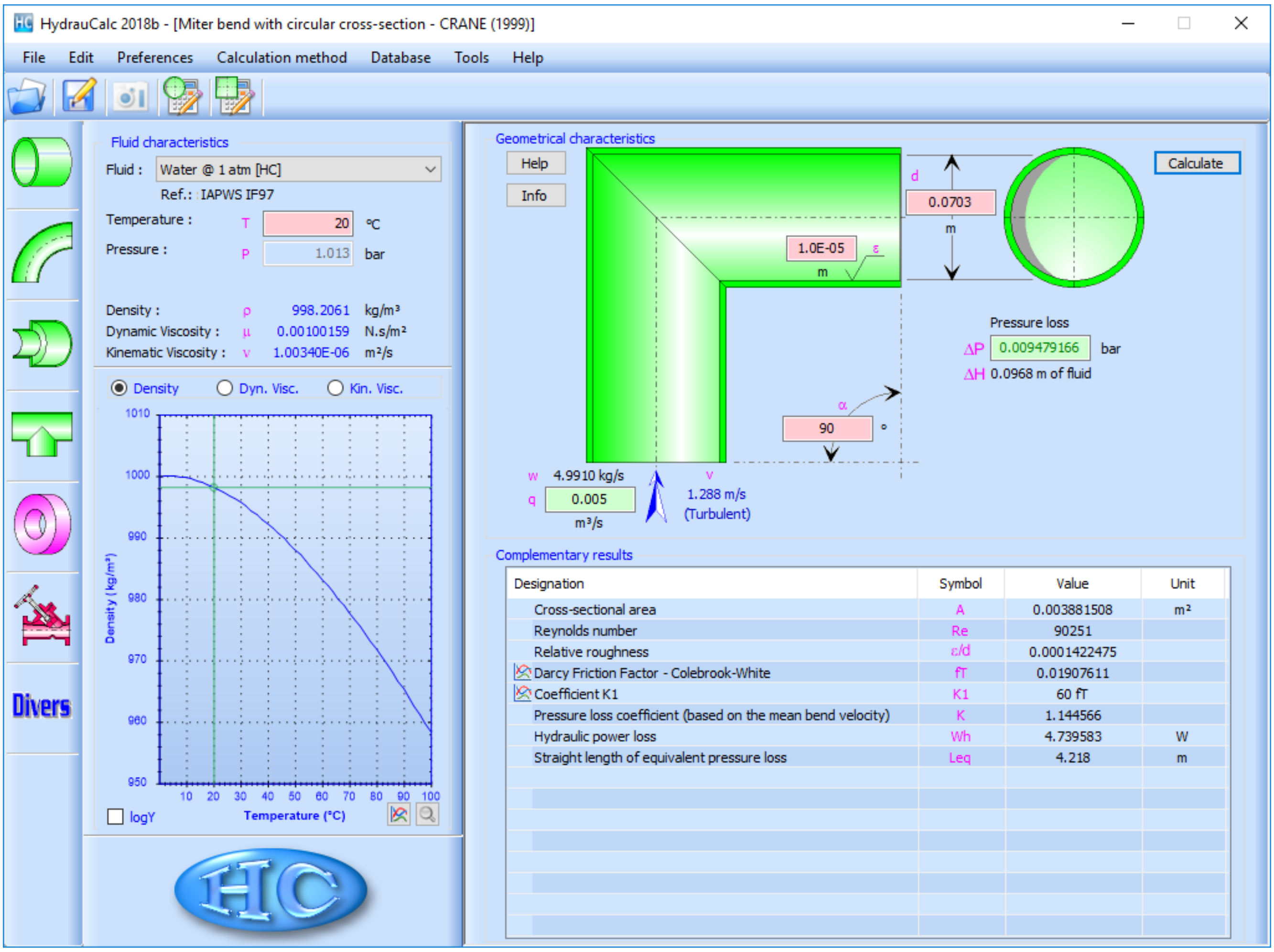
d	Pipe internal diameter (m)
A	Cross-section area (m^2)
q	Volume flow rate (m^3/s)
v	Mean velocity (m/s)
w	Mass flow rate (kg/s)
Re	Reynolds number ()
ε	Absolute roughness of walls (m)
f_T	Darcy friction factor

α	Angle of bend (°)
K	Resistance coefficient for a miter bend ()
K_B	Total pressure loss coefficient (based on mean velocity in bend) ()
ΔP	Total pressure loss (Pa)
ΔH	Total head loss of fluid (m)
Wh	Hydraulic power loss (W)
L_{eq}	Straight length of equivalent pressure loss (m)
ρ	Fluid density (kg/m³)
ν	Fluid kinematic viscosity (m²/s)
g	Gravitational acceleration (m/s²)

Validity range:

- turbulent flow regime ($Re \geq 10^4$)
- stabilized flow upstream of the bend
- angle between 0° and 90°

Example of application:



References:

[1] CRANE - Flow of Fluids Through Valves, Fitting and Pipe - Technical Paper No. 410 - Edition 1999