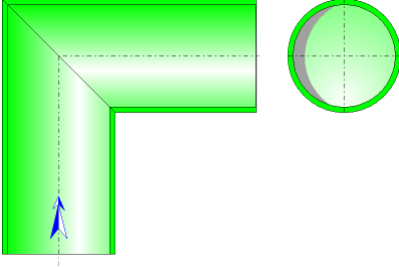




Miter Bend Circular Cross-Section (CRANE)



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 (m²):

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

Mean velocity (m/s):

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

Mass flow rate (kg/s):

$$w = q \cdot \rho$$

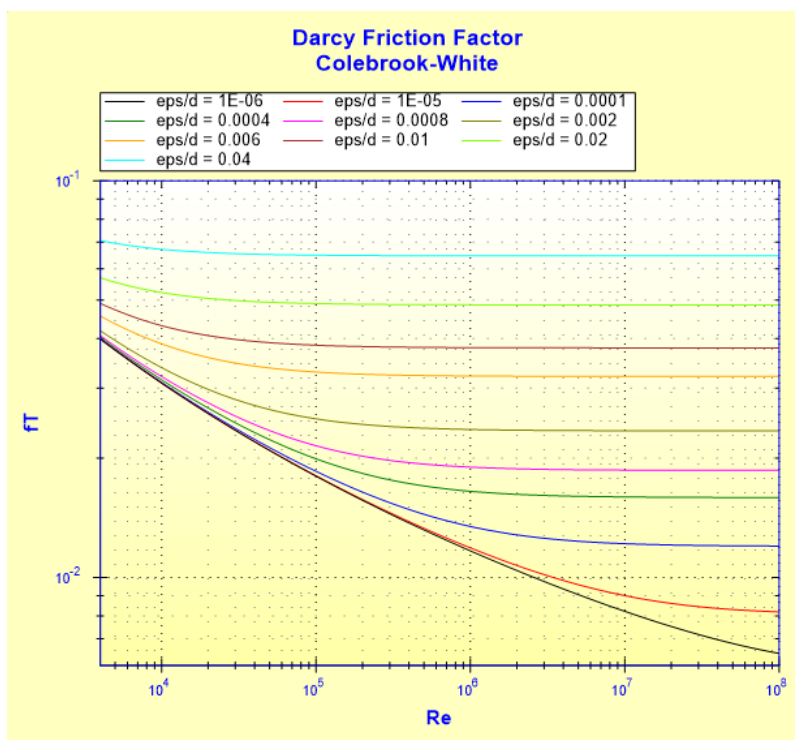
Reynolds number:

$$Re = \frac{v \cdot d}{\nu}$$

Darcy friction factor:

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

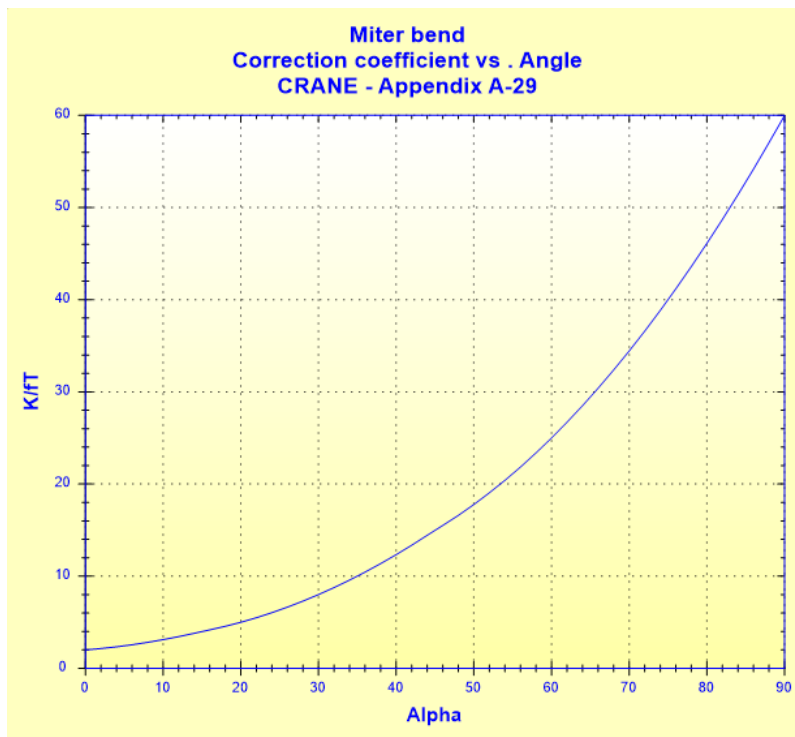
Colebrook-White equation



Resistance coefficient for a miter bend:

$$K = f(\alpha, f_T) \quad ([1] \text{ Appendix A-29})$$

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 ($^{\circ}$)
K	Resistance coefficient for a miter bend ($\text{}$)
K_B	Total pressure loss coefficient (based on mean velocity in bend) ($\text{}$)
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/m^3)
ν	Fluid kinematic viscosity (m^2/s)
g	Gravitational acceleration (m/s^2)

Validity range:

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

Example of application:

The screenshot shows the HydraulCalc 2018b software interface for a miter bend calculation. The fluid is Water @ 1 atm [HC] with a temperature of 20 °C and pressure of 1.013 bar. The density is 998.2061 kg/m³, dynamic viscosity is 0.00100159 N.s/m², and kinematic viscosity is 1.00340E-06 m²/s. The flow rate is 4.9910 kg/s (0.005 m³/s) and the velocity is 1.288 m/s (Turbulent). The pipe diameter is 0.0703 m and the roughness is 1.0E-05 m. The bend angle is 90 degrees. The pressure loss is 0.009479166 bar, and the head loss is 0.0968 m of fluid. The equivalent straight length is 4.218 m.

Fluid characteristics

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

Temperature : T 20 °C
 Pressure : P 1.013 bar

Density : ρ 998.2061 kg/m³
 Dynamic Viscosity : μ 0.00100159 N.s/m²
 Kinematic Viscosity : ν 1.00340E-06 m²/s

Density Dyn. Visc. Kn. Visc.

Geometrical characteristics

Help Info

Calculate

Pressure loss
 ΔP 0.009479166 bar
 ΔH 0.0968 m of fluid

Complementary results

Designation	Symbol	Value	Unit
Cross-sectional area	A	0.003881508	m ²
Reynolds number	Re	90251	
Relative roughness	c/d	0.0001422475	
Darcy Friction Factor - Colebrook-White	f _T	0.01907611	
Coefficient K1	K1	60 ft	
Pressure loss coefficient (based on the mean bend velocity)	K	1.144566	
Hydraulic power loss	Wh	4.739583	W
Straight length of equivalent pressure loss	Leq	4.218	m

References:

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

