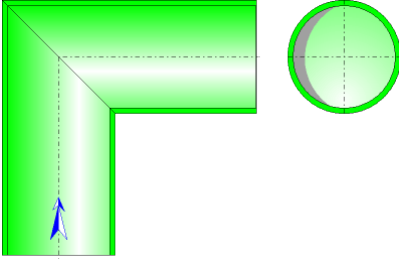




## Miter Bend Circular Cross-Section (IDELCHIK)



### 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 at the entrance bend.

### Model formulation:

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Hydraulic diameter (m):

$$D_h = D_0$$

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

$$F_0 = \pi \cdot \frac{D_0^2}{4}$$

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Mean velocity (m/s):

$$w_0 = \frac{Q}{F_0}$$

---

Mass flow rate (kg/s):

$$G = Q \cdot \rho$$

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Reynolds number:

$$Re = \frac{w_0 \cdot D_h}{\nu}$$

---

Relative roughness:

$$\frac{\Delta}{D_0}$$

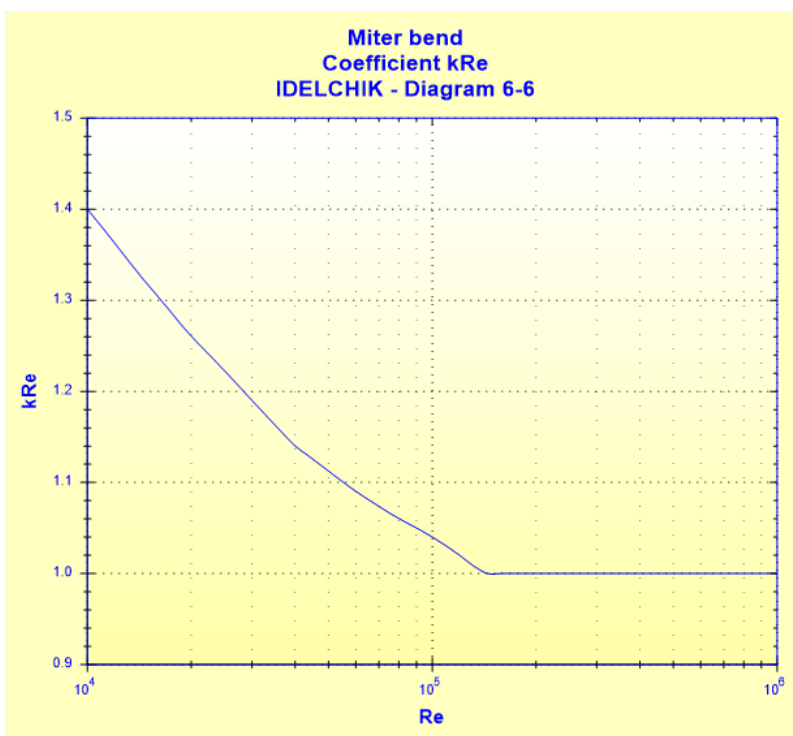
Coefficient of effect of the roughness:

$$k_{\Delta} = f(\text{Re}, \bar{\Delta}) \quad ([1] \text{ diagram 6.6})$$

$\bar{\Delta}$	Re	
	$3 \cdot 10^3 - 4 \cdot 10^4$	$> 4 \cdot 10^4$
0	1.0	1.0
0 - 0.001	1.0	$1 + 0.5 \cdot 10^3 \cdot \bar{\Delta}$
$> 0.001$	1.0	1.5

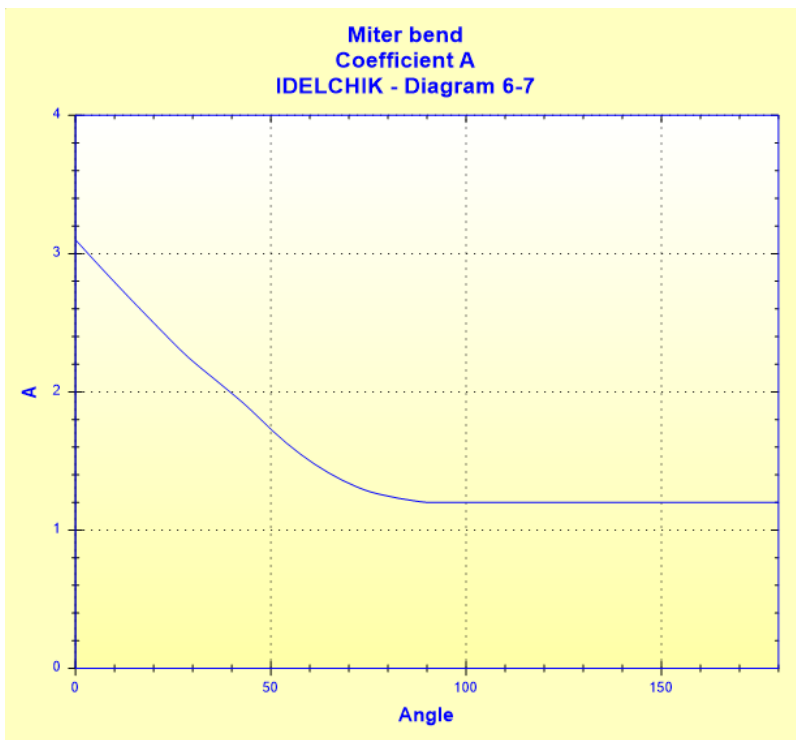
Coefficient of effect of the Reynolds number ( $\text{Re} \geq 10^4$ ):

$$k_{\text{Re}} = f(\text{Re}) \quad ([1] \text{ diagram 6.6})$$



Coefficient of effect of the angle:

$$A = f(\delta) \quad ([1] \text{ diagram 6.7})$$

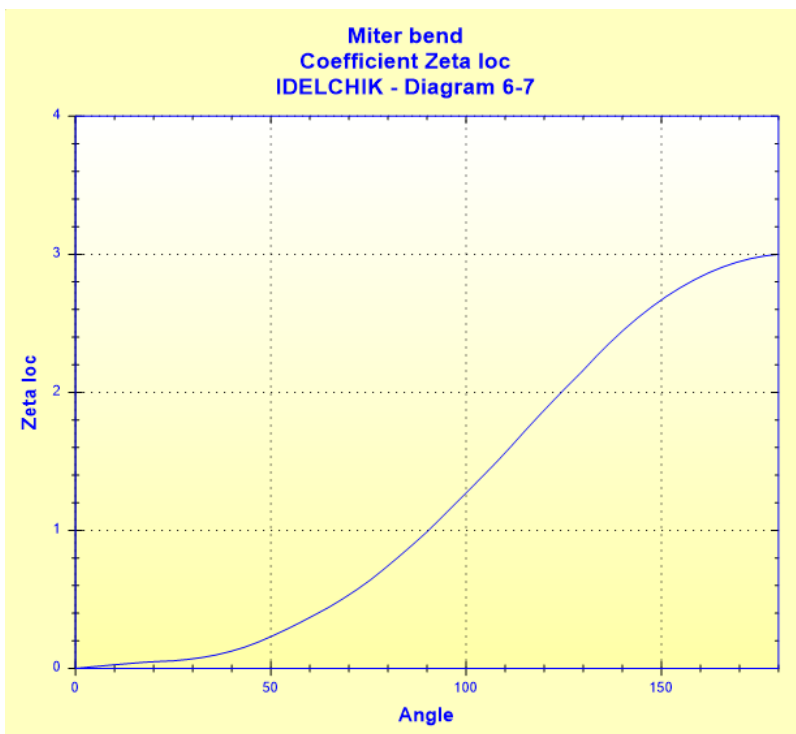


Coefficient of effect of the relative elongation of the cross section:

$$\boxed{C_1 = 1} \quad ([1] \text{ diagram 6.7})$$

Coefficient of local resistance:

$$\boxed{\zeta_{loc} = f(\delta)} \quad ([1] \text{ diagram 6.7})$$



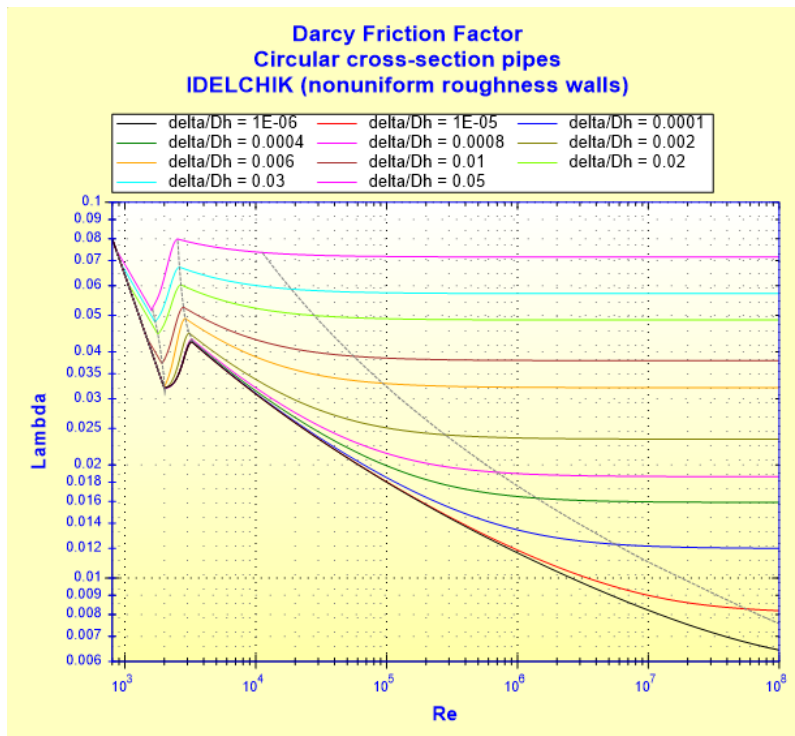
Total pressure loss coefficient (based on the mean velocity in the bend):

$$\boxed{\zeta = k_{\Delta} \cdot k_{Re} \cdot C_1 \cdot A \cdot \zeta_{loc}} \quad ([1] \text{ diagram 6.7})$$

Darcy friction factor:

$$\lambda = f\left(\text{Re}, \frac{\Delta}{D_h}\right)$$

See [Straight Pipe - Circular Cross-Section and Nonuniform Roughness Walls \(IDELCHIK\)](#)



Straight length of equivalent pressure loss (m):

$$L_{eq} = \zeta \cdot \frac{D_0}{\lambda}$$

Total pressure loss (Pa):

$$\Delta P = \zeta \cdot \frac{\rho \cdot w_0^2}{2} \quad ([1] \text{ diagram 6.7})$$

Total head loss of fluid (m):

$$\Delta H = \zeta \cdot \frac{w_0^2}{2 \cdot g}$$

Hydraulic power loss (W):

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

**Symbols, Definitions, SI Units:**

- D<sub>h</sub> Bend hydraulic diameter (m)
- D<sub>0</sub> Bend internal diameter (m)
- F<sub>0</sub> Cross-sectional area (m<sup>2</sup>)
- Q Volume flow rate (m<sup>3</sup>/s)
- w<sub>0</sub> Mean velocity (m/s)
- G Mass flow rate (kg/s)

$Re$	Reynolds number ( )
$\Delta$	Absolute roughness of walls (m)
$\bar{\Delta}$	Relative roughness of walls ( )
$k_{\Delta}$	Coefficient that allows for the effect of the roughness
$k_{Re}$	Coefficient that allows for the effect of the Reynolds number
$\delta$	Angle of the bend (°)
$A$	Coefficient that allows for the effect of the angle
$C_1$	Coefficient that allows for the effect of the relative elongation of the cross section
$\zeta_{loc}$	Coefficient of local resistance ( )
$\zeta$	Total pressure loss coefficient (based on the mean velocity in the bend) ( )
$\lambda$	Darcy friction coefficient ( )
$L_{eq}$	Straight length of equivalent pressure loss (m)
$\Delta P$	Total pressure loss (Pa)
$\Delta H$	Total head loss of fluid (m)
$Wh$	Hydraulic power loss (W)
$\rho$	Fluid density ( $\text{kg/m}^3$ )
$\nu$	Fluid kinematic viscosity ( $\text{m}^2/\text{s}$ )
$g$	Gravitational acceleration ( $\text{m/s}^2$ )

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#### Validity range:

- stabilized flow upstream bend
- length of the straight section downstream:  $\geq 10 D_0$
- curvature angle: 0 to 180°
- flow regime:  $Re \geq 10^4$

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#### Example of application:

HydrauCalc 2018b - [Miter bend with circular cross-section - IDELCHIK (3rd Ed.)]

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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.  Kn. Visc.

Geometrical characteristics

Hydraulic diameter: 0.0703 m

Pressure loss:  $\Delta P$  0.01106294 bar  
 $\Delta H$  0.1130 m of fluid

Flow rate: G 4.9910 kg/s, Q 0.005 m<sup>3</sup>/s  
Velocity: w 1.288 m/s (Turbulent)

Angle: 90°

Complementary results

Designation	Symbol	Value	Unit
Hydraulic diameter	Dh	0.0703	m
Cross-sectional area	F0	0.003881508	m <sup>2</sup>
Reynolds number	Re	90251	
Coefficient of effect of the relative elongation of the section ...	C1	1	
<input checked="" type="checkbox"/> Coefficient of local resistance	$\zeta_{loc}$	0.99	
<input checked="" type="checkbox"/> Coefficient	A	1.2	
Roughness correction (Diagram 6-6)	$k_s$	1.071124	
<input checked="" type="checkbox"/> Reynolds number correction factor (Diagram 6-6)	$k_{Re}$	1.049749	
Pressure loss coefficient (based on the mean bend velocity)	$\zeta$	1.3358	
Hydraulic power loss	Wh	5.531472	W
<input checked="" type="checkbox"/> Darcy Friction Factor	$\lambda$	0.01907611	
Straight length of equivalent pressure loss	Leq	4.922743	m

## References:

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

HydrauCalc

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