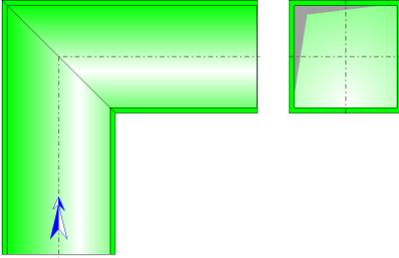




Miter Bend Rectangular Cross-Section (IDELCHIK)



Model description:

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

Model formulation:

Hydraulic diameter (m):

$$D_h = \frac{2 \cdot a_0 \cdot b_0}{a_0 + b_0} \quad ([1] \text{ diagram 6-7})$$

Cross-section area (m²):

$$F_0 = a_0 \cdot b_0$$

Mean velocity (m/s):

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

Mass flow rate (kg/s):

$$G = Q \cdot \rho$$

Reynolds number:

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

Relative roughness:

$$\bar{\Delta} = \frac{\Delta}{D_h}$$

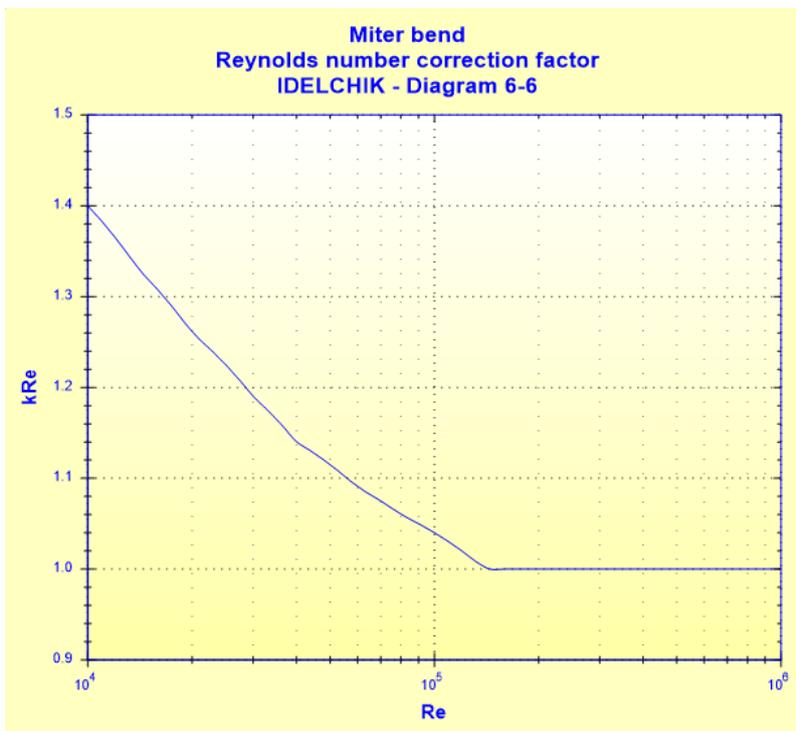
Coefficient of effect of the roughness:

$$k_{\Delta} = f(\text{Re}, \bar{\Delta}) \quad ([1] \text{ diagram 6-6})$$

$\bar{\Delta}$	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

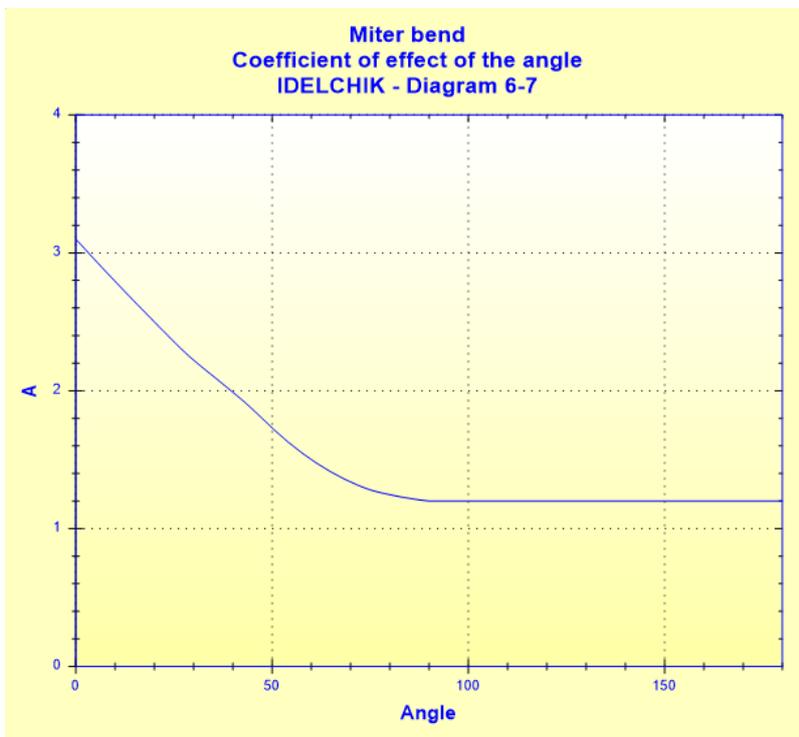
Coefficient of effect of the Reynolds number ($\text{Re} \geq 10^4$):

$$k_{\text{Re}} = f(\text{Re}) \quad ([1] \text{ diagram 6-6})$$



Coefficient of effect of the angle:

$$A = f(\delta) \quad ([1] \text{ diagram 6-7})$$



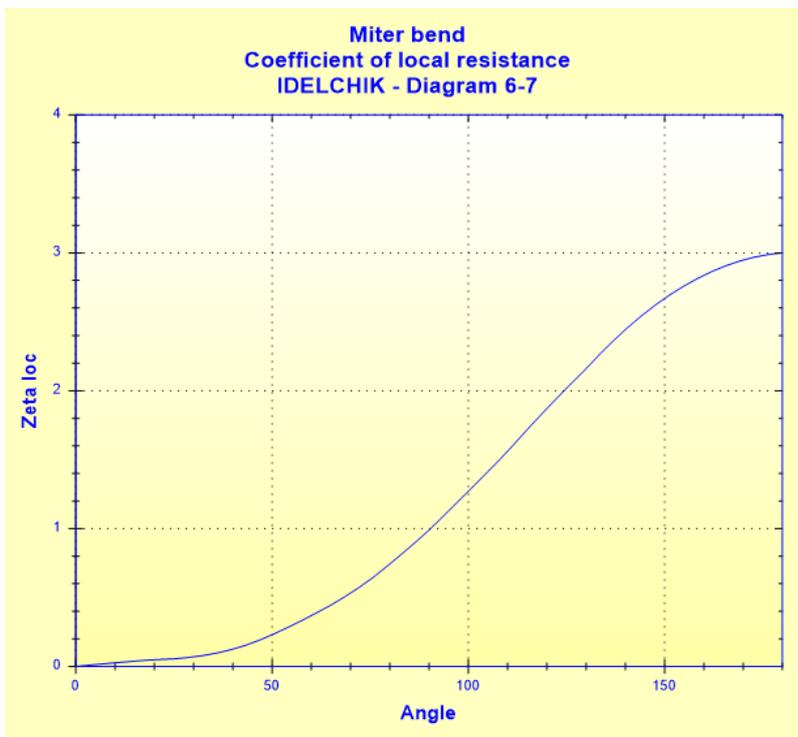
Coefficient of effect of the relative elongation of the cross section:

$$C_1 = f\left(\frac{a_0}{b_0}\right) \quad ([1] \text{ diagram 6-7})$$



Coefficient of local resistance:

$$\zeta_{loc} = f(\delta) \quad ([1] \text{ diagram 6-7})$$



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

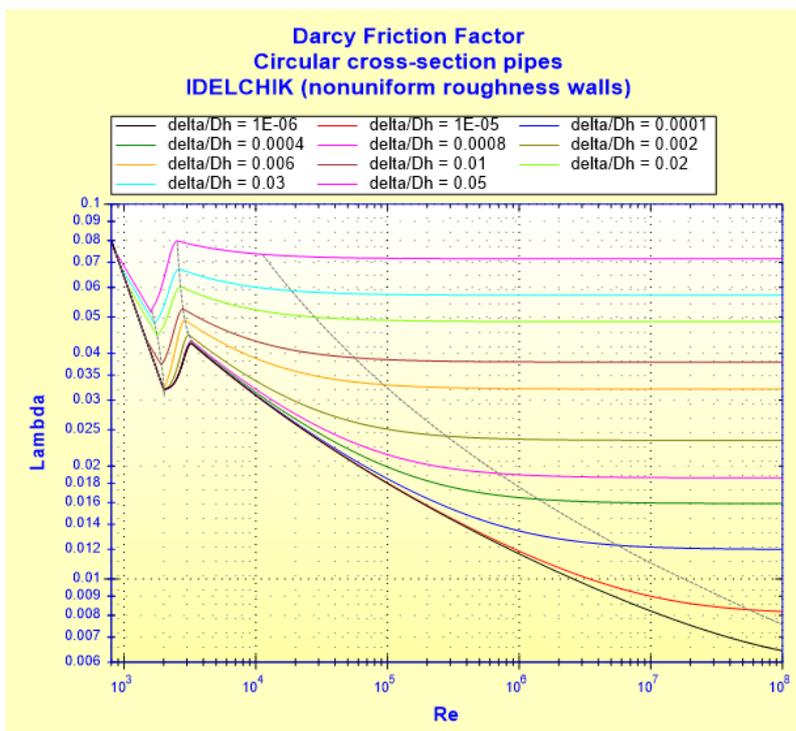
$$\zeta = k_{\Delta} \cdot k_{Re} \cdot C_1 \cdot A \cdot \zeta_{loc} \quad ([1] \text{ diagram 6-7})$$

Darcy friction factor:

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

- Darcy friction factor for circular cross-section

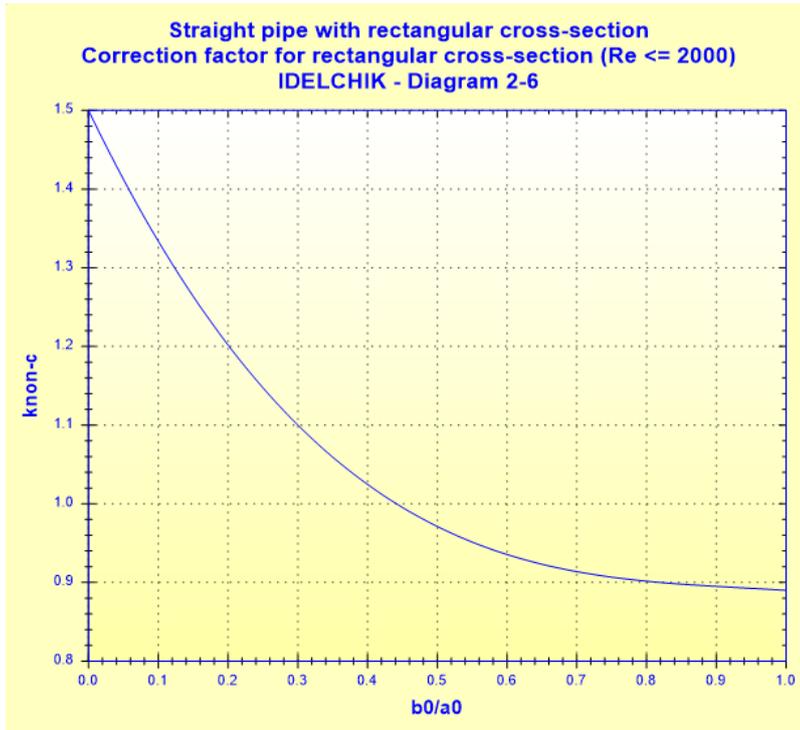
$$\lambda_{circ} = f \left(Re, \frac{\Delta}{D_h} \right)$$



- Correction for Darcy friction factor for noncircular cross-section

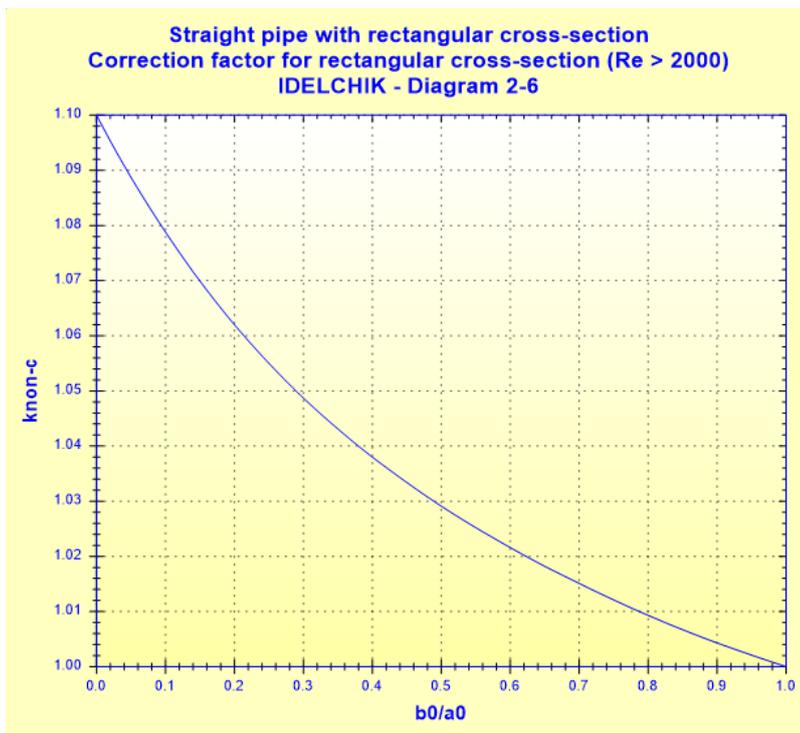
- laminar flow ($Re \leq 2000$):

$$k_{non-c} = f(b_0/a_0) \quad ([1] \text{ diagram 2.6})$$



- turbulent flow ($Re > 2000$):

$$k_{non-c} = f(b_0/a_0) \quad ([1] \text{ diagram 2.6})$$



- Darcy friction factor for rectangular cross-section

$$\lambda_{rect} = \lambda_{circ} \cdot k_{non-c} \quad ([1] \text{ diagram 2.6})$$

Straight length of equivalent pressure loss (m):

$$L_{eq} = \zeta \cdot \frac{D_h}{\lambda_{rect}}$$

Total pressure loss (Pa):

$$\Delta P = \zeta \cdot \frac{\rho \cdot W_0^2}{2}$$

([1] 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:

a_0	Rectangular cross-section width (m)
b_0	Rectangular cross-section height (m)
D_h	Bend hydraulic diameter (m)
F_0	Cross-sectional area (m ²)
Q	Volume flow rate (m ³ /s)
w_0	Mean velocity (m/s)
G	Mass flow rate (kg/s)
Re	Reynolds number ()
Δ	Absolute roughness of walls (m)
$\bar{\Delta}$	Relative roughness of walls ()
k_{Δ}	Coefficient that allows for the effect of the roughness
k_{Re}	Coefficient that allows for the effect of the Reynolds number
δ	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
ζ_{loc}	Coefficient of local resistance ()
ζ	Total pressure loss coefficient (based on the mean velocity in the bend) ()
λ_{circ}	Darcy friction coefficient for circular cross-section ()
λ_{rect}	Darcy friction coefficient for rectangular cross-section ()
k_{non-c}	Correction for Darcy friction factor for noncircular cross-section ()
L_{eq}	Straight length of equivalent pressure loss (m)
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:

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

Example of application:

The screenshot displays the HydrCalc 2020a software interface for a miter bend with a rectangular cross-section. The window title is "HydrCalc 2020a - [Miter bend with rectangular cross-section - IDELCHIK (3rd Ed.)]".

Fluid characteristics:

- Fluid: Water @ 1 atm [HC]
- Ref.: IAPWS IF97
- Temperature: T = 20 °C
- Pressure: P = 1.013 bar
- Density: $\rho = 998.2061 \text{ kg/m}^3$
- Dynamic Viscosity: $\mu = 0.00100159 \text{ N.s/m}^2$
- Kinematic Viscosity: $\nu = 1.00340E-06 \text{ m}^2/\text{s}$

Geometrical characteristics:

- Hydraulic diameter: $D_h = 0.06666667 \text{ m}$
- Passage cross-section area: $F_0 = 0.005 \text{ m}^2$
- Sides ratio: $b_0/a_0 = 0.5$
- Reynolds number: $Re = 66440.97$
- Pressure loss: $\Delta P = 0.006225057 \text{ bar}$
- Pressure loss equivalent: $\Delta H = 0.0636 \text{ m of fluid}$

Complementary results:

Designation	Symbol	Value	Unit
Hydraulic diameter	D_h	0.06666667	m
Passage cross-section area	F_0	0.005	m^2
Sides ratio	b_0/a_0	0.5	
Reynolds number	Re	66440.97	
Coefficient of effect of the relative elongation of the section ...	C_1	0.904	
Coefficient of local resistance	ζ_{loc}	0.99	
Coefficient of effect of the angle	A	1.2	
Roughness correction (Diagram 6-6)	K_A	1.075	
Reynolds number correction factor (Diagram 6-6)	K_{Re}	1.080339	
Pressure loss coefficient (based on the mean bend velocity)	ζ	1.247249	
Hydraulic power loss	W_h	3.112529	W
Friction factor for circular cross-section	λ_{circ}	0.02024362	
Correction factor for rectangular cross-section	k_{non-c}	1.0291	
Friction factor for rectangular cross-section	λ_{rect}	0.0208327	
Straight length of equivalent pressure loss	L_{eq}	3.991318	m

References:

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