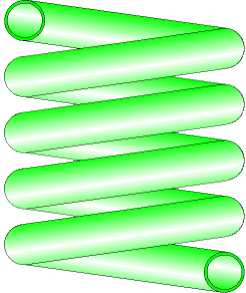




Helical Tube (Coil) Circular Cross-Section (IDELCHIK)



Model description:

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

Model formulation:

Hydraulic diameter (m):

$$D_h = D_0$$

Cross-section area (m²):

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

Length measured along the axis (m):

$$l = N \cdot 2 \cdot \pi \cdot R_0$$

Mean velocity (m/s):

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

Mass flow rate (kg/s):

$$G = Q \cdot \rho$$

Fluid volume (m³):

$$V = F_0 \cdot l$$

Fluid mass (kg):

$$M = V \cdot \rho$$

Reynolds number:

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

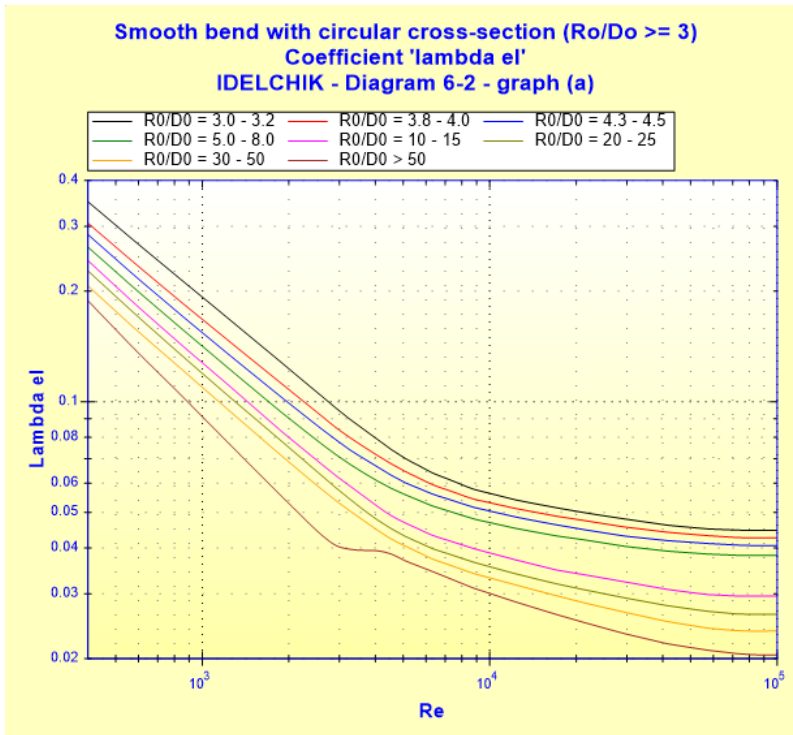
Relative roughness:

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

Friction factor smooth wall:

$$\lambda_{el} = f\left(Re, \frac{R_0}{D_0}\right)$$

([1] diagram 6.2)



Pressure loss coefficient:

$$\zeta = 0.0175 \cdot (N \cdot 360) \cdot \lambda_{el} \cdot \frac{R_0}{D_h}$$

([1] diagram 6.2)

Straight length of equivalent pressure loss (m):

$$L_{eq} = \zeta \cdot \frac{D_0}{\lambda_{el}}$$

Total pressure loss (Pa):

$$\Delta P = \zeta \cdot \frac{\rho \cdot w_0^2}{2}$$

([1] diagram 6.1 - 6.2)

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_h	Hydraulic diameter of the helical tube (m)
D_0	Internal diameter of the helical tube (m)
F_0	Cross-sectional area (m ²)
N	Number of turns constituting the helical tube ()
l	Length measured along the axis (m)
R_0	Radius of curvature (m)
Q	Volume flow rate (m ³ /s)
w_0	Mean velocity (m/s)
G	Mass flow rate (kg/s)
V	Fluid volume (m ³)
M	Fluid mass (kg)
Re	Reynolds number ()
λ_{el}	Friction coefficient ()
ζ	Total pressure loss coefficient (based on the mean velocity in the bend) ()
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:

- flow regime: $400 \leq Re \leq 10^5$
for Reynolds number 'Re' lower than 400 or greater than 10^5 , the coefficient ' λ_{el} ' is linearly extrapolated.
- $R_0/D_0 \geq 3$
- hydraulically smooth flow
- stabilized flow upstream bend

Example of application:

HydrauCalc 2021a - [Helical tube 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 : ρ 998.2061 kg/m³
Dynamic Viscosity : μ 0.00100159 N.s/m²
Kinematic Viscosity : ν 1.00340E-06 m²/s

Density Dyn. Visc. Kin. Visc.

Geometrical characteristics

Help Info

w_0 1.132 m/s (Turbulent)
G 4.9910 kg/s
Q 0.005 m³/s

Pressure loss
 ΔP 0.1131618 bar
 ΔH 1.1560 m of fluid

Number of turns N 10

Calculate

Complementary results

Designation	Symbol	Value	Unit
Hydraulic diameter	Dh	0.075	m
Passage cross-section area	F0	0.004417865	m ²
Relative radius of curvature	R0/Do	8	
Developed straight length from the axis	l	37.69911	m
Internal helical tube volume	V	0.1665496	m ³
Mass of fluid in the helical tube	M	166.2508	kg
Reynolds number	Re	84595.27	
Friction factor (Diagram 6-2)	λ_{el}	0.03521475	
Pressure loss coefficient (based on the mean helical tube vel...)	ζ	17.70086	
Hydraulic power loss	Wh	56.58088	W
Straight length of equivalent pressure loss	Leq	71.244	m

Divers HC

References:

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