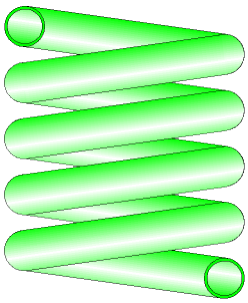
Helical Tube (Coil)
Circular Cross-Section
(IDELCHIK)



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 (m^2):

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

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 (m^3):

$$V = F_0 \cdot l$$

Fluid mass (kg):

$$M = V \cdot \rho$$

Reynolds number:

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

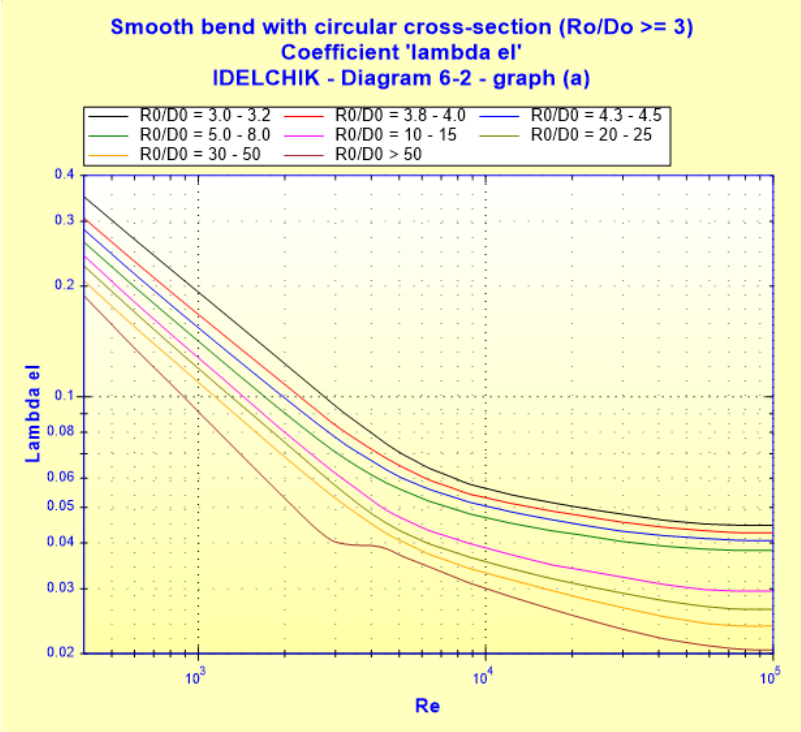
Relative roughness:

$$\overline{\Delta} = \frac{\Delta}{D_0}$$

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):

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

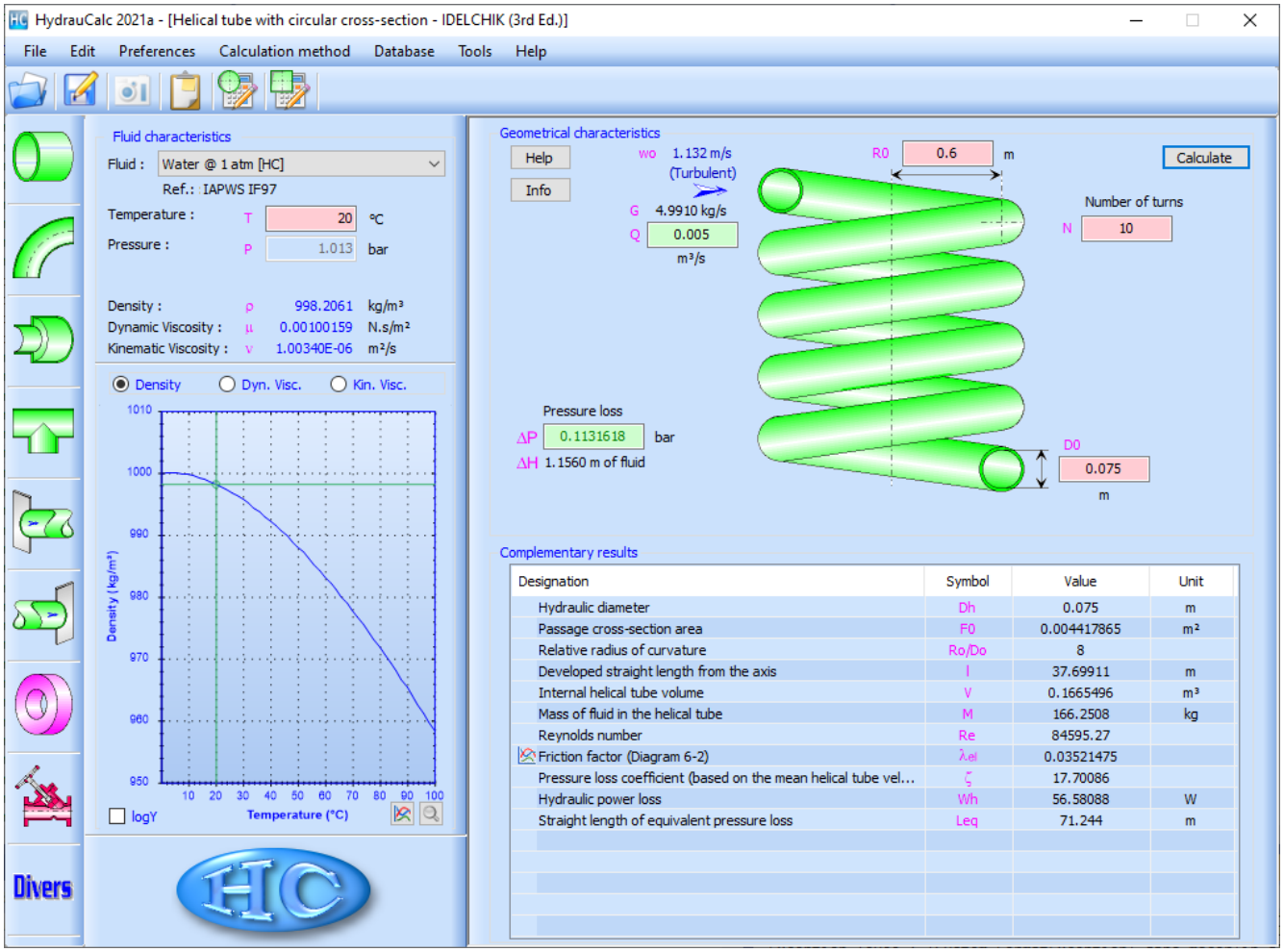
Symbols, Definitions, SI Units:

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:



References:

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