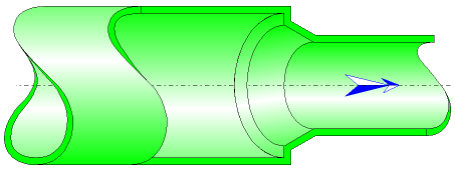
Sudden Contraction Bevelled Circular Cross-Section (IDELCHIK)



Model description:

This model of component calculates the minor head loss (pressure drop) generated by the flow in a sudden contraction bevelled.

The head loss by friction in the inlet and outlet piping is not taken into account in this component.

Model formulation:

Ratio of small to large diameter:

$$\beta = \frac{D_1}{D_0}$$

Top angle of cone (°):

$$\alpha = 2 \cdot \tan^{-1}\left(\frac{D_2 - D_0}{2 \cdot l}\right)$$

Minor cross-sectional area (m^2):

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

Major cross-sectional area (m^2):

$$F_1 = \pi \cdot \frac{D_1^{\,2}}{4}$$

Mean velocity in minor diameter (m/s):

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

Mean velocity in major diameter (m/s):

$$w_1 = \frac{Q}{F_1}$$

Mass flow rate (kg/s):

$$G = Q \cdot \rho$$

Reynolds number in minor diameter:

$$\mathrm{Re}_0 = \frac{w_0 \cdot D_0}{\nu}$$

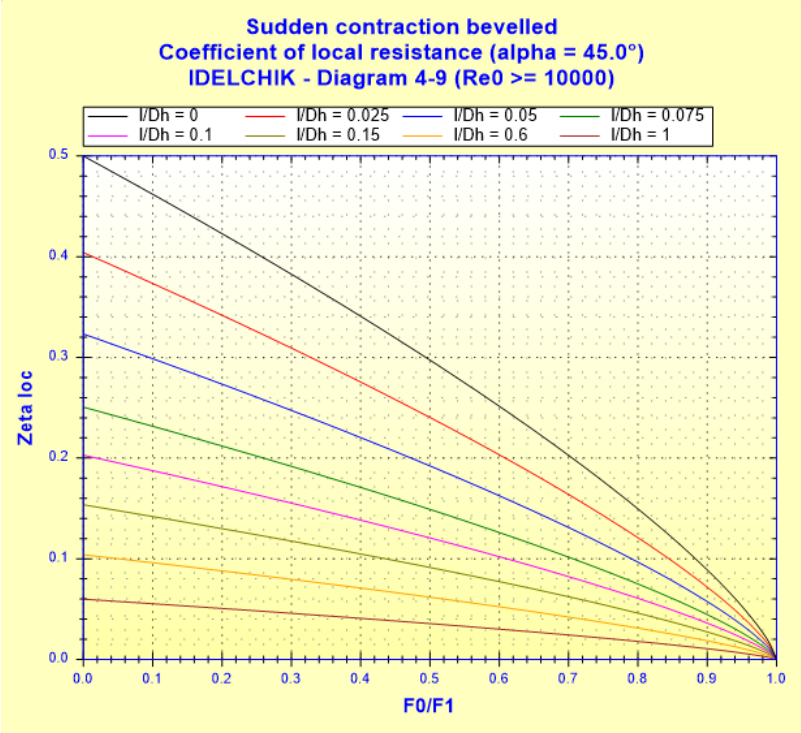
Reynolds number in major diameter:

$$\mathrm{Re}_1 = \frac{w_1 \cdot D_1}{\nu}$$

Local resistance coefficient:

$$\zeta_{loc} = \zeta'' \cdot \left(1 - \frac{F_0}{F_1}\right)^{3/4}$$

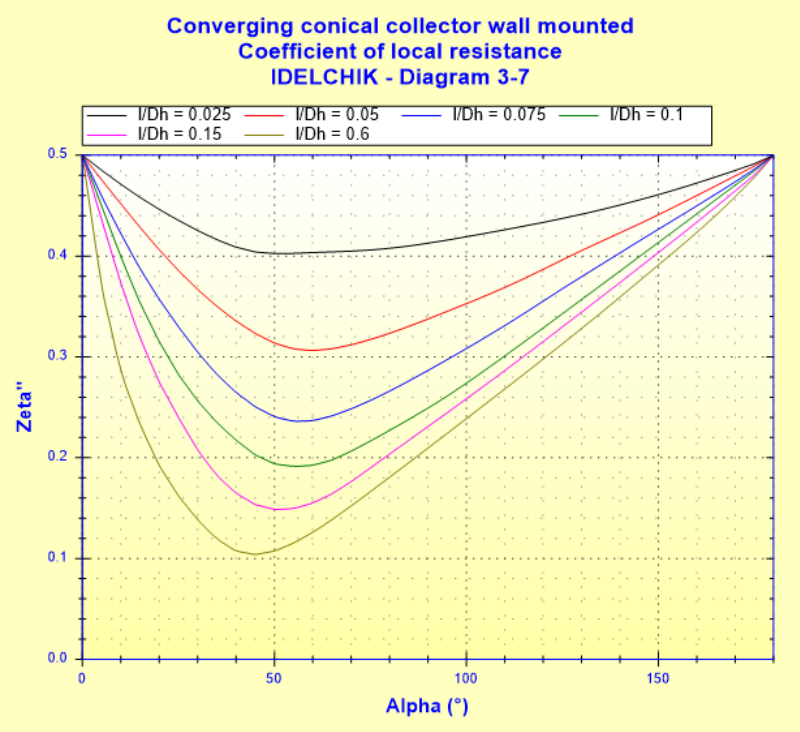
([1] diagram 4-9)



with:

$$\zeta'' = f(\alpha, l/D_h)$$

([1] diagram 3-7)



Total pressure loss coefficient (based on mean velocity in minor diameter):

$$\zeta = \zeta_{loc}$$

Total pressure loss (Pa):

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

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_0	Minor diameter (m)
D_1	Major diameter (m)
D_2	Base diameter of the cone (m)
β	Ratio of small to large diameter ()
F_0	Minor cross-sectional area (m^2)
F_1	Major cross-sectional area (m^2)
Q	Volume flow rate (m^3/s)
G	Mass flow rate (kg/s)
w_0	Mean velocity in minor diameter (m/s)
w_1	Mean velocity in major diameter (m/s)
Re_0	Reynolds number in minor diameter ()
Re_1	Reynolds number in major diameter ()

α	Top angle of cone (2 x bevel angle) (°)
l	Bevel length (m)
ζ_{loc}	Local resistance coefficient ()
ζ	Total pressure loss coefficient (based on mean velocity in minor diameter) ()
ΔP	Total pressure loss (Pa)
ΔH	Total head loss of fluid (m)
Wh	Hydraulic power loss (W)
ρ	Fluid density (kg/m³)
ν	Fluid kinematic viscosity (m²/s)
g	Gravitational acceleration (m/s²)

Validity range:

- turbulent flow regime in pipe ($Re_0 \geq 10^4$)
- relative length of bevel (l/D_h) equal to or lower than 0.6
  note: for relative lengths of bevel "l/D_h" greater than 0.6, the local pressure loss coefficient is extrapolated

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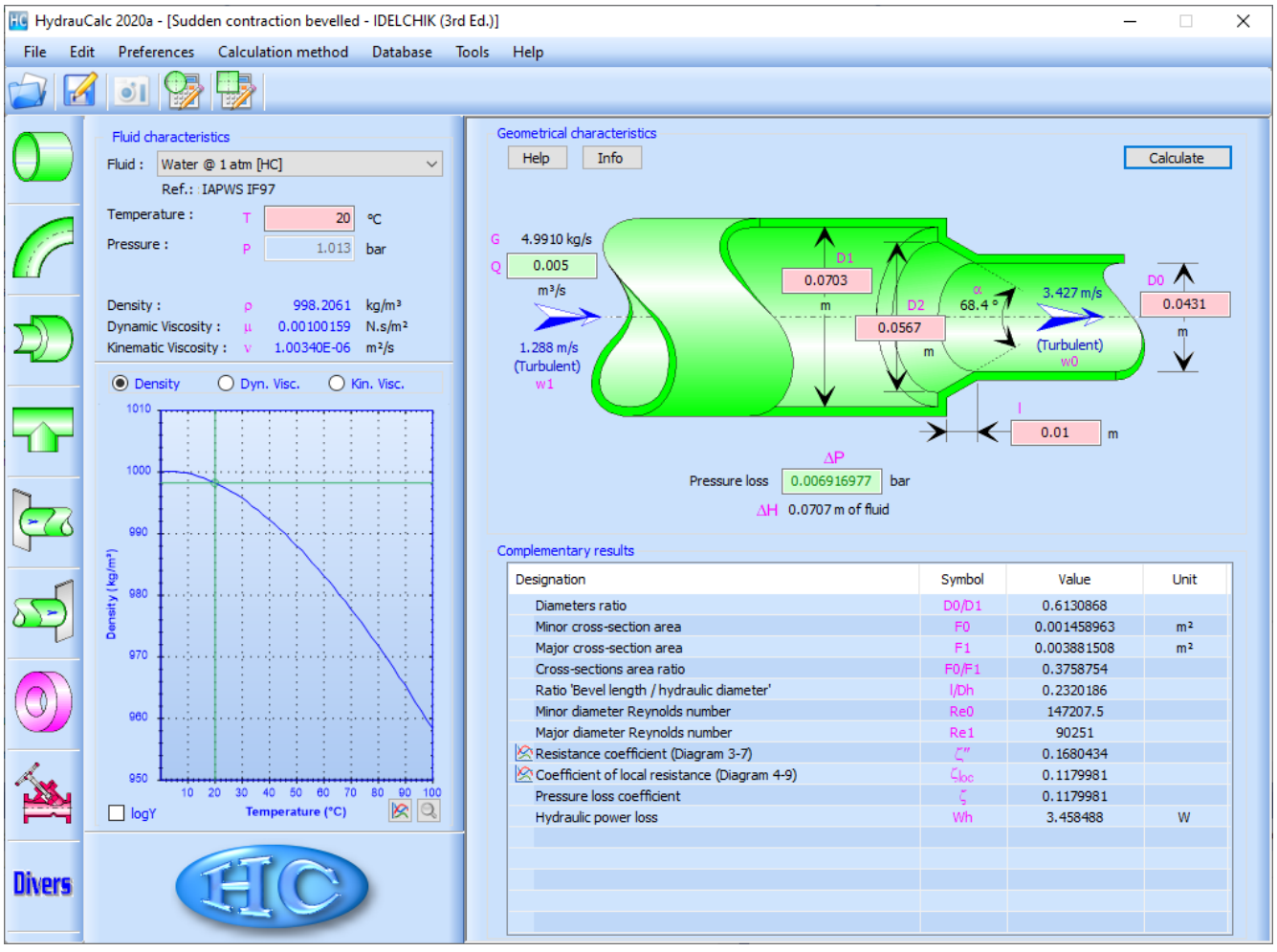
Example of application:



References:

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

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