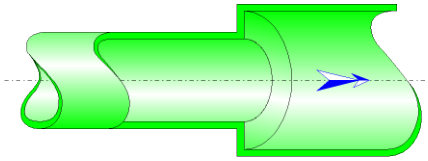
Sudden Expansion
Circular Cross-Section
Uniform Velocity Distribution
(IDELCHIK)



Model description:

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

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

Model formulation:

Minor cross-sectional area (m^2):

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

Major cross-sectional area (m^2):

$$F_2 = \pi \cdot \frac{D_2^2}{4}$$

Mean velocity in minor diameter (m/s):

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

Mean velocity in major diameter (m/s):

$$w_2 = \frac{Q}{F_2}$$

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:

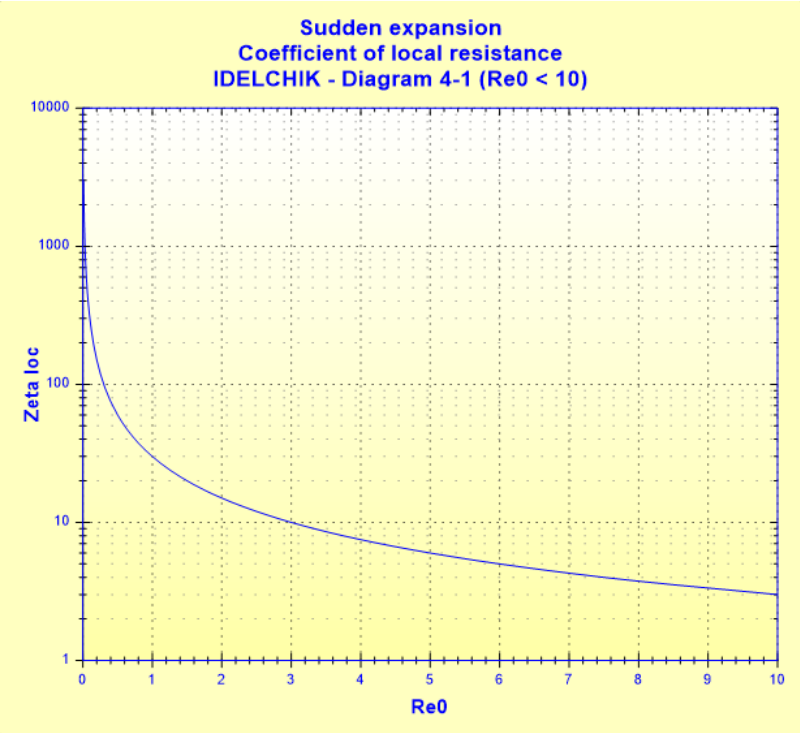
$$\mathrm{Re}_2 = \frac{w_2 \cdot D_2}{\nu}$$

Local resistance coefficient:

- $\mathrm{Re}_0 < 10$

$$\zeta_{loc} = \frac{30}{\mathrm{Re}_0}$$

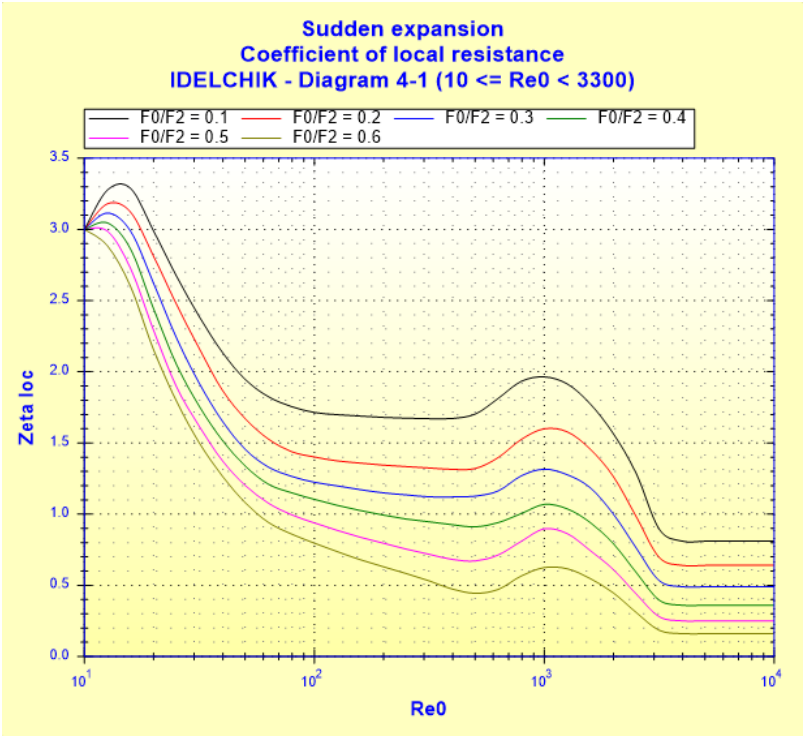
([1] diagram 4.1)



- $10 \le \mathrm{Re}_0 < 3300$

$$\zeta_{loc} = f\left(\mathrm{Re}_0, \frac{F_0}{F_2}\right)$$

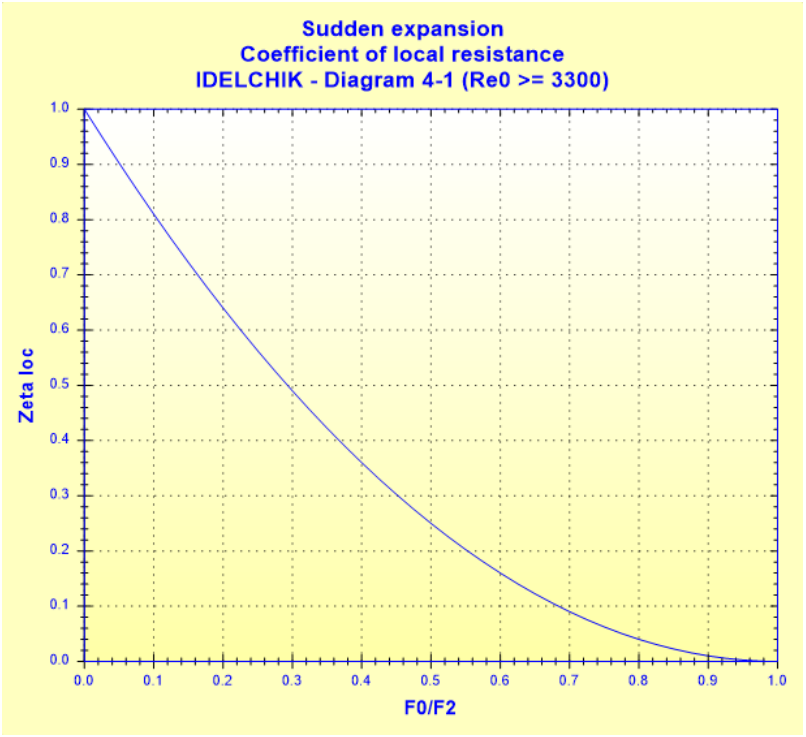
([1] diagram 4.1)



■ $Re_0 \geq 3300$

$$\zeta_{loc} = \left(1 - \frac{F_0}{F_2}\right)^2$$

([1] diagram 4.1)



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_2	Major diameter (m)
F_0	Minor cross-sectional area (m^2)
F_2	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_2	Mean velocity in major diameter (m/s)
Re_0	Reynolds number in minor diameter ()
Re_2	Reynolds number in major diameter ()
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/m^3)
ν	Fluid kinematic viscosity (m^2/s)
g	Gravitational acceleration (m/s^2)

Validity range:

- any flow regime: laminar and turbulent

  note: for Reynolds number "Re_0" between 10 and 3300, and area ratio "F_0/ F_2" lower than 0.1 or greater than 0.6, the local pressure loss coefficient is extrapolated

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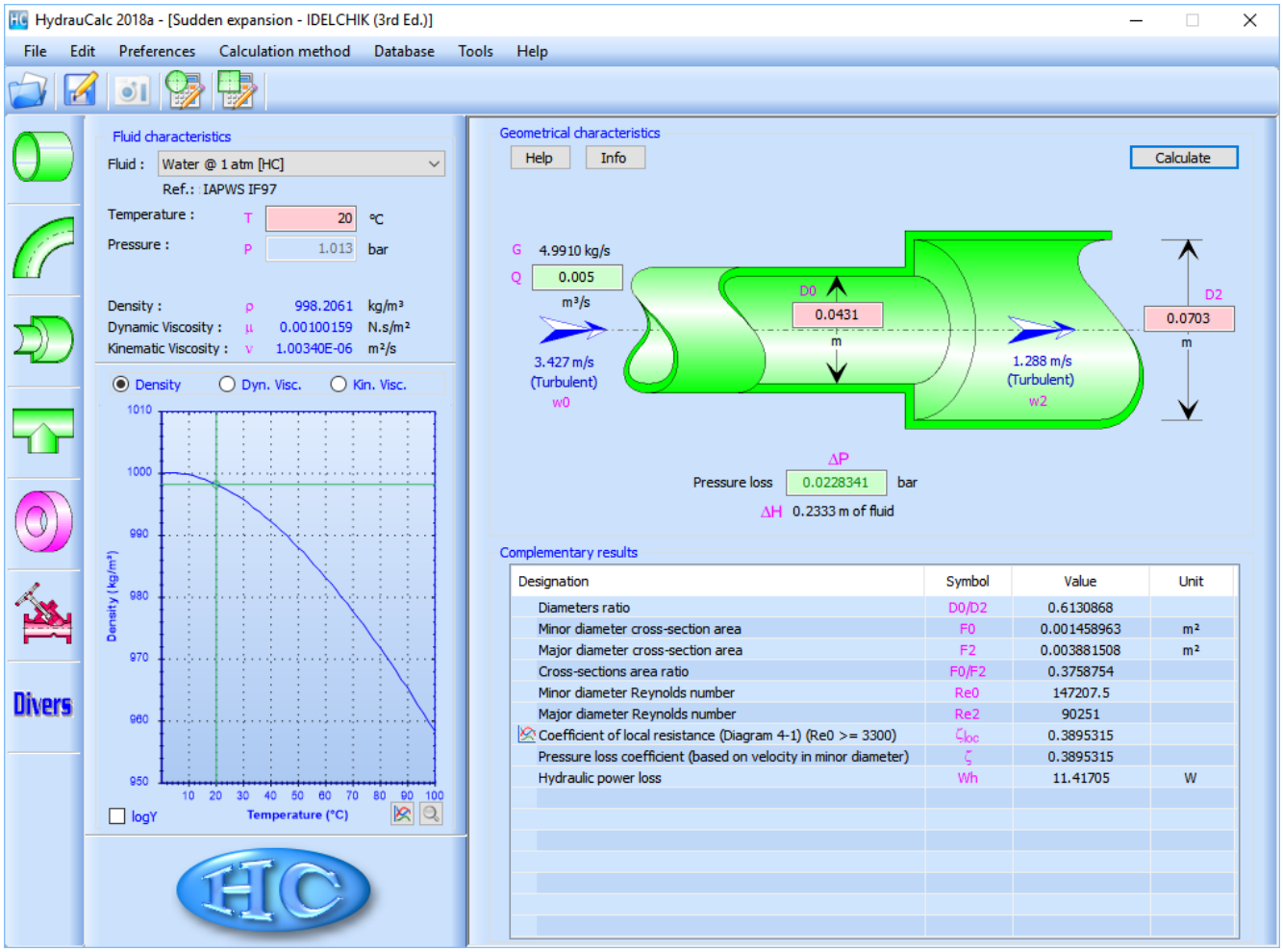
Example of application:



References:

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