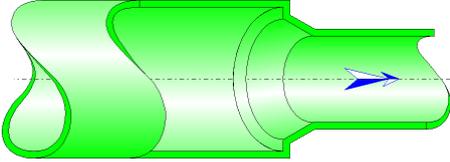




Sudden Contraction Bevelled Circular Cross-Section (IDELCHIK)



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 (m²):

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

Major cross-sectional area (m²):

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

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:

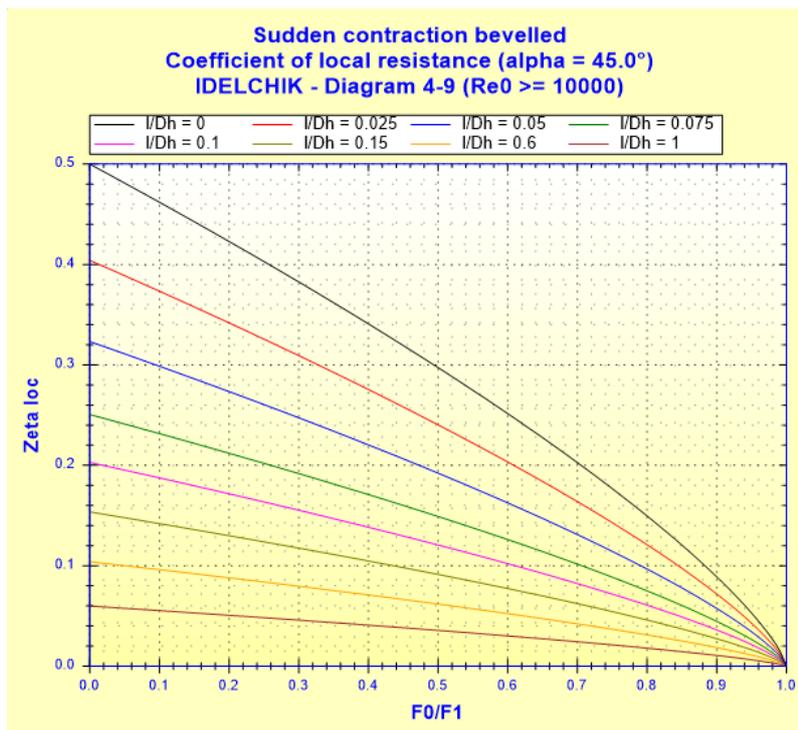
$$Re_0 = \frac{w_0 \cdot D_0}{\nu}$$

Reynolds number in major diameter:

$$Re_1 = \frac{w_1 \cdot D_1}{\nu}$$

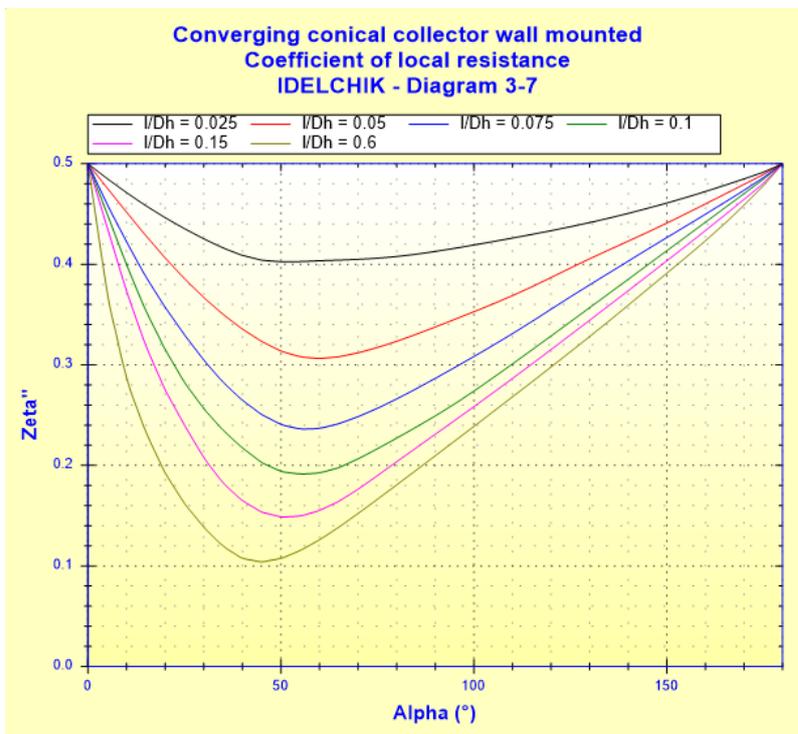
Local resistance coefficient:

$$\zeta_{loc} = \zeta'' \cdot \left(1 - \frac{F_0}{F_1}\right)^{3/4} \quad ([1] \text{ diagram 4-9})$$



with:

$$\zeta'' = f(\alpha, l/D_h) \quad ([1] \text{ diagram 3-7})$$



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/m ³)
ν	Fluid kinematic viscosity (m ² /s)
g	Gravitational acceleration (m/s ²)

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

Example of application:

The screenshot shows the HydrCalc 2020a software interface for a "Sudden contraction bevelled - IDELCHIK (3rd Ed.)".

Fluid characteristics:

- Fluid: Water @ 1 atm [HC]
- Ref.: IAPWS IF97
- Temperature: T = 20 °C
- Pressure: P = 1.013 bar
- Density: $\rho = 998.2061$ kg/m³
- Dynamic Viscosity: $\mu = 0.00100159$ N.s/m²
- Kinematic Viscosity: $\nu = 1.00340E-06$ m²/s

Geometrical characteristics:

- Mass flow rate: G = 4.9910 kg/s
- Volume flow rate: Q = 0.005 m³/s
- Inlet velocity: $w_1 = 1.288$ m/s (Turbulent)
- Outlet velocity: $w_0 = 3.427$ m/s (Turbulent)
- Major diameter: D1 = 0.0703 m
- Minor diameter: D0 = 0.0431 m
- Bevel length: l = 0.01 m
- Bevel angle: $\alpha = 68.4^\circ$
- Pressure loss: $\Delta P = 0.006916977$ bar
- Head loss: $\Delta H = 0.0707$ m of fluid

Complementary results:

Designation	Symbol	Value	Unit
Diameters ratio	D0/D1	0.6130868	
Minor cross-section area	F0	0.001458963	m ²
Major cross-section area	F1	0.003881508	m ²
Cross-sections area ratio	F0/F1	0.3758754	
Ratio 'Bevel length / hydraulic diameter'	l/Dh	0.2320186	
Minor diameter Reynolds number	Re0	147207.5	
Major diameter Reynolds number	Re1	90251	
Resistance coefficient (Diagram 3-7)	ζ''	0.1680434	
Coefficient of local resistance (Diagram 4-9)	ζ_{loc}	0.1179981	
Pressure loss coefficient	ζ	0.1179981	
Hydraulic power loss	Wh	3.458488	W

References:

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

