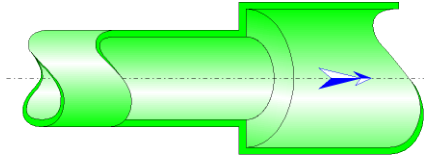




**Sudden Expansion
Circular Cross-Section
Uniform Velocity Distribution
(IDELCHIK)**



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 (m²):

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

Major cross-sectional area (m²):

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

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:

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

Reynolds number in major diameter:

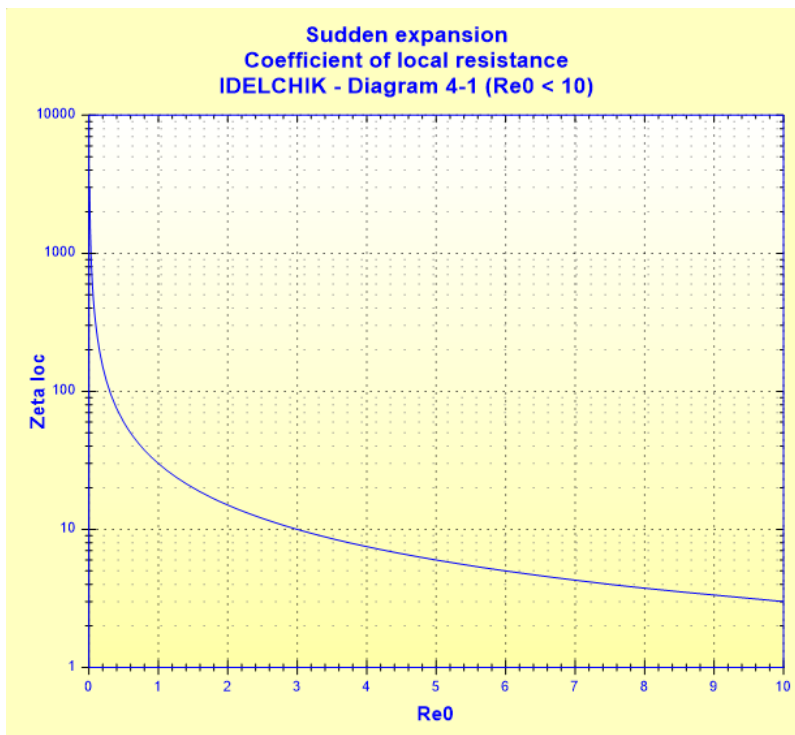
$$\text{Re}_2 = \frac{w_2 \cdot D_2}{\nu}$$

Local resistance coefficient:

■ $\text{Re}_0 < 10$

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

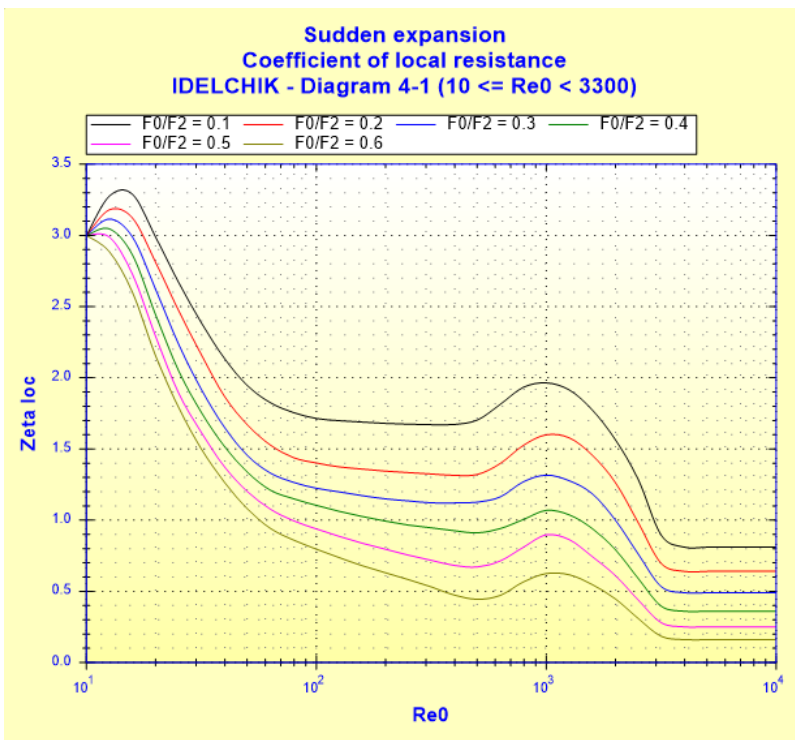
([1] diagram 4.1)



■ $10 \leq \text{Re}_0 < 3300$

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

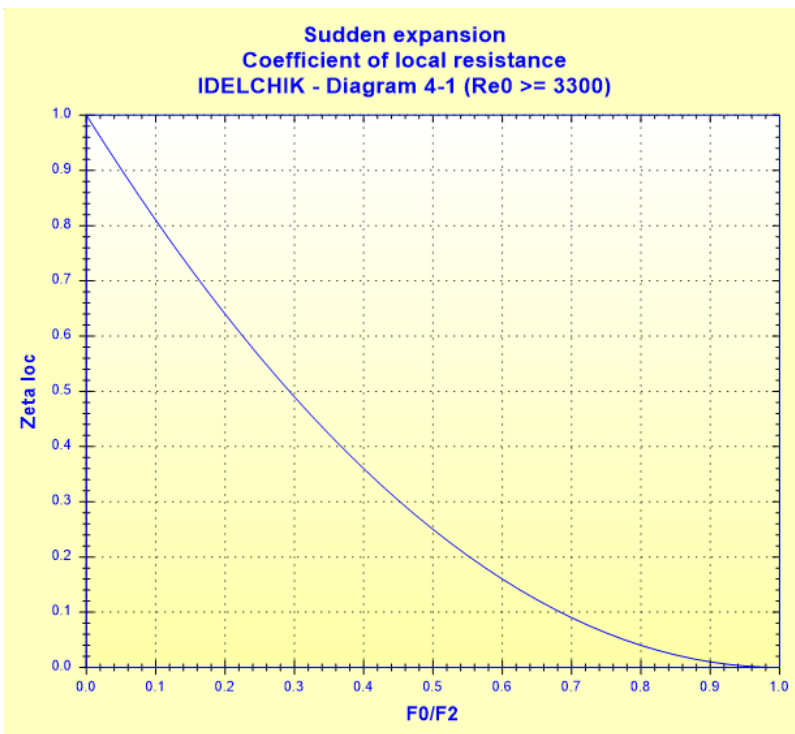
([1] diagram 4.1)



■ Re₀ ≥ 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 "Re₀" between 10 and 3300, and area ratio "F₀/ F₂" lower than 0.1 or greater than 0.6, the local pressure loss coefficient is extrapolated

Example of application:

HydrauCalc 2018a - [Sudden expansion - IDELCHIK (3rd Ed.)]

File Edit Preferences Calculation method Database Tools Help

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 Calculate

Pressure loss ΔP 0.0228341 bar
 ΔH 0.2333 m of fluid

Complementary results

Designation	Symbol	Value	Unit
Diameters ratio	$D0/D2$	0.6130868	
Minor diameter cross-section area	$F0$	0.001458963	m ²
Major diameter cross-section area	$F2$	0.003881508	m ²
Cross-sections area ratio	$F0/F2$	0.3758754	
Minor diameter Reynolds number	$Re0$	147207.5	
Major diameter Reynolds number	$Re2$	90251	
<input checked="" type="checkbox"/> Coefficient of local resistance (Diagram 4-1) ($Re0 \geq 3300$)	ζ_{loc}	0.3895315	
Pressure loss coefficient (based on velocity in minor diameter)	ζ	0.3895315	
Hydraulic power loss	Wh	11.41705	W

References:

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