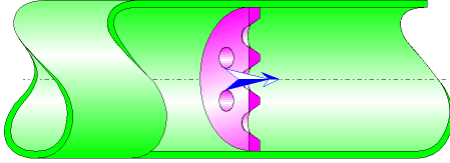




Sharp-Edged Grid Circular Cross-Section (IDELCHIK)



Model description:

This model of component calculates the minor head loss (pressure drop) generated by the flow in a sharp-edged grid (perforated plate) installed in a straight pipe.

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

Model formulation:

Hydraulic diameter (m):

$$D_h = D_0$$

Pipe cross-section area (m²):

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

Cross-section area of one hole (m²):

$$f_0 = \pi \cdot \frac{D_0^2}{4}$$

Clear cross-sectional area of the grid (m²):

$$F_0 = f_0 \cdot N$$

Mean velocity in pipe (m/s):

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

Mean velocity in holes (m/s):

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

Mass flow rate (kg/s):

$$G = Q \cdot \rho$$

Reynolds number in pipe:

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

Reynolds number in holes:

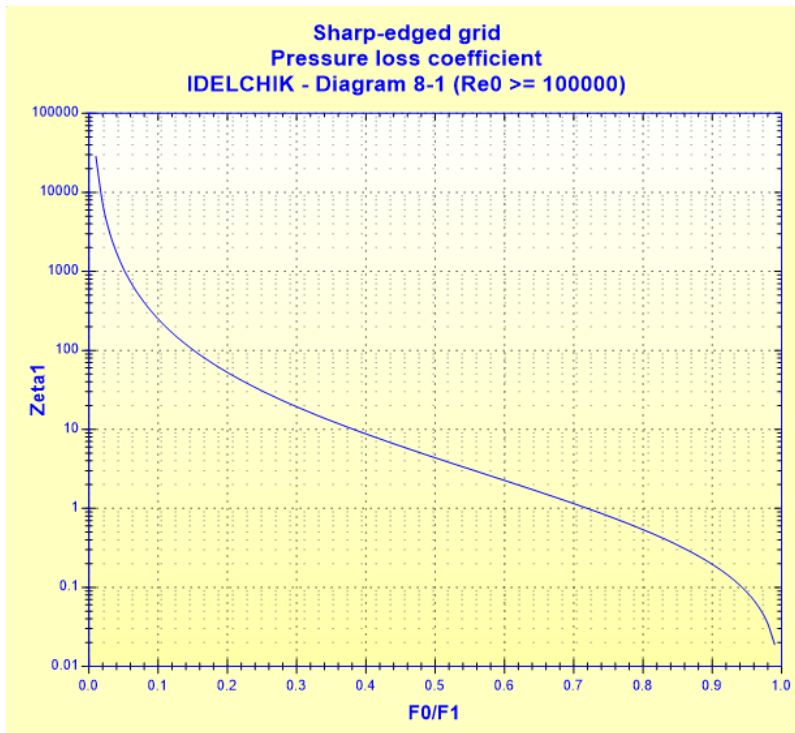
$$Re_0 = \frac{w_0 \cdot D_0}{\nu}$$

Coefficient of local resistance:

■ $Re_0 \geq 10^5$

$$\zeta_1 = \left[0.707 \cdot \left(1 - \frac{F_0}{F_1} \right)^{0.375} + \left(1 - \frac{F_0}{F_1} \right) \right]^2 \cdot \left(\frac{F_1}{F_0} \right)^2$$

([1] diagram 8-1)



■ $Re_0 < 10^5$

Quadratic coefficient of local resistance:

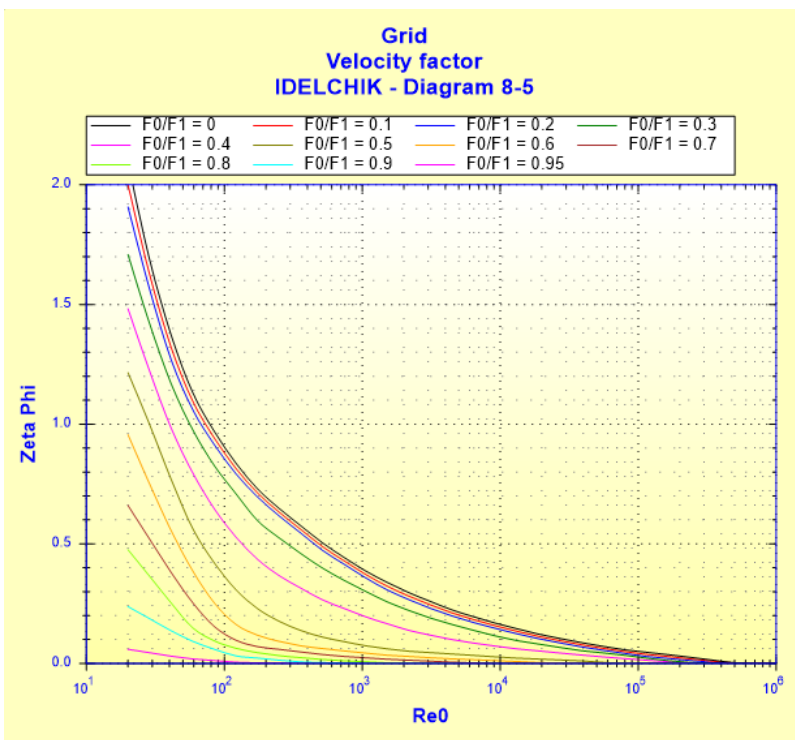
$$\zeta_{1quad} = \left[0.707 \cdot \left(1 - \frac{F_0}{F_1} \right)^{0.375} + \left(1 - \frac{F_0}{F_1} \right) \right]^2 \cdot \left(\frac{F_1}{F_0} \right)^2$$

([1] diagram 8-1)

Velocity factor:

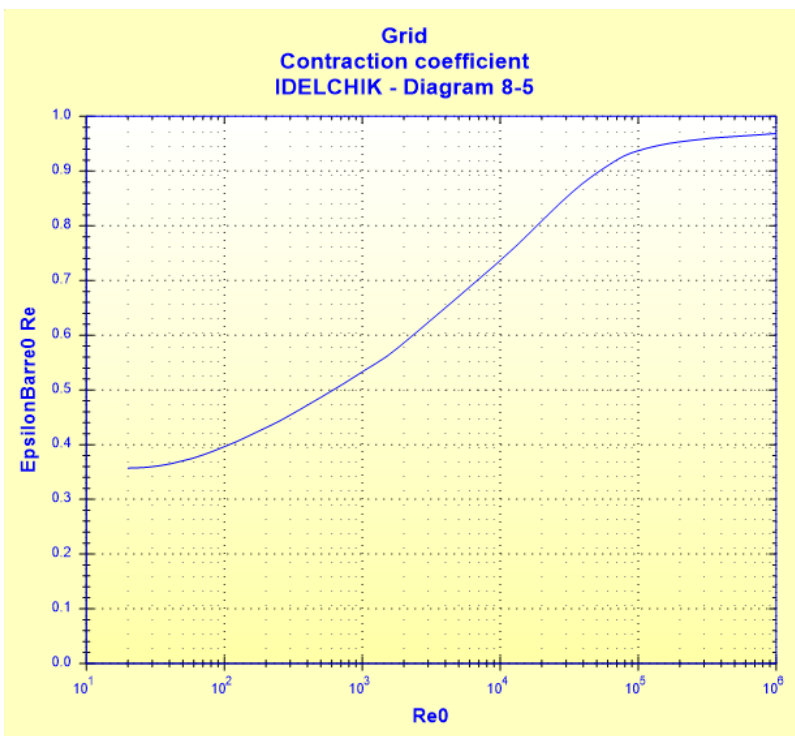
$$\zeta_\varphi = f \left(Re_0, \frac{F_0}{F_1} \right)$$

([1] diagram 8-5)



Contraction factor:

$$\bar{\varepsilon}_{0Re} = f(Re_0) \quad ([1] \text{ diagram 8-5})$$



Coefficient of local resistance:

- $30 < Re_0 < 10^5$

$$\zeta_1 = \zeta_\varphi \cdot \left(\frac{F_1}{F_0}\right)^2 + \bar{\varepsilon}_{0Re} \cdot \zeta_{1quad}$$

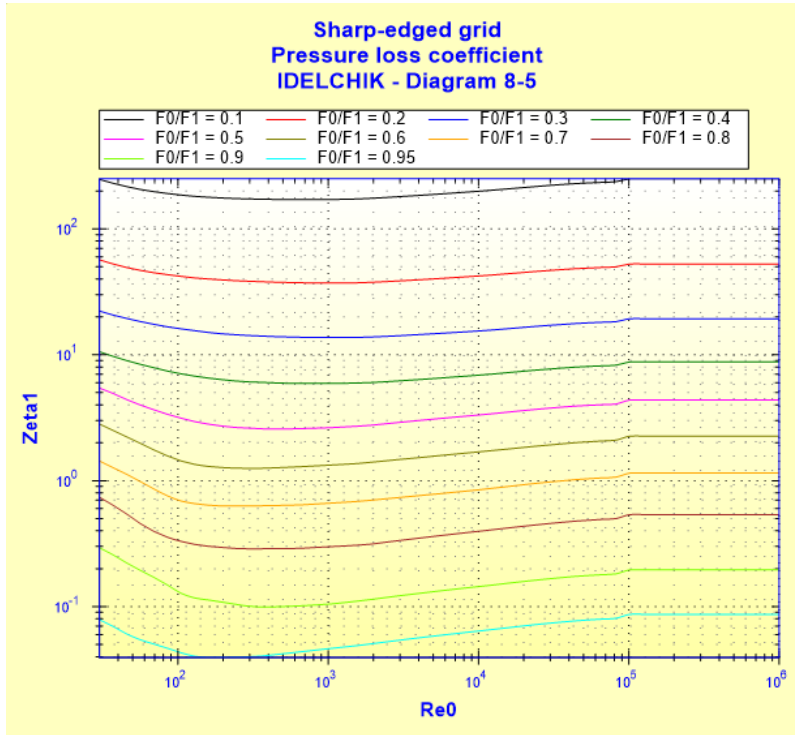
([1] diagram 8-5)

- $10 < Re_0 \leq 30$

$$\zeta_1 = \frac{33}{Re_0} \cdot \left(\frac{F_1}{F_0}\right)^2 + \bar{\varepsilon}_0 Re_0 \cdot \zeta_{1quad} \quad ([1] \text{ diagram 8-5})$$

- $Re_0 \leq 10$

$$\zeta_1 = \frac{33}{Re_0} \cdot \left(\frac{F_1}{F_0}\right)^2 \quad ([1] \text{ diagram 8-5})$$



Pressure loss coefficient (based on the mean pipe velocity):

$$\zeta = \zeta_1$$

Total pressure loss (Pa):

$$\Delta P = \zeta \cdot \frac{\rho \cdot W_1^2}{2}$$

Total head loss of fluid (m):

$$\Delta H = \zeta \cdot \frac{W_1^2}{2 \cdot g}$$

Hydraulic power loss (W):

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

Symbols, Definitions, SI Units:

- D_h Hydraulic diameter (m)
- D_1 Pipe internal diameter (m)
- F_1 Pipe cross-sectional area (m²)
- N Holes number ()
- D_0 Holes diameter (m)

F_0	Clear cross-sectional area of the grid (m^2)
f_0	Cross-section area of one hole (m^2)
Q	Volume flow rate (m^3/s)
w_1	Mean velocity in pipe (m/s)
w_0	Mean velocity in holes (m/s)
G	Mass flow rate (kg/s)
Re_1	Reynolds number in pipe ($\text{}$)
Re_0	Reynolds number in holes ($\text{}$)
l	Grid thickness (m)
ζ_{1quad}	Quadratic pressure loss coefficient determined as $Re = 10^5$ ($\text{}$)
ζ_{ρ}	Velocity factor ($\text{}$)
ε_{0Re}	Contraction factor ($\text{}$)
ζ_1	Coefficient of local resistance ($\text{}$)
ζ	Pressure loss coefficient (based on the mean pipe velocity) ($\text{}$)
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
- stabilized flow upstream of the grid
- thickness to orifice diameter ratio (l/D_0) lower than or equal to 0.015

Example of application:

HydrauCalc 2020a - [Sharp-edged grid - 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. Kn. Visc.

Geometrical characteristics

Help Info Grid plot Calculate

Complementary results

Designation	Symbol	Value	Unit
Hydraulic diameter	Dh	0.015	m
Pipe cross-section area	F1	0.003881508	m ²
One hole cross-section area	f0	0.0001767146	m ²
Total holes cross-section area	F0	0.001237002	m ²
Diameters ratio	D0/D1	0.2133713	
Cross-sections area ratio (Porosity)	F0/F1	0.3186911	
Pipe Reynolds number	Re1	90251	
Holes Reynolds number	Re0	60425.19	
<input checked="" type="checkbox"/> Quadratic pressure loss coefficient (Re0 = 1e5) (Diag. 8-1)	ζ_{quad}	16.47508	
<input checked="" type="checkbox"/> Contraction coefficient (Diagram 8-5)	ζ_{vna}	0.910014	
<input checked="" type="checkbox"/> Velocity factor (Diagram 8-5)	ζ_v	0.03858278	
<input checked="" type="checkbox"/> Pressure loss coefficient (Re0 < 1e5) (Diagram 8-5)	ζ_l	15.37244	
Pressure loss coefficient (based on the mean pipe velocity)	ζ	15.37244	
Hydraulic power loss	Wh	63.65638	W

References:

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