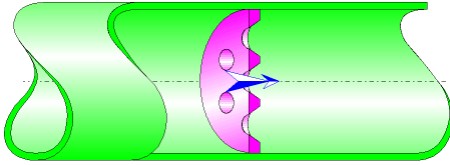




Sharp-edged Grid Circular Cross-Section (Pipe Flow - Guide)



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:

Pipe cross-sectional area (m²):

$$A = \pi \cdot \frac{d^2}{4}$$

Cross-sectional area of one hole (m²):

$$a_o = \pi \cdot \frac{d_o^2}{4}$$

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

$$A_0 = a_o \cdot N$$

Porosity:

$$\phi = \frac{A_0}{A}$$

Equivalent section orifice diameter (m):

$$d_e = \sqrt{\frac{4 \cdot A_0}{\pi}}$$

Ratio between the diameters of the equivalent section orifice and the pipe:

$$\beta = \frac{d_e}{d}$$

Pipe velocity (m/s):

$$V = \frac{Q}{A}$$

Holes velocity (m/s):

$$V_o = \frac{Q}{A_o}$$

Mass flow rate (kg/s):

$$G = Q \cdot \rho_m$$

Reynolds number in pipe:

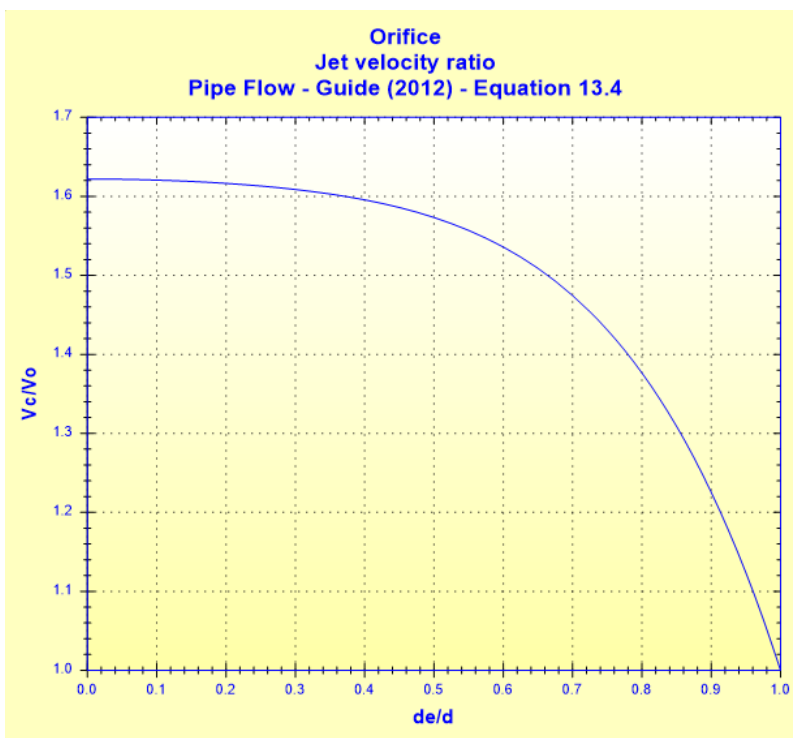
$$N_{Re} = \frac{V \cdot d}{\nu}$$

Reynolds number in holes:

$$N_{Re_o} = \frac{V_o \cdot d_o}{\nu}$$

Jet velocity ratio:

$$\lambda = 1 + 0.622 \cdot \left(1 - 0.215\beta^2 - 0.785\beta^5 \right) \quad ([1] \text{ equation 13.4})$$

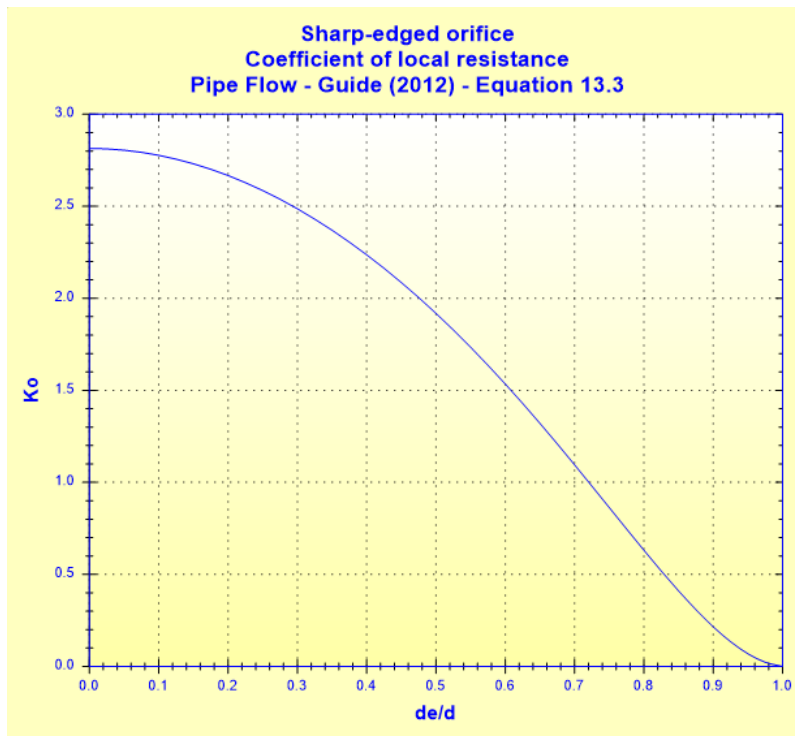


Velocity in vena contracta:

$$V_c = V_o \cdot \lambda$$

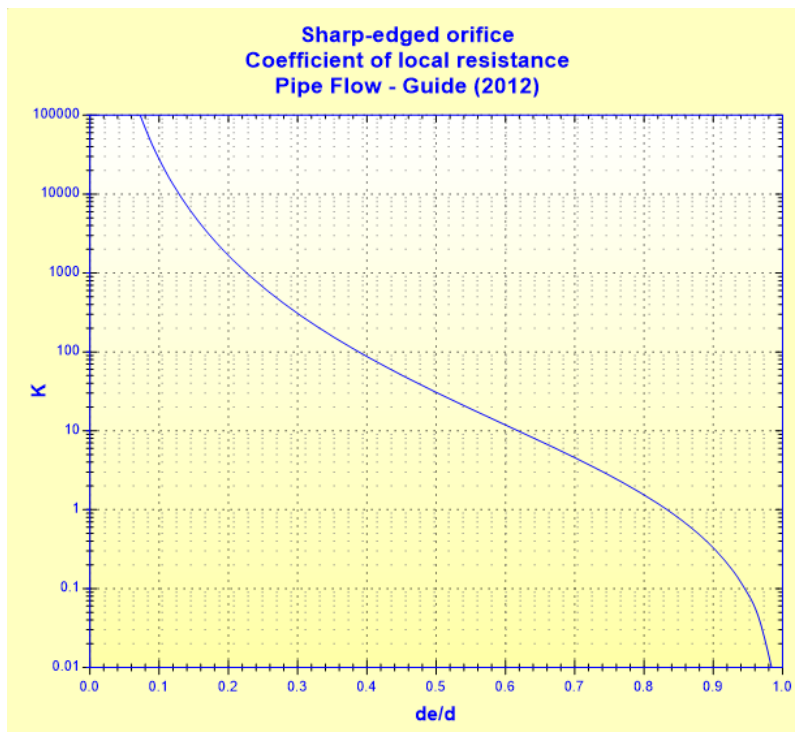
Coefficient of local resistance ($N_{Re_o} \geq 10^4$):

$$K_o = 0.0696 \cdot (1 - \beta^5) \cdot \lambda^2 + (\lambda - \beta^2)^2 \quad ([1] \text{ equation 13.3})$$



Total pressure loss coefficient (based on the mean pipe velocity):

$$K = K_o \cdot \left(\frac{A}{A_o} \right)^2$$



Total pressure loss (Pa):

$$\Delta P = K \cdot \frac{\rho_m \cdot V^2}{2}$$

Total head loss of fluid (m):

$$\Delta H = K \cdot \frac{V^2}{2 \cdot g}$$

Hydraulic power loss (W):

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

Symbols, Definitions, SI Units:

d	Internal pipe diameter (m)
A	Pipe cross-sectional area (m ²)
d ₀	Holes diameter (m)
a ₀	Cross-sectional area of one hole (m ²)
N	Holes number ()
A ₀	Clear cross-sectional area of the grid (m ²)
ϕ	Porosity ()
d _e	Equivalent section orifice diameter (m)
β	Ratio between the diameters of the equivalent section orifice and the pipe ()
Q	Volume flow rate (m ³ /s)
G	Mass flow rate (kg/s)
V ₀	Mean velocity in holes (m/s)
V	Mean velocity in pipe (m/s)
NRe ₀	Reynolds number in holes ()
NRe	Reynolds number in pipe ()
λ	Jet velocity ratio ()
V _c	Mean velocity in vena contracta (m/s)
K ₀	Coefficient of local resistance ()
K	Total pressure loss coefficient (based on the mean pipe velocity) ()
ΔP	Total pressure loss (Pa)
ΔH	Total head loss of fluid (m)
Wh	Hydraulic power loss (W)
ρ _m	Fluid density (kg/m ³)
ν	Fluid kinematic viscosity (m ² /s)
g	Gravitational acceleration (m/s ²)

Validity range:

- turbulent flow regime in holes (NRe₀ ≥ 10⁴)
- stabilized flow upstream of the grid

Example of application:

HydrauCalc 2020b - [Sharp-edged grid - Pipe Flow - Guide (2012)]

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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 Grid plot Calculate

Complementary results

Designation	Symbol	Value	Unit
Pipe cross-section area	A	0.003881508	m ²
One hole cross-section area	ao	0.0001767146	m ²
Total holes cross-section area	Ao	0.001237002	m ²
Diameters ratio (do/d)	β	0.2133713	
Cross-sections area ratio - Porosity (Ao/A)	ϕ	0.3186911	
Equivalent section orifice diameter	de	0.03968627	
Pipe Reynolds number	NRe	90251	
Holes Reynolds number	NReo	60425.19	
<input checked="" type="checkbox"/> Jet velocity ratio (Equation 13.4)	λ	1.551386	
<input checked="" type="checkbox"/> Coefficient of local resistance (Equation 13.3)	Ko	1.677446	
<input checked="" type="checkbox"/> Pressure loss coefficient (based on the mean pipe velocity)	K	16.51615	
Hydraulic power loss	Wh	68.3924	W

References:

[1] Pipe Flow: A Practical and Comprehensive Guide. Donald C. Rennels and Hobart M. Hudson. (2012)