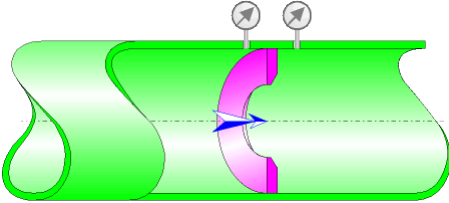




Square-Edge Orifice Flowmeter Flange pressure tapplings (ISO 5167-1:1991)



Model description:

This model of component determines the fluid flow through a square-edge orifice flowmeter with flange pressure tapplings, according to the international standard "ISO-5167-1:1991".

Model formulation:

Diameter ratio:

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

Orifice cross-sectional area (m²):

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

Pipe cross-sectional area (m²):

$$S = \pi \cdot \frac{D^2}{4}$$

Mean velocity in orifice (m/s):

$$v = \frac{q_v}{s}$$

Mean velocity in pipe (m/s):

$$V = \frac{q_v}{S}$$

Reynolds number referred to orifice diameter:

$$Re_d = \frac{v \cdot d}{\nu}$$

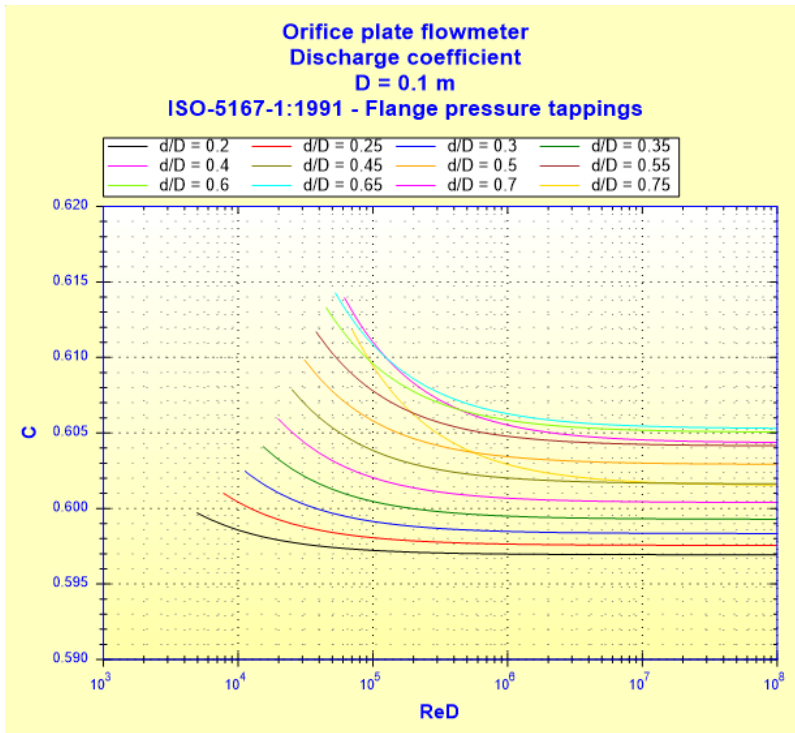
Reynolds number referred to internal pipe diameter:

$$\text{Re}_D = \frac{V \cdot D}{\nu}$$

Discharge coefficient (Stolz equation):

$$C = 0.5959 + 0.0312 \cdot \beta^{2.1} - 0.184 \cdot \beta^8 + 0.0029 \cdot \beta^{2.5} \cdot \left(\frac{10^6}{\text{Re}_D} \right)^{0.75} + 0.09 \cdot L_1 \cdot \beta^4 \cdot (1 - \beta^4)^{-1} - 0.0337 \cdot L'_2 \cdot \beta^3$$

([1] § 8.3.2.1)



with D = 100 mm

The values of L_1 and L'_2 to be used in this equations are as follows:

$$L_1 = L'_2 = \frac{25.4}{D}$$

where D is expressed in millimetres

Note: for $L_1 > 0.039/0.09 (=0.4333)$, take 0.039 as value of coefficient $\beta^4(1-\beta^4)^{-1}$

Expansibility factor:

$$\varepsilon = 1$$

([1] §3.3.5) for incompressible fluid (liquid)

Mass flow rate (kg/s):

$$q_m = \frac{C}{\sqrt{1 - \beta^4}} \cdot \varepsilon \cdot \frac{\pi}{4} \cdot d^2 \cdot \sqrt{2 \cdot \Delta p \cdot \rho}$$

([1] § 5.1 eq. 1)

Volume flow rate (m^3/s):

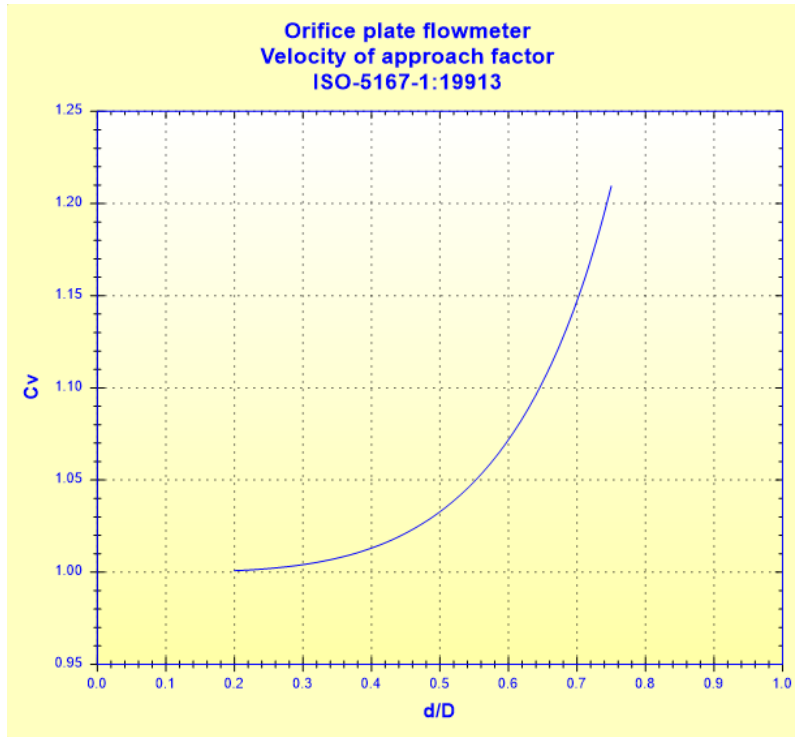
$$q_v = \frac{q_m}{\rho}$$

([1] § 5.1 eq. 3)

Velocity of approach factor:

$$C_v = \frac{1}{\sqrt{1-\beta^4}}$$

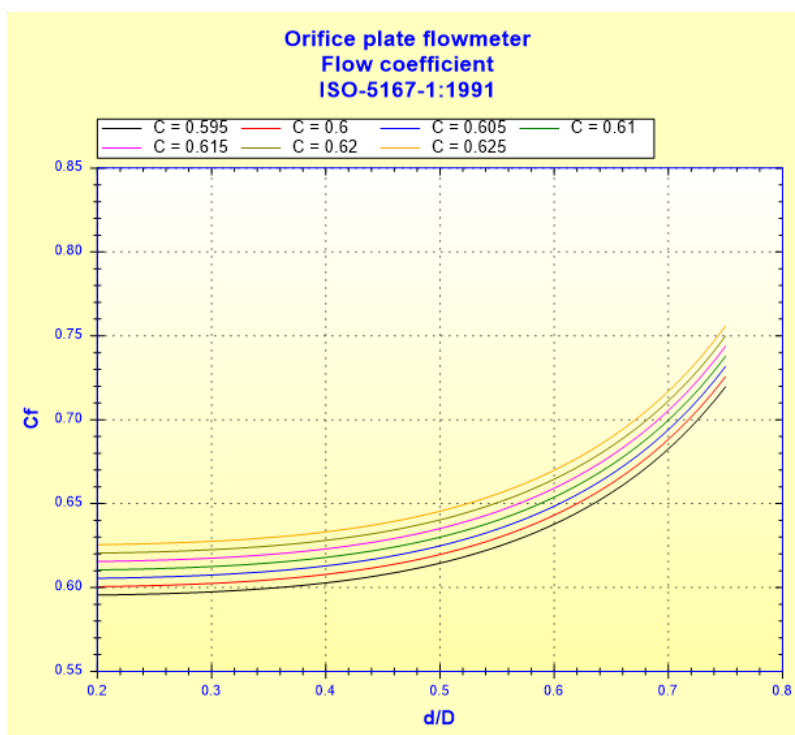
([1] §3.3.4)

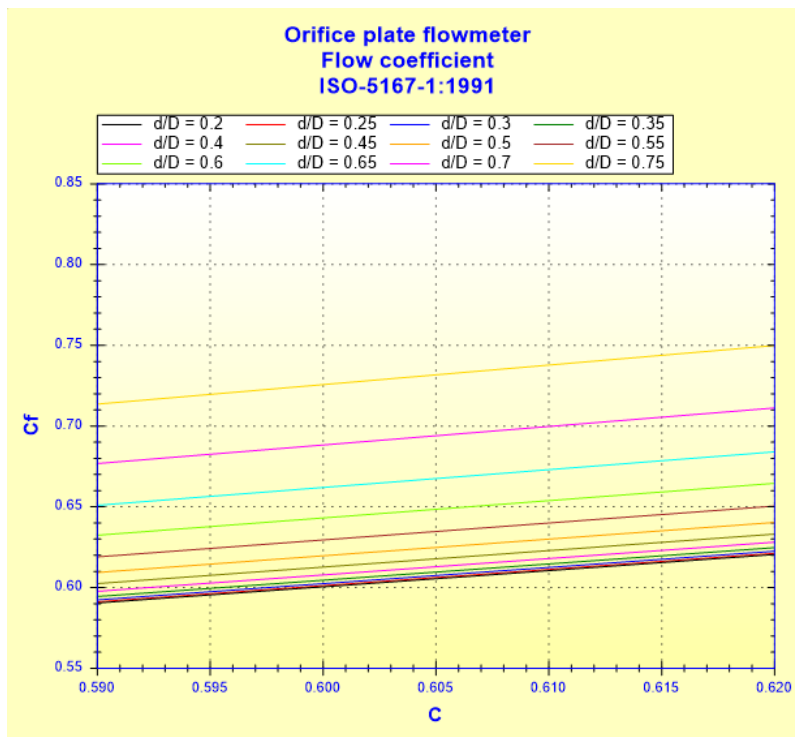


Flow coefficient:

$$C_f = C \cdot \frac{1}{\sqrt{1-\beta^4}}$$

([1] §3.3.4)





Net pressure loss (Pa):

$$\Delta \varpi = \frac{\sqrt{1 - \beta^4} - C \cdot \beta^2}{\sqrt{1 - \beta^4} + C \cdot \beta^2} \cdot \Delta p \quad ([1] \text{ § 8.4.1})$$

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

$$K = \frac{\Delta \varpi}{0.5 \cdot \rho \cdot V^2}$$

Net head loss (m):

$$\Delta h = \frac{\Delta \varpi}{\rho \cdot g}$$

Net hydraulic power loss (W):

$$Wh = \Delta \varpi \cdot q$$

Measured head loss (m):

$$\Delta H = \frac{\Delta P}{\rho \cdot g}$$

Symbols, Definitions, SI Units:

- d Orifice diameter (m)
- D Internal pipe diameter (m)
- β Diameter ratio ()
- s Orifice cross-sectional area (m²)
- S Pipe cross-sectional area (m²)
- q_v Volume flow rate (m³/s)

v	Mean velocity in orifice (m/s)
V	Mean velocity in pipe (m/s)
Re_d	Reynolds number referred to orifice ()
Re_D	Reynolds number referred to pipe ()
C	Discharge coefficient ()
L_1	Upstream relative pressure tapping spacing from the upstream face ()
L'_2	Downstream relative pressure tapping spacing from the downstream face ()
ε	Expansibility factor ()
q_m	Mass flow rate (kg/s)
C_v	Velocity of approach factor ()
C_f	Flow coefficient ()
$\Delta\overline{p}$	Net pressure loss (Pa)
ΔP	Measured pressure loss (Pa)
K	Net pressure loss coefficient (based on the mean pipe velocity) ()
Δh	Net head loss of fluid (m)
Wh	Hydraulic power loss (W)
ΔH	Measured head loss of fluid (m)
ρ	Fluid density (kg/m ³)
ν	Fluid kinematic viscosity (m ² /s)
g	Gravitational acceleration (m/s ²)

Limit of use:

- $d > 12,5 \text{ mm}$
- $50 \text{ mm} < D < 1\,000 \text{ mm}$
- $0,2 < \beta < 0,75$
- $Re_D > 1260 \beta^2 D$
where D is expressed in millimetres

Example of application:

HydrauCalc 2019a - [Orifice plate flowmeter - ISO 5167-1:1991 - Flange pressure tappings]

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 Measured differential pressure ΔP 0.5 bar Calculate

ΔH 5.1077 m of fluid

qm 6.0039 kg/s
qv 0.00601467 m³/s
V 1.55 m/s (Turbulent)
6.252 m/s (Turbulent)
D 0.0703 m
d 0.035 m
25.4 mm
25.4 mm
 ΔP 0.5 bar
Net pressure loss ΔP_0 0.3659365 bar
 Δh 3.7382 m of fluid

Complementary results

Designation	Symbol	Value	Unit
Pipe cross-section area	S	0.003881508	m ²
Orifice cross-section area	s	0.0009621127	m ²
Diameters ratio	β	0.4978663	
Cross-sections area ratio	s/S	0.2478708	
Pipe Reynolds number	ReD	108566	
Orifice Reynolds number	Re _d	218062.6	
Discharge coefficient	C	0.6051003	
Expansibility factor	ϵ	1	
Velocity of approach factor	C _v	1.032212	
Flow coefficient	C _f	0.6245919	
Net pressure loss coefficient (based on mean pipe velocity)	K	30.53465	
Hydraulic power loss	Wh	220.0987	W

References:

- [1] ISO 5167-1:1991 - Measurement of fluid flow by means of pressure differential devices