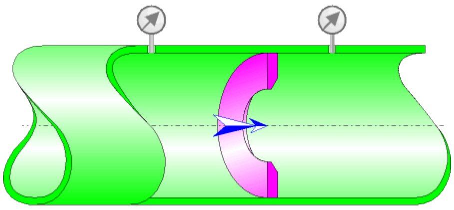
Square-Edge Orifice Flowmeter
D and D/2 pressure tappings
(ISO 5167-1:1991)



Model description:

This model of component determines the fluid flow through a square-edge orifice flowmeter with D & D/2 pressure tappings, according to the international standard "ISO-5167-1:1991".

Model formulation:

Diameter ratio:

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

Orifice cross-sectional area (m^2):

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

Pipe cross-sectional area (m^2):

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

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:

$$\mathrm{Re}_d = \frac{v \cdot d}{\nu}$$

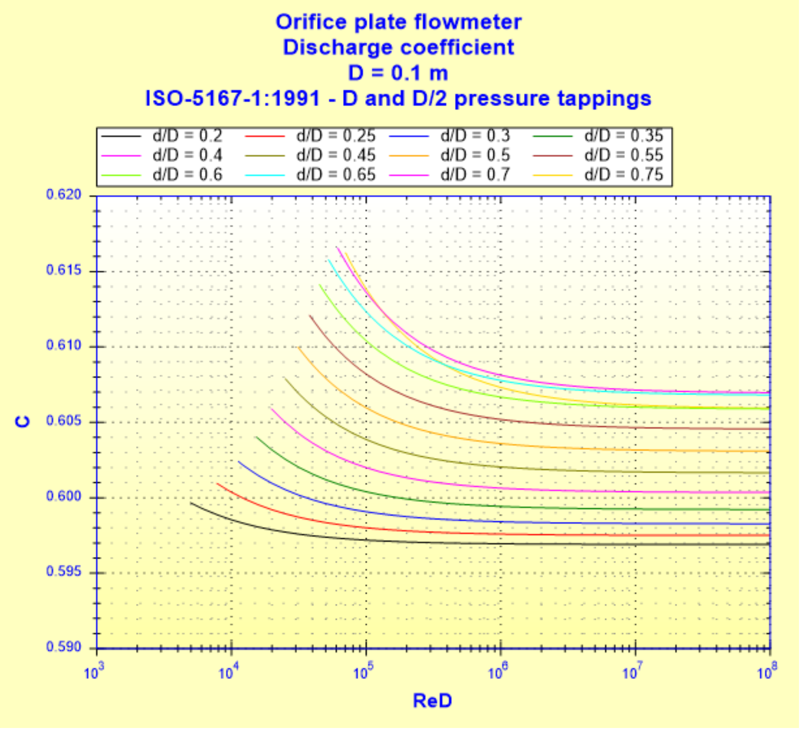
Reynolds number referred to internal pipe diameter:

$$Re_D = \frac{V \cdot D}{\nu}$$

Discharge coefficient (Stolz equation):

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

([1] § 8.3.2.1)



with D = 100 mm

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

$$L_1 = 1$$

$$L'_2 = 0.47$$

Note: for L1 > 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):

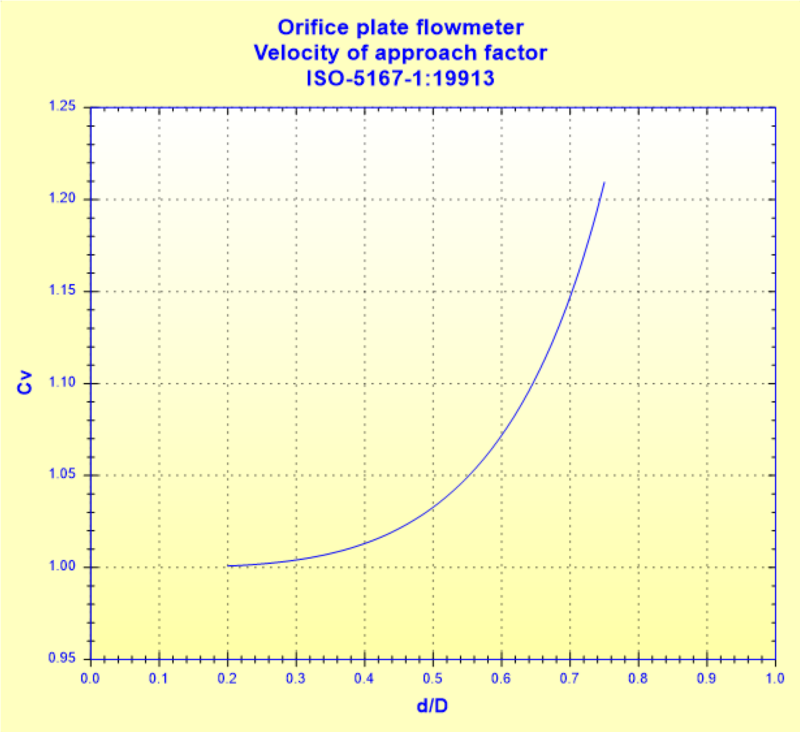
$$q_v = \frac{q_m}{\rho}$$

([1] § 5.1 eq. 3)

Velocity of approach factor:

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

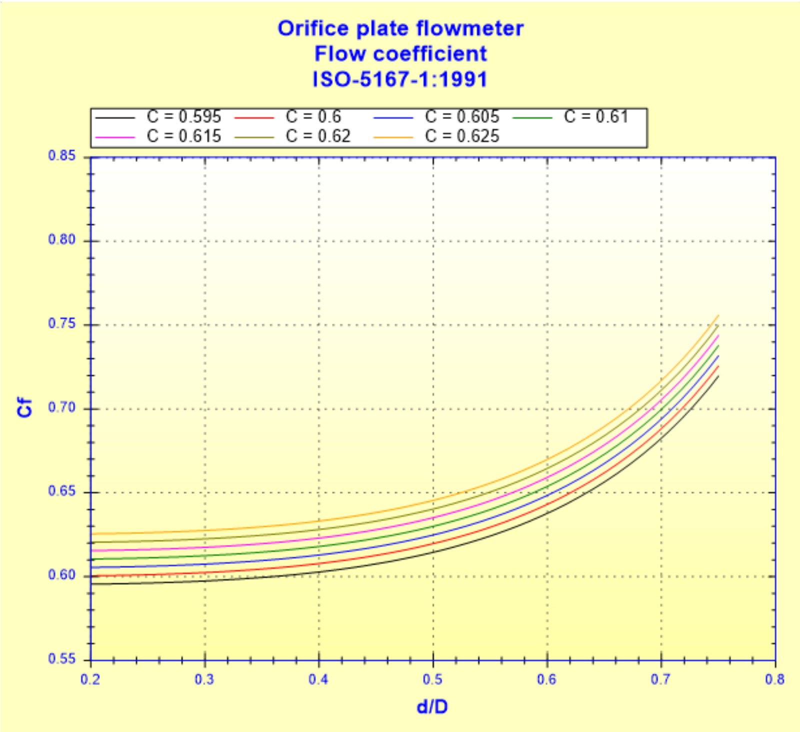
([1] §3.3.4)

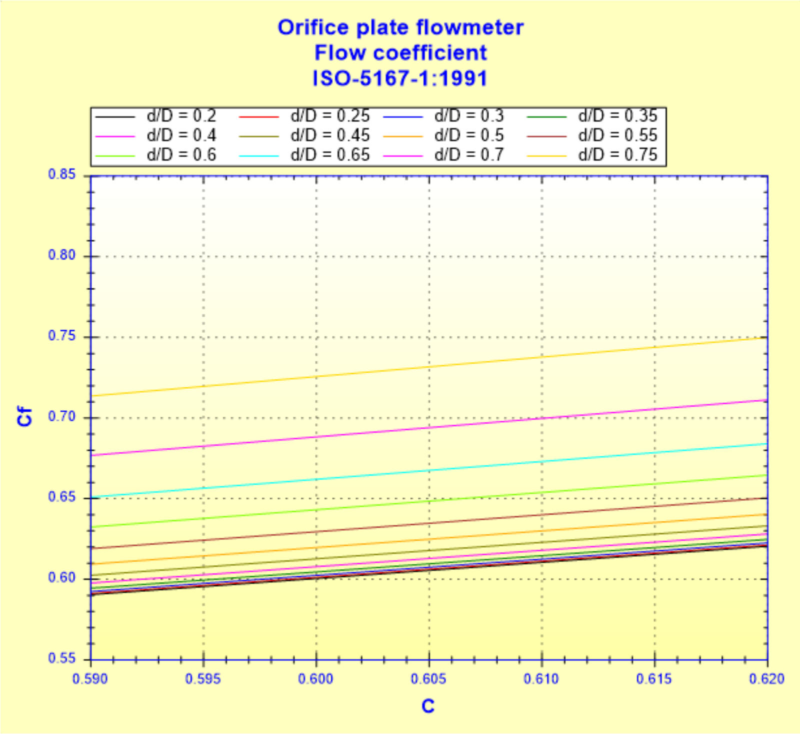


Flow coefficient:

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

([1] §3.3.4)





Net pressure loss (Pa):

$$\Delta\varpi = \frac{\sqrt{1-\beta^4} - C\cdot\beta^2}{\sqrt{1-\beta^4} + C\cdot\beta^2}\cdot\Delta p$$

([1] § 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:

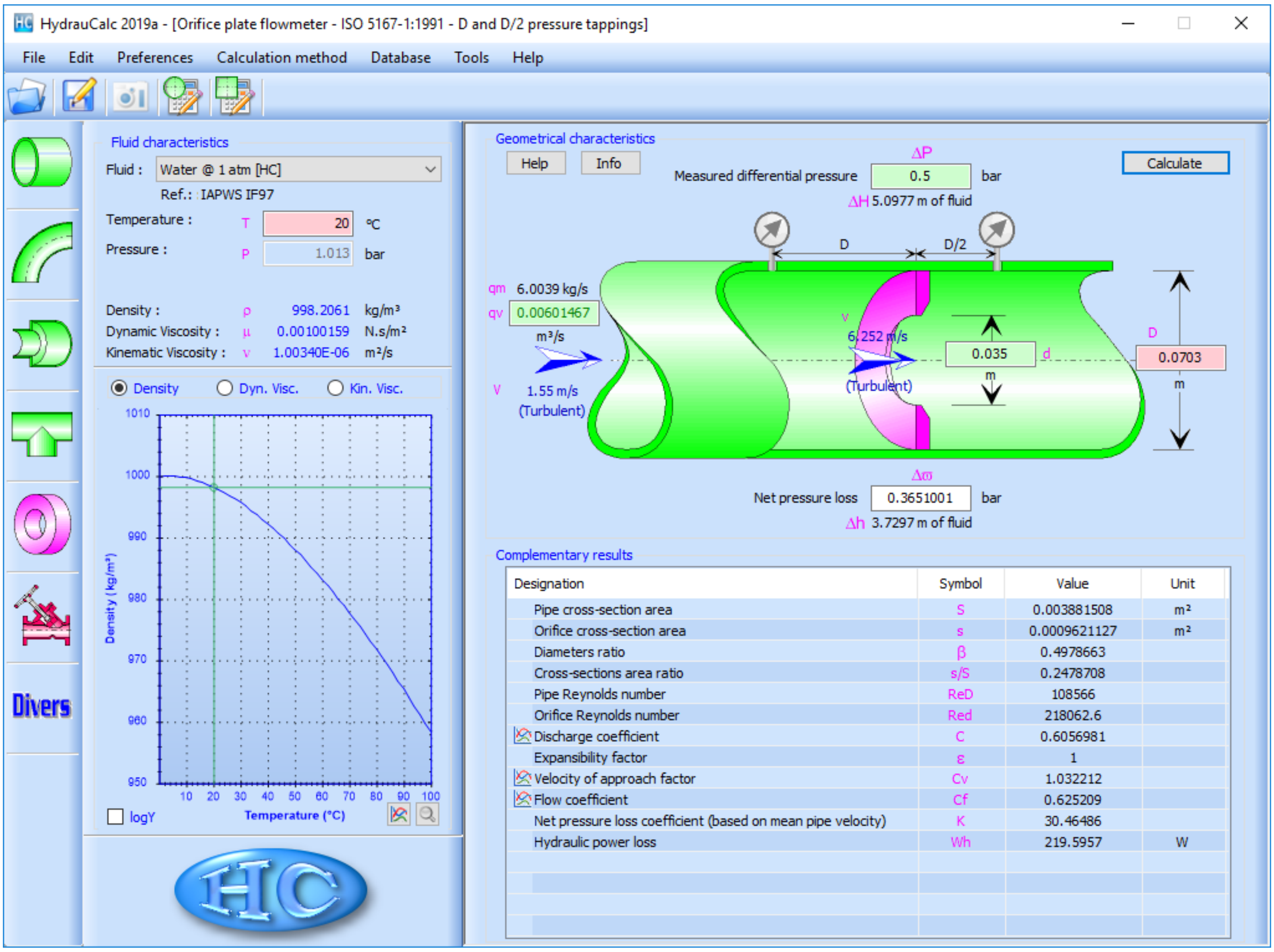
d	Orifice diameter (m)
D	Internal pipe diameter (m)
β	Diameter ratio ()
s	Orifice cross-sectional area (m^2)
S	Pipe cross-sectional area (m^2)
q_v	Volume flow rate (m^3/s)

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 ()
$\Delta\varpi$	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/m³)
ν	Fluid kinematic viscosity (m²/s)
g	Gravitational acceleration (m/s²)

Limit of use:

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

Example of application:



References:

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