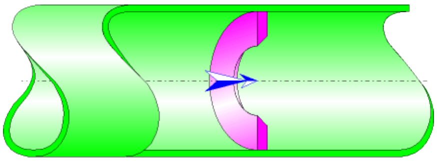
Square-Edged Orifice
Circular Cross-Section
(CRANE)



Model description:

This model of component calculates the minor head loss (pressure drop) generated by the flow in a square-edged orifice.

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

Model formulation:

Diameter ratio:

$$\beta = \frac{D_1}{D_2}$$

Orifice cross-sectional area (m²):

$$A_1 = \pi \cdot \frac{D_1^{\;2}}{4}$$

Pipe cross-sectional area (m²):

$$A_2 = \pi \cdot \frac{D_2^{\;2}}{4}$$

Mean velocity in orifice (m/s):

$$V_1 = \frac{q}{A_1}$$

Mean velocity in pipe (m/s):

$$V_2 = \frac{q}{A_2}$$

Mass flow rate (kg/s):

$$w = q \cdot \rho$$

Reynolds number in orifice:

$$Re_1 = \frac{v_1 \cdot D_1}{\nu}$$

Reynolds number in pipe:

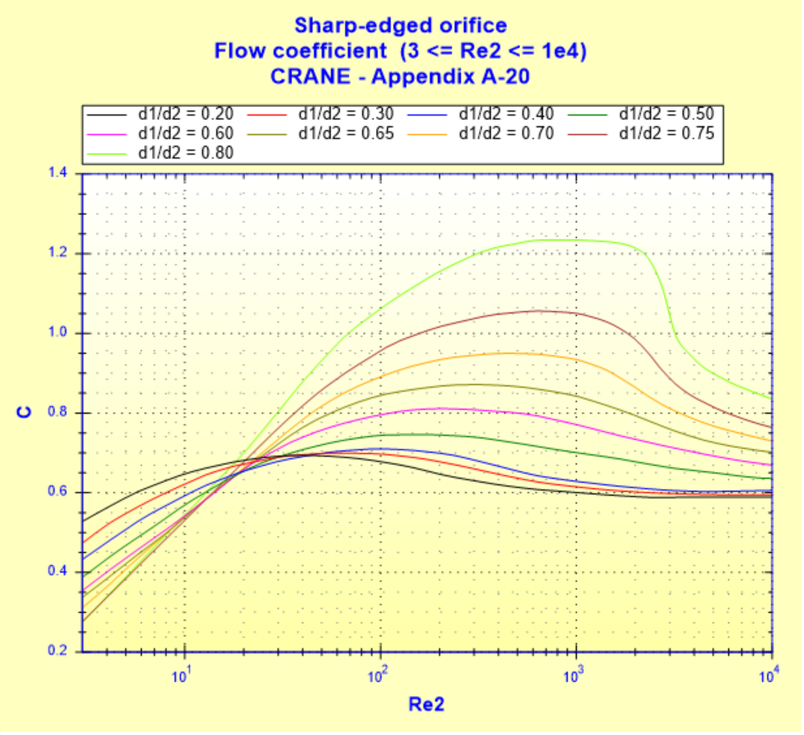
$$Re_2 = \frac{v_2 \cdot D_2}{\nu}$$

Flow coefficient:

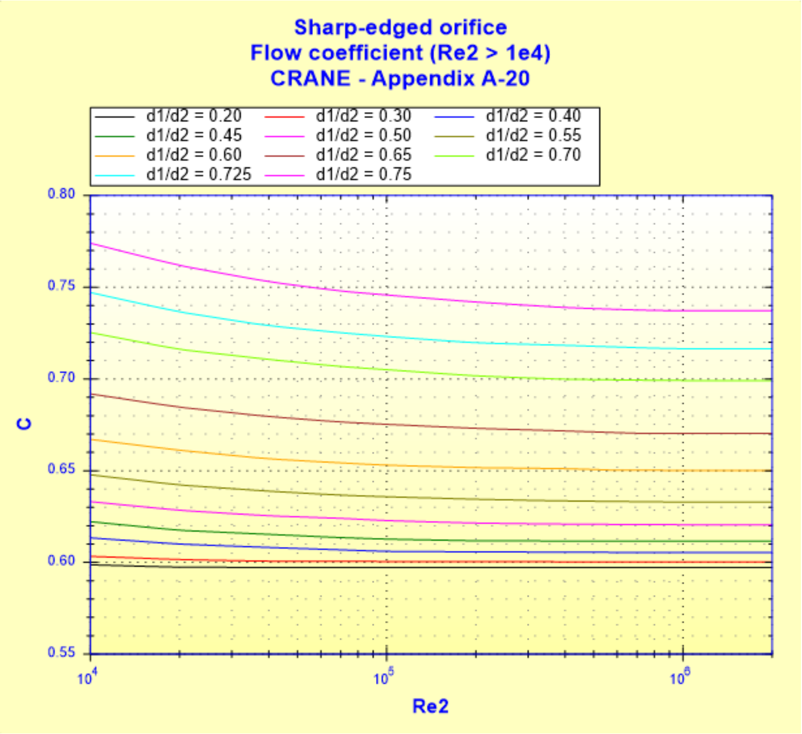
$$C = f\left(Re_2, \frac{d_1}{d_2}\right)$$

([1] appendix A-20)

- $3 \leq Re_2 \leq 10^4$



- $Re_2 > 10^4$



Resistance coefficient of orifice:

$$K_o = \frac{1-\beta^2}{C^2 \cdot \beta^4}$$

([1] appendix A-20)

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

$$K = K_o$$

Total pressure loss (Pa):

$$\Delta P = K \cdot \frac{\rho \cdot v_2^{\,2}}{2}$$

Total head loss of fluid (m):

$$\Delta H = K \cdot \frac{v_2^{\,2}}{2 \cdot g}$$

Hydraulic power loss (W):

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

Symbols, Definitions, SI Units:

D_1	Orifice diameter (m)
D_2	Pipe diameter (m)
β	Diameter ratio ()
A_1	Orifice cross-sectional area (m^2)
A_2	Pipe cross-sectional area (m^2)
q	Volume flow rate (m^3/s)
w	Mass flow rate (kg/s)

v_1	Mean velocity in orifice (m/s)
v_2	Mean velocity in pipe (m/s)
Re_1	Reynolds number in orifice ()
Re_2	Reynolds number in pipe ()
C	Flow coefficient ()
K_o	Resistance coefficient of orifice ()
K	Total pressure loss coefficient (based on mean velocity in pipe) ()
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)

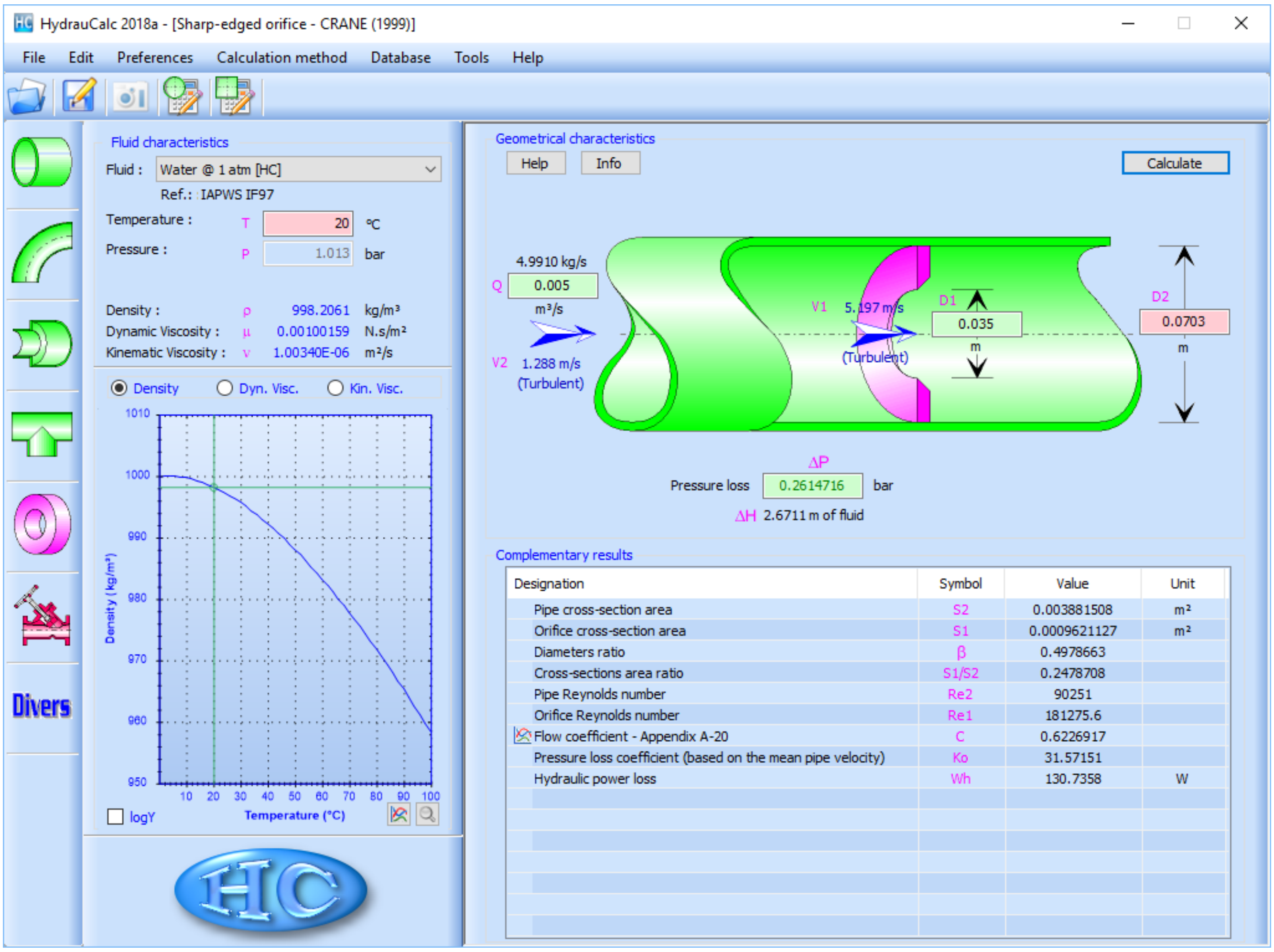
Validity range:

- any flow regime: laminar and turbulent
- stabilized flow upstream of the orifice

note: 1) for Reynolds number "Re_2" between 3 and 10^4, and diameter ratio "D_1/D_2" lower than 0.2 or greater than 0.8, the flow coefficient "*C*" is extrapolated

2) for Reynolds number "Re_2" between 10^4 and 2.10^6, and diameter ratio "D_1/D_2" lower than 0.2 or greater than 0.75, the flow coefficient "*C*" is extrapolated

Example of application:



References:

[1] CRANE - Flow of Fluids Through Valves, Fitting and Pipe - Technical Paper No. 410 – Edition 1999