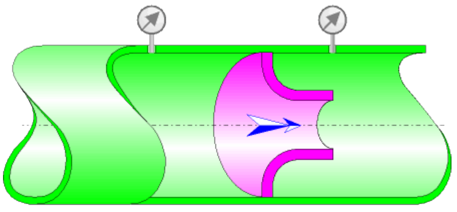
Long radius nozzle
(ISO 5167-3:2003)



Model description:

This model of component determines the fluid flow through a long radius nozzle flowmeter, according to the international standard "ISO-5167-3:2003".

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:

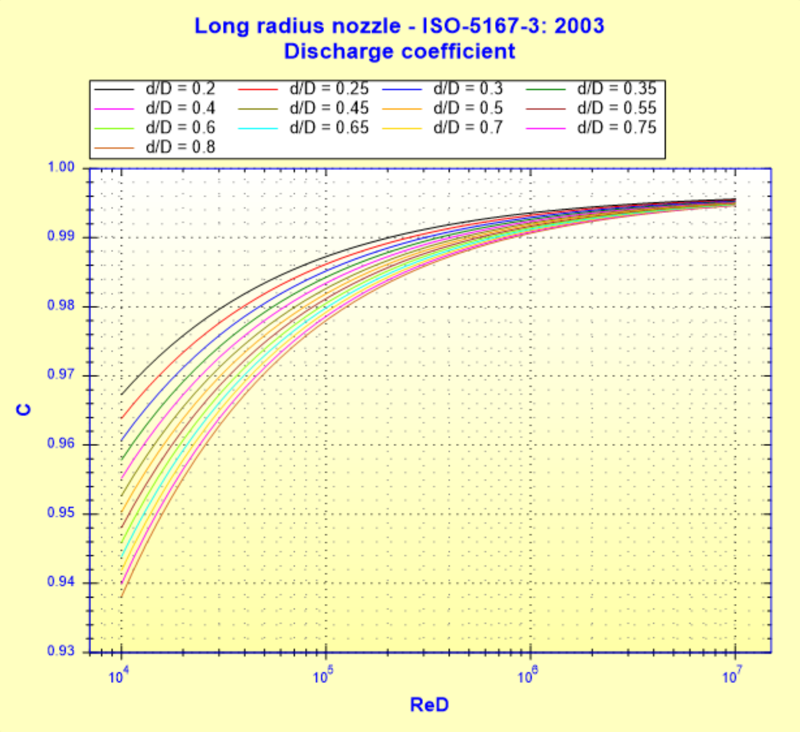
$$\mathrm{Re}_d = \frac{v \cdot d}{\nu}$$

Reynolds number referred to internal pipe diameter:

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

Discharge coefficient:

$$C = 0.9965 - 0.00653 \cdot \sqrt{\frac{10^6 \cdot \beta}{\mathrm{Re}_D}}$$ ([2] §5.2.6.2 eq. 8)



Expansibility factor:

$$\varepsilon = 1$$ ([1] §3.3.6) for incompressible fluid (liquid)

Mass flow rate (kg/s):

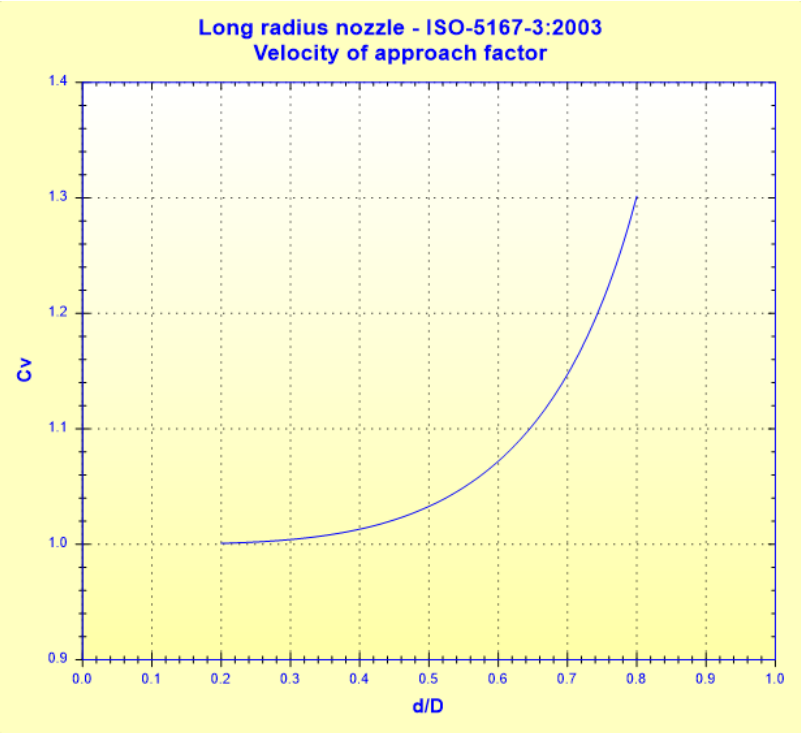
$$q_m = \frac{C}{\sqrt{1-\beta^4}} \cdot \varepsilon \cdot \frac{\pi}{4} \cdot d^2 \cdot \sqrt{2 \cdot \Delta p \cdot \rho}$$ ([1] §5.1 eq. 1 and [2] §4 eq. 1)

Volume flow rate (m^3/s):

$$q_v = \frac{q_m}{\rho}$$ ([1] §5.1 eq. 3 and [2] §4 eq. 2)

Velocity of approach factor:

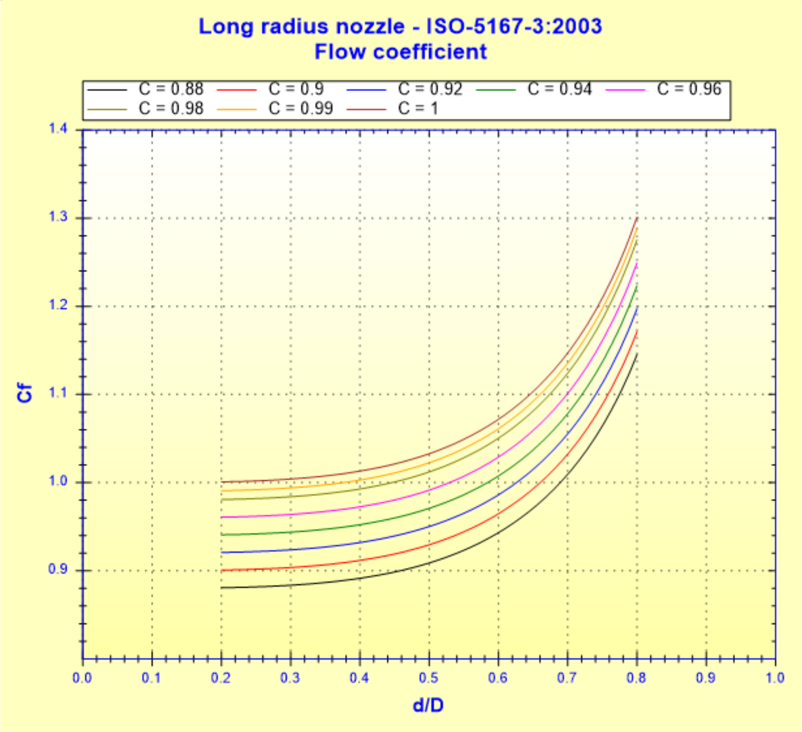
$$C_v = \frac{1}{\sqrt{1-\beta^4}}$$ ([1] §3.3.4)



Flow coefficient:

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

([1] §3.3.5)



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] § 5.1.8 eq. 5)

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

$$K = \frac{\Delta\varpi}{0.5 \cdot \rho \cdot V^2}$$ ([1] § 5.1.8 eq. 7)

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:

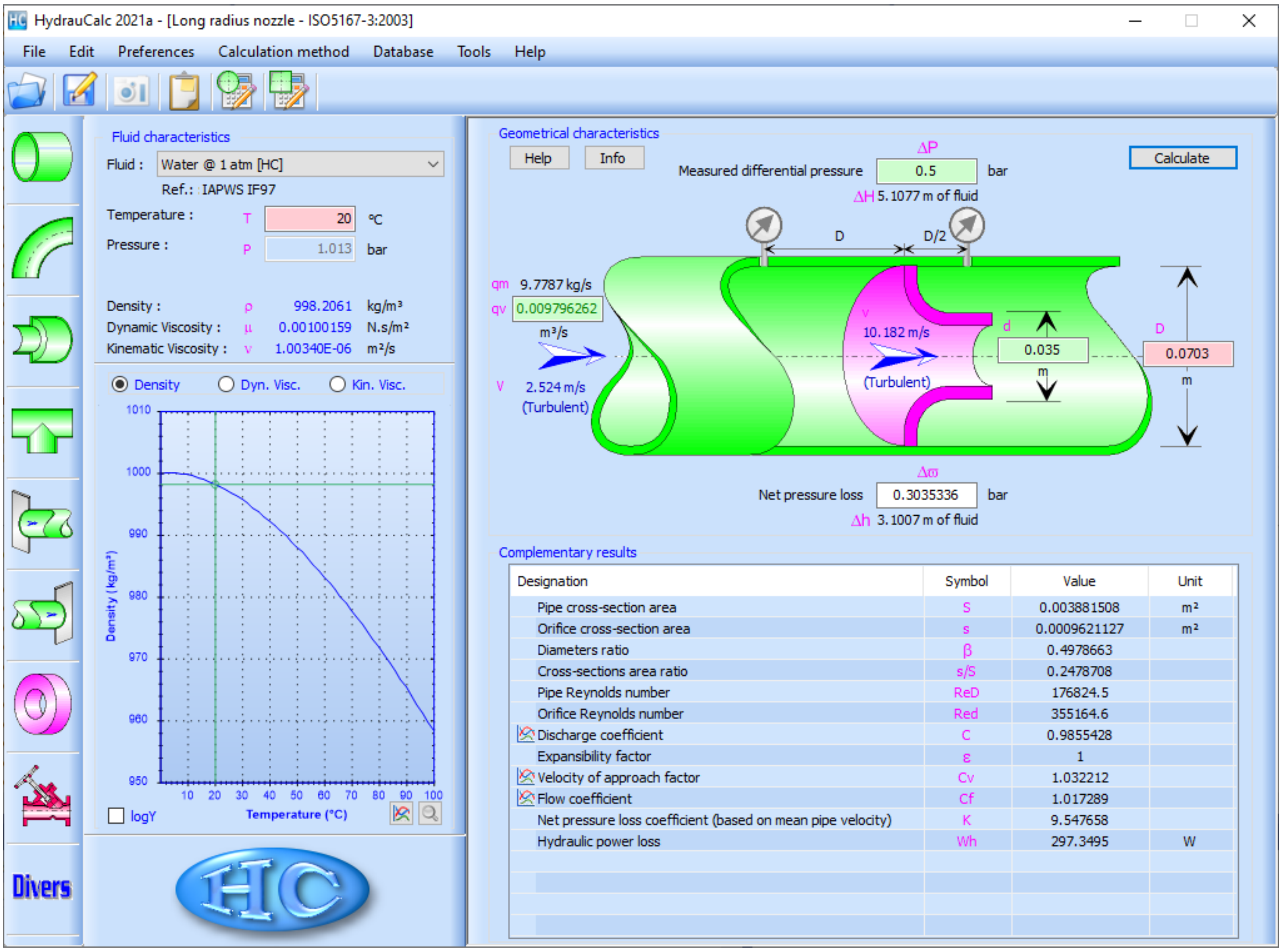
d	Orifice diameter (m)
D	Internal pipe diameter (m)
β	Diameter ratio ()
s	Orifice cross-sectional area (m^2)
S	Pipe cross-sectional area (m^2)
q_v	Volume flow rate (m^3/s)
v	Mean velocity in orifice (m/s)
V	Mean velocity in pipe (m/s)
Re_d	Reynolds number referred to orifice ()
Re_D	Reynolds number referred to pipe ()
C	Discharge coefficient ()
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	Net 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 ([2] §5.2.6.1):

- 50 mm $\leq$ D $\leq$ 630 mm
- 0.2 $\leq \beta \leq$ 0.8

- $10^4 \leq Re_D \leq 10^7$

Example of application:



References:

[1] ISO 5167-1:2003 - Measurement of fluid flow by means of pressure differential devices inserted in circular-cross section conduits running full
Part 1: General principles and requirements

[2] ISO 5167-3:2003 - Measurement of fluid flow by means of pressure differential devices inserted in circular-cross section conduits running full
Part 3: Nozzles and Venturi nozzles