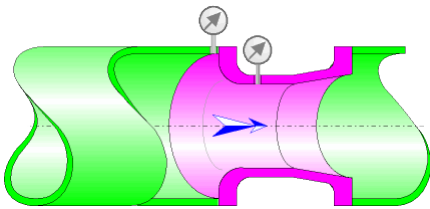




Venturi nozzle (ISO 5167-1:1991)



Model description:

This model of component determines the fluid flow through a Venturi nozzle flowmeter, 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:

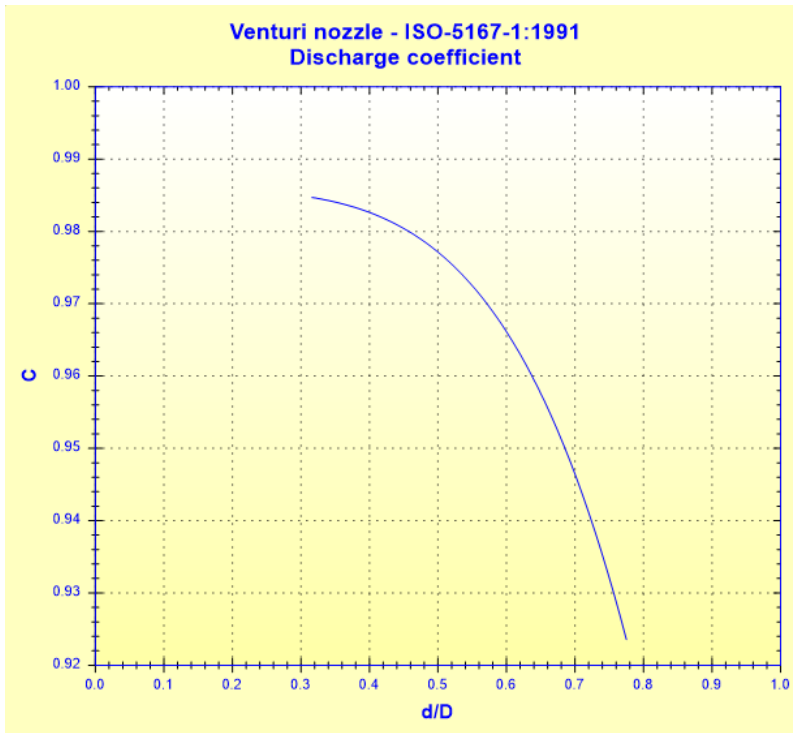
$$Re_d = \frac{v \cdot d}{\nu}$$

Reynolds number referred to internal pipe diameter:

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

Discharge coefficient:

$$C = 0.9858 - 0.196 \cdot \beta^{4.5} \quad ([1] \text{ §10.2.4.2})$$



Expansibility factor:

$$\varepsilon = 1 \quad ([1] \text{ §3.3.5}) \text{ for incompressible fluid (liquid)}$$

Mass flow rate (kg/s):

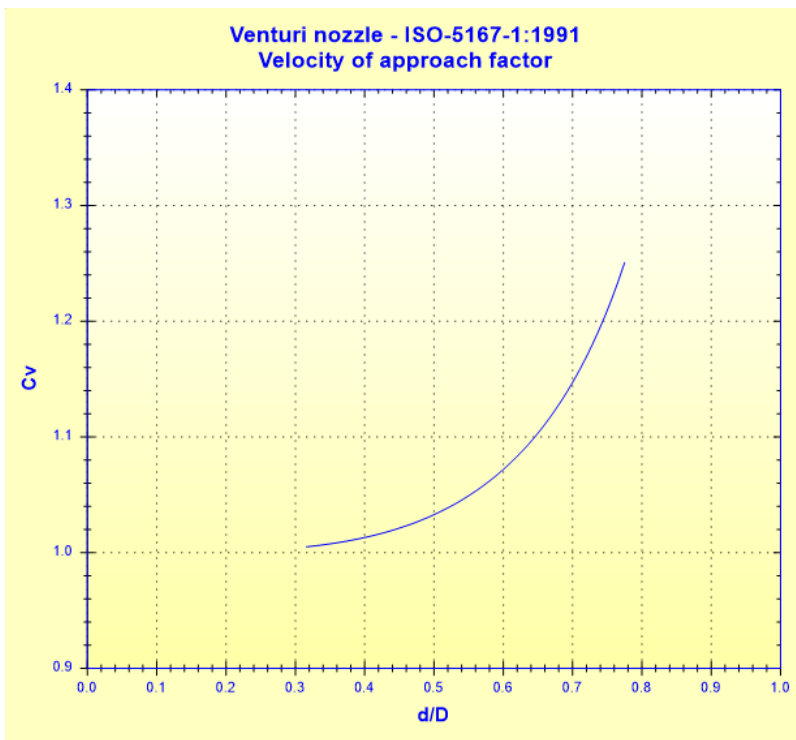
$$q_m = \frac{C}{\sqrt{1-\beta^4}} \cdot \varepsilon \cdot \frac{\pi}{4} \cdot d^2 \cdot \sqrt{2 \cdot \Delta p \cdot \rho} \quad ([1] \text{ §5.1 eq. 1})$$

Volume flow rate (m³/s):

$$q_v = \frac{q_m}{\rho} \quad ([1] \text{ §5.1 eq. 3})$$

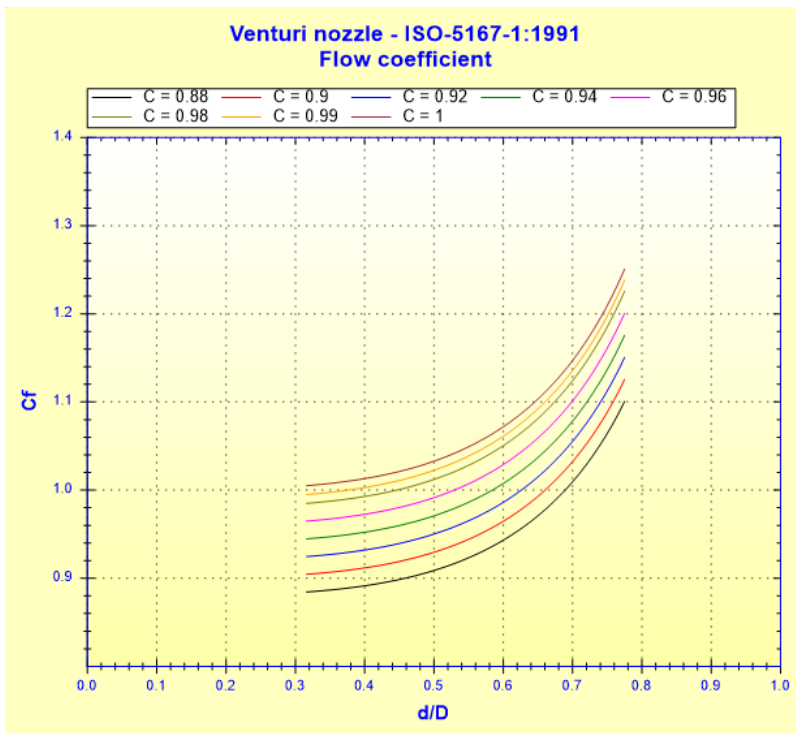
Velocity of approach factor:

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



Flow coefficient:

$$C_f = C \cdot \frac{1}{\sqrt{1-\beta^4}} \quad ([1] \text{ §3.3.4})$$



Net pressure loss (Pa):

The net pressure loss is not formulated in the reference document [1]

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 ()
ΔP	Measured pressure loss (Pa)
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 ([1] §10.2.4.1):

- $65 \text{ mm} \leq D \leq 500 \text{ mm}$
- $d \geq 50 \text{ mm}$
- $0.316 \leq \beta \leq 0.775$
- $1.5 \cdot 10^5 \leq Re_D \leq 2 \cdot 10^6$

Example of application:

HydrauCalc 2021a - [Venturi nozzle - ISO5167-1:1991]

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. Kin. Visc.

Geometrical characteristics

Measured differential pressure ΔP 0.5 bar
 ΔH 5.1077 m of fluid

Calculate

qm 9.6969 kg/s
qv 0.009714358 m³/s
v 2.503 m/s (Turbulent)
10.097 m/s (Turbulent)
0.035 m
D 0.0703 m

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	175346.1	
Orifice Reynolds number	Red	352195.2	
<input checked="" type="checkbox"/> Discharge coefficient	C	0.977303	
Expansibility factor	ϵ	1	
<input checked="" type="checkbox"/> Velocity of approach factor	Cv	1.032212	
<input checked="" type="checkbox"/> Flow coefficient	Cf	1.008784	

Divers HC

References:

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