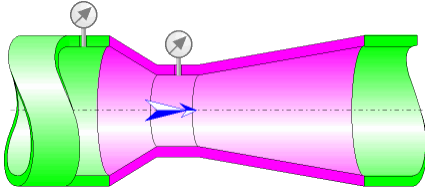




Classical Venturi tube with a rough-welded sheet-iron convergent (ISO 5167-1:1991)



Model description:

This model of component determines the fluid flow through a classical Venturi tube with a rough-welded sheet-iron convergent, 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:

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

Reynolds number referred to internal pipe diameter:

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

Discharge coefficient:

$$C = 0.985 \quad ([1] \text{ §10.1.5.4})$$

Expansibility factor:

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

Mass flow rate (kg/s):

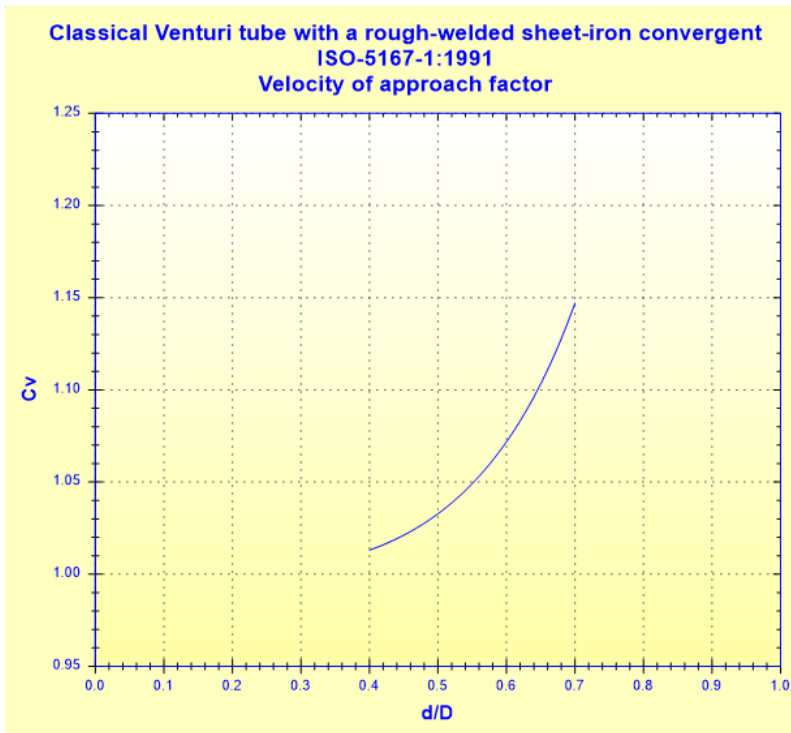
$$q_m = \frac{C}{\sqrt{1-\beta^4}} \cdot \varepsilon \cdot \frac{\pi}{4} \cdot d^2 \cdot \sqrt{2 \cdot \Delta p \cdot \rho} \quad ([1] \text{ §5.1 eq. 1})$$

Volume flow rate (m³/s):

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

Velocity of approach factor:

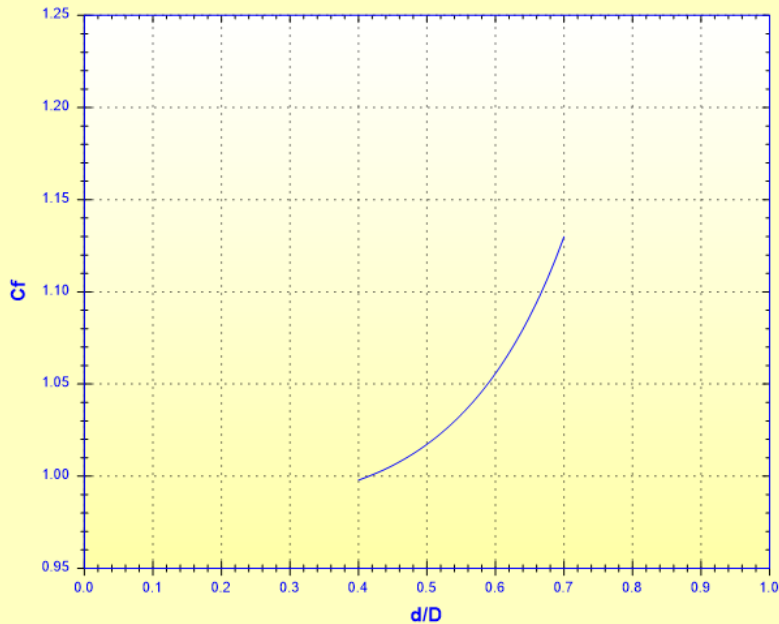
$$C_v = \frac{1}{\sqrt{1-\beta^4}} \quad ([1] \text{ §3.3.4})$$



Flow coefficient:

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

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 Flow coefficient



Net pressure loss:

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] §10.1.5.4):

- $200 \text{ mm} \leq D \leq 1200 \text{ mm}$
- $0,4 \leq \beta \leq 0,7$
- $2 \cdot 10^5 \leq Re_D \leq 2 \cdot 10^6$

Example of application:

The screenshot displays the HydraulCalc 2021a software interface. The title bar reads "HydraulCalc 2021a - [Classical Venturi tube with a rough-welded sheet-iron convergent - ISO5167-1:1991]". The interface is divided into several sections:

- Fluid characteristics:** Fluid: Water @ 1 atm [HC], Ref.: IAPWS IF97. Temperature: 20 °C, Pressure: 1.013 bar. Density: 998.2061 kg/m³, Dynamic Viscosity: 0.00100159 N.s/m², Kinematic Viscosity: 1.00340E-06 m²/s. A graph shows Density (kg/m³) vs Temperature (°C).
- Geometrical characteristics:** Measured differential pressure: 0.5 bar, ΔH 5.1077 m of fluid. Pipe diameter: 0.0703 m, Orifice diameter: 0.035 m. Velocity of approach: 2.522 m/s (Turbulent), Orifice velocity: 10.176 m/s (Turbulent). Mass flow rate: 9.7733 kg/s, Volumetric flow rate: 0.009790866 m³/s.
- Complementary results:**

Designation	Symbol	Value	Unit
Pipe cross-section area	S	0.003881508	m²
Orifice cross-section area	s	0.0009621127	m²
Diameters ratio	β	0.4978663	
Cross-sections area ratio	s/S	0.2478708	
Pipe Reynolds number	ReD	176727.1	
Orifice Reynolds number	Red	354969	
Discharge coefficient	C	0.985	
Expansibility factor	ϵ	1	
Velocity of approach factor	Cv	1.032212	
Flow coefficient	Cf	1.016729	
Net pressure loss coefficient (based on mean pipe velocity)	K	9.56076	
Hydraulic power loss	Wh	297.2657	W

References:

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