Orifice Plate Flow (ISO 5167)

Mass and volume flow through an orifice plate from the differential pressure, by ISO 5167-2 with the Reader-Harris/Gallagher discharge coefficient and expansibility.

Method: ISO 5167-1 (general principles); ISO 5167-2 (orifice plates); ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Pipe inside diameter	102.30	mm
Orifice bore	60.000	mm
Pressure tappings	Flange	
Differential pressure	250.00	mbar
Upstream pressure (absolute) Needed for gases and steam (expansibility). Absolute; choose a gauge unit to enter gauge readings.	5.0000	bar
Density at the upstream tapping	998.20	kg/m³
Dynamic viscosity	1.0020	cP
Isentropic exponent (0 = liquid) 0 for liquids. Air and flue gas 1.4; natural gas 1.31; superheated steam 1.3; saturated steam 1.135.	0	

Calculated results

Parameter	Value	Unit
Mass flow	46,627	kg/h
Volume flow at upstream conditions	46.711	m³/h
Discharge coefficient	0.60884	
Expansibility factor	1.0000	
Diameter ratio d/D	0.58651	
Pipe Reynolds number	160,880	
Permanent pressure loss	160.61	mbar

Formula and method

$$q_m = \frac{C}{\sqrt{1-\beta^4}}\,\varepsilon\,\frac{\pi}{4}d^2\sqrt{2\,\Delta p\,\rho_1} \qquad \beta = \frac{d}{D} \qquad Re_D = \frac{4\,q_m}{\pi\,\mu\,D} \qquad q_V = \frac{q_m}{\rho_1}$$

$$C = 0.5961 + 0.0261\beta^2 - 0.216\beta^8 + 0.000521\left(\frac{10^6\beta}{Re_D}\right)^{0.7} + (0.0188 + 0.0063A)\,\beta^{3.5}\left(\frac{10^6}{Re_D}\right)^{0.3}$$

$$+ \left(0.043 + 0.080e^{-10L_1} - 0.123e^{-7L_1}\right)(1 - 0.11A)\frac{\beta^4}{1-\beta^4} - 0.031\left(M_2{}' - 0.8M_2{}'^{1.1}\right)\beta^{1.3}$$

$$\varepsilon = 1 - (0.351 + 0.256\beta^4 + 0.93\beta^8)\left[1 - \left(\frac{p_1 - \Delta p}{p_1}\right)^{1/\kappa}\right] \qquad \Delta\varpi = \frac{\sqrt{1-\beta^4(1-C^2)} - C\beta^2}{\sqrt{1-\beta^4(1-C^2)} + C\beta^2}\,\Delta p$$

Variables

D	pipe inside diameter at flowing temperature	m

d	orifice bore at flowing temperature	m
taps	pressure tappings: corner, D and D/2, or flange	–
Δp	differential pressure	Pa
p_1	absolute pressure at the upstream tapping	Pa
ρ_1	density at the upstream tapping	kg/m³
μ	dynamic viscosity	Pa·s
κ	isentropic exponent (0 for a liquid)	–
q_m	mass flow	kg/s
q_V	volume flow at upstream conditions	m³/s
C	discharge coefficient	–
ε	expansibility factor	–
β	diameter ratio	–
Re_D	Reynolds number referred to the pipe diameter	–
$\Delta\varpi$	permanent pressure loss	Pa
$L_1\$, \$L_2'$	tapping distances divided by D	–

Method and standards

ISO 5167-2: mass flow equation of ISO 5167-1, discharge coefficient by the Reader-Harris/Gallagher (1998) equation, expansibility factor and pressure loss of ISO 5167-2 (equations of the 2003 edition, retained in the 2022 edition). The flow is found by iterating on the Reynolds number until the discharge coefficient converges.

Assumptions and limits

- Limits of use of ISO 5167-2, each flagged when exceeded: d ≥ 12.5 mm; 50 mm ≤ D ≤ 1 000 mm; 0.10 ≤ β ≤ 0.75; Re_D ≥ 5 000 (and ≥ 16 000β² for β > 0.56 with corner or D and D/2 taps; ≥ 170β²D[mm] with flange taps); $p_2/p_1 \geq 0.75$.
- Square-edged concentric plate, single-phase flow, straight lengths as ISO 5167-2 requires.
- Diameters at flowing temperature: correct d and D for thermal expansion yourself for hot service.
- Density and viscosity are your inputs; take steam and water values from the steam and water property calculators.

References

• ISO 5167-1 (general principles)
• ISO 5167-2 (orifice plates)
• Reader-Harris/Gallagher (1998) equation

Report details

Report reference	FCC-KMBJ-4XC6 (the same inputs always give the same reference)
Generated	17 November 2026, 19:44 UTC
Calculator	Orifice Plate Flow (ISO 5167)
Method last reviewed	10 November 2026
Software release	FireCAD Calc, release of 17 November 2026
Release checks	4 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/instrumentation/flow/orifice-flow

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.