Orifice Plate Bore Sizing for a Chosen DP

Orifice bore that gives a chosen differential pressure at the maximum flow, by ISO 5167-2 (Reader-Harris/ Gallagher), with β ratio and permanent pressure loss.

Method: ISO 5167-1; ISO 5167-2

Input parameters

Unit system: SI

Parameter	Value	Unit
Pipe inside diameter	102.30	mm
Maximum mass flow	36,000	kg/h
Differential pressure wanted at maximum flow	250.00	mbar
Pressure tappings	Flange	
Upstream pressure (absolute)	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 1.4; natural gas 1.31; superheated steam 1.3; saturated steam 1.135.	0	

Calculated results

Parameter	Value	Unit
Orifice bore	53.456	mm
Diameter ratio d/D	0.52254	
Discharge coefficient	0.60673	
Expansibility factor	1.0000	
Permanent pressure loss	177.45	mbar

Formula and method

$$q_m = \frac{C}{\sqrt{1-\beta^4}}\,\varepsilon\,\frac{\pi}{4}d^2\sqrt{2\,\Delta p\,\rho_1} \qquad \beta = \frac{d}{D}\ \text{found by bisection}$$

$$\varepsilon = 1-(0.351+0.256\beta^4+0.93\beta^8)\left[1-\left(\frac{p_2}{p_1}\right)^{1/\kappa}\right], \quad \Delta\varpi = \frac{\sqrt{1-\beta^4(1-C^2)}-C\beta^2}{\sqrt{1-\beta^4(1-C^2)}+C\beta^2}\,\Delta p$$

Variables

D	pipe inside diameter	m
q_m	maximum mass flow	kg/s
Δp	differential pressure at max flow	Pa
taps	tapping arrangement	–
p_1	upstream pressure	Pa
ρ_1	upstream density	kg/m³
μ	viscosity	Pa·s
κ	isentropic exponent (0 liquid)	–
d	bore	m
β	diameter ratio	–

C	discharge coefficient	–
ε	expansibility	–
$\Delta\varpi$	permanent pressure loss	Pa

Method and standards

ISO 5167-2 orifice equation with the Reader-Harris/Gallagher discharge coefficient and the expansibility equation, solved for β by bisection.

Assumptions and limits

- The bore is searched between β 0.05 and 0.85, wider than the ISO 5167-2 range of 0.10 to 0.75; a result outside that range is given with a warning and is outside the standard's uncertainty statement.
- Within ISO 5167-2 limits; straight lengths as the standard requires.

References

- ISO 5167-1
- ISO 5167-2

Report details

Report reference	FCC-KWKC-6ZQT (the same inputs always give the same reference)
Generated	17 November 2026, 19:48 UTC
Calculator	Orifice Plate Bore Sizing for a Chosen DP
Method last reviewed	12 November 2026
Software release	FireCAD Calc, release of 17 November 2026
Release checks	3 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-bore-for-dp

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Reopens the calculator with the inputs of this report.