Restriction Orifice Sizing: Liquid or Gas

Bore of a restriction orifice for a liquid at a set pressure drop or for a gas, choked or subcritical, with the cavitation index for liquid service.

Method: Orifice equation (liquid) and critical flow through an orifice (gas) (definitions; Lipták, Instrument Engineers' Handbook, 4th ed. (CRC Press))

Input parameters

Unit system: SI

Parameter	Value	Unit
Service	Liquid	
Mass flow	7,200.0	kg/h
Upstream pressure (absolute)	20.000	bar
Pressure drop (liquid)	10.000	bar
Liquid density (liquid)	998.00	kg/m³
Vapour pressure (liquid)	3.1700	kPa
Gas temperature (gas)	26.850	°C
Gas molar mass	28.960	kg/kmol
Ratio of specific heats	1.4000	
Downstream pressure, absolute (gas; 0 = assume choked) Gas only. Above the critical pressure p* the flow is subcritical and the bore is sized by the subcritical equation.	0	bar
Discharge coefficient	0.61000	

Calculated results

Parameter	Value	Unit
Orifice bore	9.6664	mm
Orifice area	73.387	mm²
Cavitation index (p_1 − p_v)/Δp (liquid)	1.9968	
Critical downstream pressure (gas)	0	bar

Notes for this case

- Cavitation index below about 2 (a common screening level, not a standard limit): cavitation is likely; check with the plate maker and consider multi-stage orifices.
- Thin plate, single hole; velocity of approach neglected (small bore relative to pipe). Use several plates in series for large liquid drops.

Formula and method

$$A = \frac{\dot{m}}{C_d\sqrt{2\rho\Delta p}}\ \text{(liquid)}, \quad A = \frac{\dot{m}}{C_d p_1\sqrt{\frac{\gamma}{RT_1}\left(\frac{2}{\gamma+1}\right)^{\frac{\gamma+1}{\gamma-1}}}}\ \text{(choked gas)}$$

$$A = \frac{\dot{m}}{C_d p_1\sqrt{\frac{2\gamma}{(\gamma-1)RT_1}\left[\left(\frac{p_2}{p_1}\right)^{2/\gamma} - \left(\frac{p_2}{p_1}\right)^{(\gamma+1)/\gamma}\right]}}\ (\text{gas},\ p_2 > p^*), \quad p^* = p_1\left(\frac{2}{\gamma+1}\right)^{\frac{\gamma}{\gamma-1}}, \quad R = \frac{R_u}{M}$$

Variables

$\mathrm{service}$	Service	-
$\dot{m}$	Mass flow	kg/s
p_1	Upstream pressure (absolute)	Pa
Δp	Pressure drop (liquid)	Pa
ρ	Liquid density (liquid)	kg/m³
p_v	Vapour pressure (liquid)	Pa
T_1	Gas temperature (gas)	K
M	Gas molar mass	kg/kmol
γ	Ratio of specific heats	-
p_2	Downstream pressure, absolute (gas; 0 = assume choked)	Pa
C_d	Discharge coefficient	-
R	Specific gas constant	J/(kg·K)
R_u	Universal gas constant, 8 314.462 618	J/(kmol·K)
d	Orifice bore	m
A	Orifice area	m²
σ	Cavitation index (p₁ − p_v)/Δp (liquid)	-
p^*	Critical downstream pressure (gas)	Pa

Method and standards

Orifice equation for liquids; isentropic flow of an ideal gas through the orifice for gases, choked when $p_2 \le p^*$ and subcritical above it.

Assumptions and limits

- Sharp-edged; small β.
- Gas: if the downstream pressure is left at 0, choked flow is assumed and the page says so; enter p_2 to have subcritical flow sized correctly.
- The cavitation index of 2 used for the warning is a common screening level, not a limit from a standard; use the plate maker's data for the design.

References

• Orifice equation (liquid) and critical flow through an orifice (gas) (definitions; Lipták, Instrument Engineers' Handbook, 4th ed. (CRC Press))

Report details

Report reference	FCC-NZEC-R23T (the same inputs always give the same reference)
Generated	17 November 2026, 19:34 UTC
Calculator	Restriction Orifice Sizing: Liquid or Gas
Method last reviewed	13 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/restriction-orifice-sizing

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.