Pump Intake Minimum Submergence against Vortexing

Minimum liquid submergence above a pump suction bell or pipe inlet to avoid air-entraining vortices, from flow and inlet diameter by the Froude-number rule.

Method: Froude-number submergence rule for intakes

Input parameters

Unit system: SI

Parameter	Value	Unit
Flow	1,800.0	m³/h
Bell or inlet diameter	600.00	mm
Froude coefficient	2.3000	

Calculated results

Parameter	Value	Unit
Inlet velocity	1.7684	m/s
Froude number	0.72902	
Minimum submergence	1.6061	m
Submergence in diameters	2.6768	

Notes for this case

• S = D(1 + c·Fr_D), Fr_D = V/√(gD), with c ≈ 2.3 in common intake practice. Sump geometry (approach flow, walls, floor clearance about D/2) matters as much as depth; anti-vortex devices or model tests settle doubtful cases.

Formula and method

$$S = D(1 + c\,Fr_D), \quad Fr_D = \frac{V}{\sqrt{gD}}$$

Variables

Q	Flow	m³/s
D	Bell or inlet diameter	m
c	Froude coefficient	-
V	Inlet velocity	m/s
Fr_D	Froude number	-
S	Minimum submergence	m
S/D	Submergence in diameters	-

Method and standards

Submergence rule.

Assumptions and limits

- Vertical suction; reasonably uniform approach flow.

References

Froude-number submergence rule for intakes

Report details

Report reference	FCC-MJKR-QT3S (the same inputs always give the same reference)
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Calculator	Pump Intake Minimum Submergence against Vortexing
Method last reviewed	17 November 2026
Software release	FireCAD Calc, release of 22 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/mechanical/pumps/pump-intake-submergence

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.