Slug Impact Force on a Pipe Elbow

Resultant force of a liquid slug passing an elbow from slug density, velocity, pipe area and bend angle, with a dynamic load factor for support design.

Method: Momentum balance on a bend

Input parameters

Unit system: SI

Parameter	Value	Unit
Slug density	1,000.0	kg/m³
Slug velocity	15.000	m/s
Pipe inside diameter	150.00	mm
Bend angle	90.000	°
Dynamic load factor	2.0000	

Calculated results

Parameter	Value	Unit
Pipe flow area	176.71	cm²
Resultant momentum force	5.6230	kN
Design force with load factor	11.246	kN

Notes for this case

• Momentum change of the slug turning through θ: F = ρv²A√(2(1 − cos θ)), acting along the bisector of the bend. A slug arriving suddenly loads supports dynamically, up to twice the static value (DLF 2). Water hammer from valve closure and pressure thrust are separate checks.

Formula and method

$$F = \rho v^2 A\sqrt{2(1-\cos\theta)}, \quad F_d = DLF \cdot F$$

Variables

ρ	Slug density	kg/m³
v	Slug velocity	m/s
D	Pipe inside diameter	m
θ	Bend angle	rad
DLF	Dynamic load factor	-
A	Pipe flow area	m²
F	Resultant momentum force	N
F_d	Design force with load factor	N

Method and standards

Slug momentum.

Assumptions and limits

- Slug fills the pipe; incompressible liquid; steady turning.

References

Momentum balance on a bend

Report details

Report reference	FCC-7DHN-ZQ1B (the same inputs always give the same reference)
Generated	23 November 2026, 17:50 UTC
Calculator	Slug Impact Force on a Pipe Elbow
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/piping/slug-force-on-elbow

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.