Pressure Rise in Blocked-In Liquid-Full Pipe on Heating

Pressure rise per kelvin and for a temperature rise in a closed, liquid-full thin-walled pipe, from liquid expansion and compressibility and pipe elasticity.

Method: Volume balance of a closed liquid-full thin cylinder

Input parameters

Unit system: SI

Parameter	Value	Unit
Liquid volumetric expansion coefficient	2.0700e-04	1/K
Liquid compressibility	0.45900	1/GPa
Pipe linear expansion coefficient	1.2000e-05	1/K
Pipe mean diameter	200.00	mm
Wall thickness	8.0000	mm
Pipe elastic modulus	200.00	GPa
Poisson's ratio	0.30000	
Temperature rise	10.000	K

Calculated results

Parameter	Value	Unit
Pipe pressure compliance	0.11875	1/GPa
Pressure rise per kelvin of heating	2.9598	bar
Pressure rise	29.598	bar

Notes for this case

• Volume balance: (β − 3α)ΔT = (κ + C_p)Δp, with C_p = D(5/4 − ν)/(Et) the volumetric strain per pressure of a closed thin cylinder. Water's β rises steeply with temperature; even a few kelvin can overpressure blocked-in lines, hence thermal relief valves.

Formula and method

$$\frac{dp}{dT} = \frac{\beta - 3\alpha}{\kappa + \frac{D}{Et}\left(\frac{5}{4} - \nu\right)}$$

Variables

β	Liquid volumetric expansion coefficient	1/K
κ	Liquid compressibility	1/Pa
α	Pipe linear expansion coefficient	1/K
D	Pipe mean diameter	m
t	Wall thickness	m
E	Pipe elastic modulus	Pa
ν	Poisson's ratio	-
ΔT	Temperature rise	K
C_p	Pipe pressure compliance	1/Pa
dp/dT	Pressure rise per kelvin of heating	Pa
Δp	Pressure rise	Pa

Method and standards

Trapped-liquid pressure.

Assumptions and limits

- Closed, thin-walled, unrestrained pipe; elastic.

References

Volume balance of a closed liquid-full thin cylinder

Report details

Report reference	FCC-CR8Q-N8EH (the same inputs always give the same reference)
Generated	23 November 2026, 17:51 UTC
Calculator	Pressure Rise in Blocked-In Liquid-Full Pipe on Heating
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/blocked-in-liquid-pressure-rise

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.