Pipeline Hydrotest: Pressure Change per Degree of Water Temperature

Pressure change of a water-filled, closed, restrained pipeline per kelvin of water temperature change during a hydrostatic test, from the water and steel properties.

Method: Pressure–temperature relation of a restrained water-filled pipe (B − 2A)/(D(1 − ν²)/Et + C); IAPWS-IF97 water density; …

Input parameters

Unit system: SI

Parameter	Value	Unit
Pipe outside diameter	508.00	mm
Wall thickness	12.700	mm
Test pressure (gauge)	100.00	bar
Water temperature	15.000	°C
Elastic modulus of steel	207.00	GPa
Poisson's ratio	0.30000	
Linear thermal expansion of steel	11.700	µm/(m·K)
Temperature change during the test	1.0000	K

Calculated results

Parameter	Value	Unit
Volumetric thermal expansion of the water	169.86	µm/(m·K)
Compressibility of the water	4.5530e-04	1/MPa
Pressure change per kelvin	2.3206	bar
Pressure change for the temperature change	2.3206	bar

Notes for this case

• In a closed, full pipe the water tries to expand by its volumetric expansion B per kelvin while the steel bore grows by about 2A (the pipe is restrained along its length). The difference is taken up by compressing the water (C) and stretching the pipe wall (D(1 − ν²)/(E t)), giving Δp/ΔT = (B − 2A)/[D(1 − ν²)/(E t) + C]. Cold water expands little, so near 4 °C the pressure barely changes and below it may even fall as the water warms; at 15–20 °C a change of 1 K moves the pressure by a few bar. Record the water temperature during a hold test and correct for it before judging a leak. Water properties are from IAPWS-IF97 at the test pressure.

Formula and method

$$\frac{\Delta p}{\Delta T} = \frac{B - 2A}{\frac{D(1-\nu^2)}{E\,t} + C}$$

Variables

D	Pipe outside diameter	m
t	Wall thickness	m
p	Test pressure (gauge)	Pa
T_w	Water temperature	K
E	Elastic modulus of steel	Pa
ν	Poisson's ratio	-
A	Linear thermal expansion of steel	1/K
ΔT	Temperature change during the test	K

B	Volumetric thermal expansion of the water	1/K
C	Compressibility of the water	1/Pa
$\Delta p/\Delta T$	Pressure change per kelvin	Pa
Δp	Pressure change for the temperature change	Pa

Method and standards

Hydrotest temperature correction.

Assumptions and limits

- Long restrained pipe full of air-free water; thin wall.

References

Pressure–temperature relation of a restrained water-filled pipe (B − 2A)/(D(1 − ν²)/Et + C), IAPWS-IF97 water density, expansion and compressibility

Report details

Report reference	FCC-79G2-HT63 (the same inputs always give the same reference)
Generated	23 November 2026, 17:50 UTC
Calculator	Pipeline Hydrotest: Pressure Change per Degree of Water Temperature
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/hydrotest-pressure-temperature-change

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.