Expansion Tank for a Closed Water System (Diaphragm)

Size of a diaphragm expansion tank for a closed chilled or hot water system from system volume, fill and maximum temperatures and the pressures (water from IF97).

Method: Water expansion from IAPWS-IF97 specific volumes less pipe expansion 3αΔT; diaphragm tank by Boyle's law V_t = V_e/(1 − p_1/p_2) (ASHRAE Handbook—HVAC Systems and Equipment, hydronic systems)

Input parameters

Unit system: SI

Parameter	Value	Unit
System water volume	5.0000	m³
Fill (lowest) temperature	10.000	°C
Highest temperature	90.000	°C
Pre-charge or fill pressure at the tank (absolute)	2.5000	bar
Highest pressure at the tank (absolute, below the relief setting)	5.0000	bar
Linear expansion coefficient of the piping Carbon steel about 11.7 × 10^{-6} /K; 0 to ignore.	11.700	µm/(m·K)

Calculated results

Parameter	Value	Unit
Specific volume at the fill temperature	0.001000	m³/kg
Specific volume at the highest temperature	0.001036	m³/kg
Net expansion volume	164.06	L
Tank volume	328.12	L

Notes for this case

- Water specific volumes at the highest pressure (IAPWS-IF97); the gas side follows Boyle's law at constant temperature.

Formula and method

$$V_e = V_s\left[\left(\frac{v_2}{v_1}-1\right)-3\alpha\Delta T\right],\quad V_t=\frac{V_e}{1-p_1/p_2}$$

Variables

V_s	System water volume	m³
T_1	Fill (lowest) temperature	K
T_2	Highest temperature	K
p_1	Pre-charge or fill pressure at the tank (absolute)	Pa
p_2	Highest pressure at the tank (absolute, below the relief setting)	Pa
α	Linear expansion coefficient of the piping	1/K
v_1	Specific volume at the fill temperature	m³/kg
v_2	Specific volume at the highest temperature	m³/kg
V_e	Net expansion volume	m³
V_t	Tank volume	m³

Method and standards

Volume balance and Boyle's law.

Assumptions and limits

- Diaphragm tank, isothermal gas.

References

• Water expansion from IAPWS-IF97 specific volumes less pipe expansion 3αΔT; diaphragm tank by Boyle's law V_t = V_e/(1 − p_1/p_2) (ASHRAE Handbook—HVAC Systems and Equipment, hydronic systems)

Report details

Report reference	FCC-X76A-D383 (the same inputs always give the same reference)
Generated	17 November 2026, 19:46 UTC
Calculator	Expansion Tank for a Closed Water System (Diaphragm)
Method last reviewed	12 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/hvac/chillers/expansion-tank-closed-system

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.