Maximum Safe Fill for Thermal Expansion of a Liquid

Largest fill a tank or container can take at the filling temperature so the liquid stays below a set fill at the highest expected temperature.

Method: Volumetric thermal expansion of liquids

Input parameters

Unit system: SI

Parameter	Value	Unit
Container volume	100.00	m³
Liquid volumetric expansion coefficient	0.001000	1/K
Filling temperature	15.000	°C
Highest expected liquid temperature	50.000	°C
Allowed fill at the highest temperature	97.000	%

Calculated results

Parameter	Value	Unit
Maximum fill at the filling temperature	93.664	%
Maximum volume to fill	93.664	m³
Expansion volume to the highest temperature	3.3363	m³

Notes for this case

• V(T) = V_f·exp(β(T − T_f)), constant β. Liquefied gases (LPG, ammonia) have large and strongly temperature-dependent β; use density tables there: φ_f = φ_max·ρ(T_max)/ρ(T_f). Container expansion is neglected (conservative).

Formula and method

$$\phi_f = \phi_{max} e^{-\beta(T_{max} - T_f)}$$

Variables

V	Container volume	m³
β	Liquid volumetric expansion coefficient	1/K
T_f	Filling temperature	K
T_{max}	Highest expected liquid temperature	K
ϕ_{max}	Allowed fill at the highest temperature	-
ϕ_f	Maximum fill at the filling temperature	-
V_f	Maximum volume to fill	m³
ΔV	Expansion volume to the highest temperature	m³

Method and standards

Fill limit.

Assumptions and limits

- Constant expansion coefficient; rigid container.

References

Volumetric thermal expansion of liquids

Report details

Report reference	FCC-AEG7-6WM8 (the same inputs always give the same reference)
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Calculator	Maximum Safe Fill for Thermal Expansion of a Liquid
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/vessels/tank-maximum-fill-thermal-expansion

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.