Tank Cooling Overnight: Temperature Fall and Heat Loss

Temperature of a stored liquid after a period without heating, from its mass, specific heat and the tank's UA to ambient (exponential cooling), with the heat lost.

Method: Lumped exponential cooling (Newton's law of cooling; definitions)

Input parameters

Unit system: SI

Parameter	Value	Unit
Liquid volume	50.000	m³
Liquid density	950.00	kg/m³
Specific heat	2.0000	kJ/(kg·K)
Overall coefficient to ambient	1.2000	W/(m²·K)
Surface area losing heat	90.000	m²
Initial temperature	70.000	°C
Ambient temperature	15.000	°C
Time without heating	12.000	h
Lowest acceptable temperature	50.000	°C

Calculated results

Parameter	Value	Unit
Temperature after the period	67.364	°C
Heat lost	69.558	kWh
Time constant mc_p/UA	244.34	h
Time to fall to the lowest acceptable temperature	110.44	h

Notes for this case

- Well-mixed liquid assumed; an unstirred tank stratifies, and the liquid near the outlet may cool faster than the average.

Formula and method

$$T(t) = T_a + (T_0 - T_a)e^{-t/\tau}, \quad \tau = \frac{mc_p}{UA}, \quad t_{min} = \tau \ln \frac{T_0 - T_a}{T_{min} - T_a}$$

Variables

V	Liquid volume	m³
ρ	Liquid density	kg/m³
c_p	Specific heat	J/(kg·K)
U	Overall coefficient to ambient	W/(m²·K)
A	Surface area losing heat	m²
T_0	Initial temperature	K
T_a	Ambient temperature	K
t	Time without heating	s
T_{min}	Lowest acceptable temperature	K
$T(t)$	Temperature after the period	K
Q	Heat lost	J
τ	Time constant mc_p/UA	s
t_{min}	Time to fall to the lowest acceptable temperature	s

Method and standards

Lumped-capacitance cooling.

Assumptions and limits

- The time to the lowest acceptable temperature is shown only when that temperature lies between ambient and the starting temperature; the other results do not depend on it.
- Well mixed; constant U and ambient.

References

- Lumped exponential cooling (Newton's law of cooling; definitions)

Report details

Report reference	FCC-WA1V-AC9Z (the same inputs always give the same reference)
Generated	17 November 2026, 19:46 UTC
Calculator	Tank Cooling Overnight: Temperature Fall and Heat Loss
Method last reviewed	13 November 2026
Software release	FireCAD Calc, release of 17 November 2026
Release checks	2 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/heat-transfer/tank-cooling-overnight

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.