Tank or Vessel Heat-up Time with a Steam Coil or Jacket

Time to heat a batch in a tank or jacketed vessel with steam, from mass, specific heat, coil or jacket area, U and steam pressure, with the steam used.

Method: Transient heating with constant steam temperature (lumped batch); IAPWS R7-97 IF97

Input parameters

Unit system: SI

Parameter	Value	Unit
Liquid in the tank	10.000	t
Specific heat of the liquid	4.1800	kJ/(kg·K)
Starting temperature	20.000	°C
Final temperature	80.000	°C
Overall heat transfer coefficient of coil or jacket	800.00	W/(m²·K)
Coil or jacket area	5.0000	m²
Steam pressure (absolute, saturated)	4.0000	bar

Calculated results

Parameter	Value	Unit
Heat-up time	1.9284	h
Steam used for the batch	1,175.6	kg
Average steam flow	609.63	kg/h
Heat flow at the start (peak)	494.45	kW
Steam saturation temperature	143.61	°C

Notes for this case

- Heat losses from the tank are not included; they lengthen the time and add steam.

Formula and method

$$t = \frac{mc_p}{UA}\ln\frac{T_s - T_0}{T_s - T_1} \qquad m_s = \frac{mc_p(T_1 - T_0)}{h_{fg}} \qquad \dot{Q}_0 = UA(T_s - T_0)$$

Variables

m	liquid mass	kg
c_p	specific heat	J/(kg·K)
T_0	starting temperature	K
T_1	final temperature	K
U	overall coefficient	W/(m²·K)
A	coil or jacket area	m²
p_s	steam pressure	Pa
t	heat-up time	s
m_s	steam for the batch	kg
$\dot{m}_s$	average steam flow	kg/s
$\dot{Q}_0$	heat flow at the start	W
T_s	steam saturation temperature	K
h_{fg}	latent heat (IF97)	J/kg

Method and standards

Lumped (well-mixed) batch heated by condensing steam at constant temperature; U constant.

Assumptions and limits

- Steam enters dry and saturated and leaves as condensate at saturation temperature, so each kilogram gives up h_fg. Wet steam, sub-cooled condensate, trap losses and flash steam are not included: wet steam needs more, sub-cooling a little less.
- Well-mixed liquid; constant U and steam temperature; no heat loss.

References

• Transient heating with constant steam temperature (lumped batch)
• IAPWS R7-97 IF97

Report details

Report reference	FCC-CWDB-4K14 (the same inputs always give the same reference)
Generated	17 November 2026, 19:46 UTC
Calculator	Tank or Vessel Heat-up Time with a Steam Coil or Jacket
Method last reviewed	11 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/mechanical/heat-transfer/tank-heat-up-time

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.