Steam Consumption for Heating a Process Stream

Steam needed to heat a liquid stream from its flow, specific heat and temperature rise, with losses, using IF97 steam and condensate enthalpies.

Method: Energy balance ṁ_s = ṁ_p c_p ΔT (1 + k)/(h_steam − h_condensate); IAPWS-IF97

Input parameters

Unit system: SI

Parameter	Value	Unit
Product flow	10,000	kg/h
Product specific heat	4.1868	kJ/(kg·K)
Product in	30.000	°C
Product out	80.000	°C
Steam pressure (absolute)	4.0000	bar
Steam dryness fraction	97.000	%
Condensate leaving temperature	90.000	°C
Heat losses (share of useful heat)	5.0000	%

Calculated results

Parameter	Value	Unit
Heat supplied, product heat plus losses	610.58	kW
Heat given up per kg of steam	2,296.8	kJ/kg
Steam consumption	957.00	kg/h

Notes for this case

- Steam and condensate enthalpies from IAPWS-IF97 at the steam pressure.

Formula and method

$$\dot{Q} = \dot{m}_p c_p (T_2 - T_1)(1 + k_l), \quad \dot{m}_s = \frac{\dot{Q}}{h_{steam}(p, x) - h_{cond}(p, T_c)}$$

Variables

$\dot{m}_p$	Product flow	kg/s
c_p	Product specific heat	J/(kg·K)
T_1	Product in	K
T_2	Product out	K
p_s	Steam pressure (absolute)	Pa
x	Steam dryness fraction	-
T_c	Condensate leaving temperature	K
k_l	Heat losses (share of useful heat)	-
$\dot{Q}$	Heat supplied, product heat plus losses	W
Δh	Heat given up per kg of steam	J/kg
$\dot{m}_s$	Steam consumption	kg/s

Method and standards

Energy balance.

Assumptions and limits

- Steady flow.
- Steam is wet or dry saturated at p_s (dryness x); superheated steam is not an option here (see the steam consumption from heat duty calculator).
- The heat shown includes the loss allowance; the heat reaching the product is Q/(1 + k_l).
- Condensate leaves between the product inlet temperature and the steam saturation temperature.

References

- Energy balance ṁ_s = ṁ_p c_p ΔT (1 + k)/(h_steam − h_condensate); IAPWS-IF97

Report details

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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/boilers-power-plant/steam/steam-for-process-heating

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.