Direct Steam Injection Heating (Steam Required)

Steam needed to heat water or a process liquid by direct injection (sparging), where the steam condenses into the liquid, from flow and temperatures (IAPWS-IF97).

Method: Energy balance; IAPWS R7-97 IF97

Input parameters

Unit system: SI

Parameter	Value	Unit
Liquid flow to heat	18,000	kg/h
Specific heat of the liquid	4.1800	kJ/(kg·K)
Liquid temperature in	20.000	°C
Liquid temperature out	80.000	°C
Steam pressure (absolute, saturated)	6.0000	bar

Calculated results

Parameter	Value	Unit
Steam needed	1,864.9	kg/h
Steam per kg of liquid	0.10360	kg/kg
Liquid flow out (diluted by condensate)	19,865	kg/h

Notes for this case

- All the steam condenses and stays in the product, which is diluted; the steam must be clean (culinary) where the product is food.

Formula and method

$$\dot{m}_s = \frac{\dot{m}\, c_p\, (T_2 - T_1)}{h_g - h_l(T_2)} \qquad \dot{m}_2 = \dot{m} + \dot{m}_s$$

Variables

$\dot{m}$	liquid flow	kg/s
c_p	liquid specific heat	J/(kg·K)
T_1	liquid in	K
T_2	liquid out	K
p_s	steam pressure	Pa
$\dot{m}_s$	steam needed	kg/s
$\dot{m}_s/\dot{m}$	steam per kg of liquid	kg/kg
$\dot{m}_2$	liquid out	kg/s
h_g	saturated steam enthalpy (IF97)	J/kg
h_l	enthalpy of the condensate at T_2, taken at the steam pressure (IF97)	J/kg

Method and standards

Energy balance with the steam condensing completely and leaving at the outlet temperature.

Assumptions and limits

- Complete condensation; no heat loss; saturated steam.
- The condensate enthalpy is taken at the steam pressure; for liquid water its pressure hardly matters.
- Above about 100 °C the product must be pressurised so it does not boil; the liquid pressure is not an input, and a warning appears.
- The steam-to-liquid ratio is shown even for zero flow.

References

- Energy balance
- IAPWS R7-97 IF97

Report details

Report reference	FCC-0G63-MMPA (the same inputs always give the same reference)
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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/boilers-power-plant/steam/direct-steam-injection

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.