Heat Required to Generate Steam from Feedwater

Heat to turn feedwater into wet, dry saturated or superheated steam, split into sensible, latent and superheat parts, with the fuel needed at a boiler efficiency (IF97).

Method: IAPWS-IF97 (water and steam)

Input parameters

Unit system: SI

Parameter	Value	Unit
Boiler pressure (absolute)	10.000	bar g
Feedwater temperature	60.000	°C
Steam produced	Dry saturated	
Dryness fraction (wet steam)	95.000	%
Steam temperature (superheated)	250.00	°C
Steam generated	10,000	kg/h
Boiler efficiency	80.000	%
Calorific value of the fuel (same basis, GCV or NCV, as the efficiency)	16,747	kJ/kg

Calculated results

Parameter	Value	Unit
Enthalpy of the feedwater	252.06	kJ/kg
Enthalpy of the steam	2,780.7	kJ/kg
Sensible heat, feedwater to boiling (h_f − h_fw)	529.37	kJ/kg
Latent heat added (x h_fg)	1,999.3	kJ/kg
Heat of superheat (h − h_g)	0	kJ/kg
Total heat per kg of steam	2,528.6	kJ/kg
Heat to the steam	7,024.0	kW
Fuel burnt	1,887.4	kg/h
Evaporation ratio (steam per kg of fuel)	5.2984	kg/kg

Notes for this case

- The feedwater enthalpy is taken at the boiler pressure (compressed water); exam answers that use 4.187 × t from steam tables at atmospheric pressure differ by a few kJ/kg.

Formula and method

$$\dot{Q} = \dot{m}_s\, q, \quad \dot{m}_f = \frac{\dot{Q}}{\eta_b\, GCV}, \quad ER = \frac{\dot{m}_s}{\dot{m}_f} = \frac{\eta_b\, GCV}{q}$$

One further formula is shown on the calculator page: https://calc.firecad.com/boilers-power-plant/steam/heat-to-generate-steam

Variables

p	Boiler pressure (absolute)	Pa
T_{fw}	Feedwater temperature	K
state	Steam produced	-
x	Dryness fraction (wet steam)	-
T_{sup}	Steam temperature (superheated)	K

$\dot{m}_s$	Steam generated	kg/s
η_b	Boiler efficiency	-
GCV	Calorific value of the fuel (same basis as the efficiency)	J/kg
h_{fw}	Enthalpy of the feedwater	J/kg
h_s	Enthalpy of the steam	J/kg
q_{sens}	Sensible heat, feedwater to boiling (h_f − h_fw)	J/kg
q_{lat}	Latent heat added (x h_fg)	J/kg
q_{sup}	Heat of superheat (h − h_g)	J/kg
q	Total heat per kg of steam	J/kg
$\dot{Q}$	Heat to the steam	W
$\dot{m}_f$	Fuel burnt	kg/s
ER	Evaporation ratio (steam per kg of fuel)	kg/kg

Method and standards

Enthalpies from IAPWS-IF97: feedwater as compressed water at the boiler pressure, saturation properties and superheated steam at the boiler pressure.

Assumptions and limits

- Steady operation; blowdown and losses are inside the efficiency.
- Feedwater must be liquid at the boiler pressure.
- The efficiency and the calorific value must be on the same basis (both gross or both net); mixing them misstates the fuel.
- The evaporation ratio is computed as η GCV / q, so it is shown even when the steam flow is zero.
- A gauge pressure is converted to absolute with the standard atmosphere (101.325 kPa), not the site barometer.

References

• IAPWS-IF97 (water and steam)

Report details

Report reference	FCC-XY2A-S9Q4 (the same inputs always give the same reference)
Generated	17 November 2026, 19:37 UTC
Calculator	Heat Required to Generate Steam from Feedwater
Method last reviewed	12 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/boilers-power-plant/steam/heat-to-generate-steam

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.