Waste Heat Boiler Steam Generation

Steam a waste heat boiler makes from furnace, kiln, incinerator or engine off-gas, from gas flow and temperatures, steam conditions and casing loss (IAPWS-IF97).

Method: Energy balance; IAPWS R7-97 IF97

Input parameters

Unit system: SI

Parameter	Value	Unit
Waste gas flow	54,000	kg/h
Mean specific heat of the gas	1.1500	kJ/(kg·K)
Gas temperature entering	800.00	°C
Gas temperature leaving	250.00	°C
Steam pressure (absolute)	18.000	bar
Steam condition	Dry saturated	
Superheated steam temperature	250.00	°C
Feedwater temperature	105.00	°C
Casing heat loss, share of the heat given up by the gas	1.0000	%

Calculated results

Parameter	Value	Unit
Steam generated	14,361	kg/h
Heat to the steam	9.3926	MW
Gas outlet minus saturation temperature	42.880	K

Formula and method

$$\dot{Q} = \dot{m}_g c_{p,g} (T_{g,1} - T_{g,2}) (1 - \lambda) \qquad \dot{m}_s = \frac{\dot{Q}}{h_s - h_{fw}} \qquad \Delta T = T_{g,2} - T_{sat}$$

Variables

$\dot{m}_g$	waste gas flow	kg/s
$c_{p,g}$	gas specific heat	J/(kg·K)
$T_{g,1}$	gas in	K
$T_{g,2}$	gas out	K
p	steam pressure	Pa
state	saturated or superheated	–
T_s	steam temperature	K
T_{fw}	feedwater temperature	K
λ	casing loss, share of the heat given up by the gas	–
$\dot{m}_s$	steam generated	kg/s
$\dot{Q}$	heat to steam	W
ΔT	gas outlet minus saturation	K
h_s, h_{fw}	steam and feedwater enthalpies (IF97)	J/kg
T_{sat}	saturation temperature	K

Method and standards

Energy balance of the gas with a mean specific heat; steam enthalpies from FireCAD's IAPWS-IF97.

Assumptions and limits

- Mean specific heat; steady operation.
- No blowdown: the steam figure is before blowdown. The pinch and the acid dew point are not checked; an outlet below saturation is reported with a warning, not rejected.
- For superheated steam the gas must enter hotter than the steam.

References

- Energy balance
- IAPWS R7-97 IF97

Report details

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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/hrsg-waste-heat/whb-steam-generation

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.