CO_2 per Tonne of Steam (Fossil and Biogenic)

Fuel heat for a steam output (IF97, boiler efficiency) and fossil and biogenic CO_2 per tonne of steam from the fossil share of heat and emission factors.

Method: Fuel heat from IAPWS-IF97 enthalpies and efficiency; emission factors per TJ (IPCC 2006 Vol. 2 defaults as user inputs)

Input parameters

Unit system: SI

Parameter	Value	Unit
Steam	60.000	t/h
Steam pressure (absolute)	46.000	bar
Steam temperature	440.00	°C
Feedwater temperature	105.00	°C
Boiler efficiency (on the basis of the emission factors)	80.000	%
Fossil share of heat input	15.000	%
Fossil emission factor	94.600	t/TJ
Biogenic emission factor	100.00	t/TJ

Calculated results

Parameter	Value	Unit
Fuel heat input	59.492	MW
Fossil CO_2	3.0391	t/h
Fossil CO_2 per tonne of steam	50.652	kg/t
Biogenic CO_2 (reported separately)	18.205	t/h

Notes for this case

- IPCC defaults are on net calorific value: use a net efficiency with them. Biogenic CO_2 from bagasse is reported as a memo item.

Formula and method

$$\dot{Q} = \frac{\dot{m}_s(h_s - h_{fw})}{\eta}, \quad \dot{m}_{CO_2,f} = \dot{Q} f EF_f$$

Variables

$\dot{m}_s$	Steam	kg/s
p	Steam pressure (absolute)	Pa
T	Steam temperature	K
T_{fw}	Feedwater temperature	K
η	Boiler efficiency (on the basis of the emission factors)	-
f	Fossil share of heat input	-
EF_f	Fossil emission factor	kg/J
EF_b	Biogenic emission factor	kg/J
$\dot{Q}$	Fuel heat input	W
$\dot{m}_{CO_2,f}$	Fossil CO_2	kg/s
e_f	Fossil CO_2 per tonne of steam	kg/kg
$\dot{m}_{CO_2,b}$	Biogenic CO_2 (reported separately)	kg/s

Method and standards

Energy balance: fuel heat is the heat to the steam (IAPWS-IF97 enthalpies) over the efficiency; CO_2 is the heat times each share and its emission factor.

Assumptions and limits

- Steady output.
- All the non-fossil heat input is taken as biogenic; other non-fossil heat (electric, waste heat) must be removed from the shares first.
- The efficiency must be on the same calorific basis as the emission factors (net for IPCC defaults).
- Steam must be superheated and feedwater liquid at the steam pressure.

References

- Fuel heat from IAPWS-IF97 enthalpies and efficiency; emission factors per TJ (IPCC 2006 Vol. 2 defaults as user inputs)

Report details

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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/plant-performance/steam-co2-intensity

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Reopens the calculator with the inputs of this report.