Bagasse and Biomass Boiler Steam-to-Fuel Ratio

Steam per tonne of bagasse, rice husk or other biomass from its dry calorific value, moisture, boiler efficiency and steam conditions (IAPWS-IF97).

Method: Input–output balance; IAPWS R7-97 IF97

Input parameters

Unit system: SI

Parameter	Value	Unit
Gross calorific value, dry basis From a lab analysis of your fuel.	19,000	kJ/kg
Moisture as fired	50.000	%
Boiler efficiency (on GCV)	68.000	%
Steam pressure (absolute)	45.000	bar
Steam condition	Superheated at the temperature below	
Steam temperature (superheated only)	400.00	°C
Feedwater temperature	140.00	°C

Calculated results

Parameter	Value	Unit
Steam per kg of fuel	2.4716	kg/kg
Fuel per kg of steam	404.59	kg/t
Gross calorific value as fired	9,500.0	kJ/kg
Heat added per kg of steam	2,613.7	kJ/kg

Notes for this case

- Efficiency itself falls as moisture rises; use the efficiency for this moisture (indirect method) rather than a fixed figure.

Formula and method

$$GCV_{ar} = GCV_d\,(1 - M) \qquad SFR = \frac{\eta\, GCV_{ar}}{h_s - h_{fw}} \qquad \frac{1}{SFR}$$

Variables

GCV_d	gross calorific value, dry	J/kg
M	moisture as fired	–
η	boiler efficiency on GCV	–
p	steam pressure	Pa
state	saturated or superheated	–
T_s	steam temperature	K
T_{fw}	feedwater temperature	K
SFR	steam per kg of fuel	kg/kg
$1/SFR$	fuel per kg of steam	kg/kg
GCV_{ar}	GCV as fired	J/kg
$h_s - h_{fw}$	heat added per kg of steam	J/kg

Method and standards

As-fired GCV from the dry value and moisture; steam from the useful heat with FireCAD's IAPWS-IF97 enthalpies.

Assumptions and limits

- Ash in the dry GCV basis; efficiency entered for the actual moisture.
- The heat per kg of steam is from feedwater to steam only; blowdown is not added (put it in the efficiency).
- The steam pressure is absolute in every unit system: add the atmospheric pressure to a gauge reading.
- The steam temperature is used only when superheated steam is chosen.

References

• Input–output balance
• IAPWS R7-97 IF97

Report details

Report reference	FCC-TMES-XFBK (the same inputs always give the same reference)
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Calculator	Bagasse and Biomass Boiler Steam-to-Fuel Ratio
Method last reviewed	11 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/sugar-ethanol/steam-power/bagasse-boiler-steam-to-fuel

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.