Bagasse Boiler Efficiency and Steam per kg (Hugot)

Flue gas loss, heat to steam, efficiency on GCV and steam per kg of bagasse (Hugot eqns 41.48–41.51, IF97) from moisture, sugar and excess air.

Method: Hugot; Handbook of Cane Sugar Engineering; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Bagasse moisture	48.000	%
Sugar in bagasse	2.0000	%
Air factor	1.4000	
Flue gas temperature	200.00	°C
Product of combustion, radiation and heat-loss factors Hugot: α 0.975–0.98, β 0.97–0.995, η 0.96–0.99; his example $0.97^3 = 0.913$.	91.270	%
Steam pressure (absolute)	28.439	bar
Steam temperature	380.00	°C
Feed water temperature	90.000	°C

Calculated results

Parameter	Value	Unit
Net calorific value	7,946.5	kJ/kg
Gross calorific value 4600 − 12s − 46w	9,914.3	kJ/kg
Flue gas loss	1,215.5	kJ/kg
Heat to steam per kg bagasse	6,143.4	kJ/kg
Efficiency on GCV	61.965	%
Heat per kg of steam	2,809.6	kJ/kg
Steam per kg bagasse	2.1866	

Notes for this case

- Hugot's example: 48 % moisture, 2 % sugar, m = 1.4, gas at 200 °C and 0.97^3 give about 1 470 kcal/kg to steam and 2.19 kg of steam per kg bagasse at 28 kg/cm² g, 380 °C, feed 90 °C.

Formula and method

$$q = [(1-w)(1.4m - 0.13) + 0.5]t, \quad M_v = (4250 - 4850w - 1200s - q)\alpha\beta\eta \ [\text{kcal/kg}]$$

$$\rho = \frac{M_v}{4600 - 12s - 46w}, \quad \frac{S}{B} = \frac{M_v}{h_s - h_f}$$

Variables

w	Bagasse moisture	-
s	Sugar in bagasse	-
m	Air factor	-
t	Flue gas temperature	K
$\alpha\beta\eta$	Product of combustion, radiation and heat-loss factors	-
p_s	Steam pressure (absolute)	Pa
T_s	Steam temperature	K

t_f	Feed water temperature	K
N	Net calorific value	J/kg
G	Gross calorific value 4600 − 12s − 46w	J/kg
q	Flue gas loss	J/kg
M_v	Heat to steam per kg bagasse	J/kg
ρ	Efficiency on GCV	-
Δh	Heat per kg of steam	J/kg
S/B	Steam per kg bagasse	-

Method and standards

Hugot's indirect method with IF97 steam enthalpies (s, w in % in the GCV form).

Assumptions and limits

- Hugot's average bagasse composition; his GCV and NCV correlations ignore ash and suit normal cane bagasse (moisture about 40–55 %). The flue gas loss is referred to 0 °C as in Hugot.
- M_v uses the NCV, while the efficiency divides it by the GCV, as Hugot defines it.
- The steam must be superheated (or dry) and the feed water liquid; otherwise the page stops.

References

• Hugot
• Handbook of Cane Sugar Engineering
• 3rd ed. (Elsevier, 1986)
• ch. 41
• eqns 41.20
• 41.25 and 41.48–41.51 and Table 41.22
• pp. 913–916 and 932–935
• Steam and feed enthalpies from IAPWS-IF97

Report details

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Release checks	2 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-efficiency-hugot

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Reopens the calculator with the inputs of this report.