Effect of a Fuel's Heating Value on Fuel, Air and Flue Gas

Fuel burnt, combustion air and flue gas per unit of duty for an original and a new fuel of different heating value at the same efficiency and excess air (Ganapathy).

Method: Ganapathy; Steam Plant Calculations Manual; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Boiler duty	30.000	MW
Efficiency (HHV)	82.000	%
Fuel (Ganapathy Table 2.4: dry air per MMBtu fired, lb)	Natural gas (730)	
New fuel, if of another class (0 = same as the design fuel)	Same as the design fuel	
Excess air	25.000	%
Design fuel heating value	26.516	MJ/kg
New fuel heating value	22.795	MJ/kg

Calculated results

Parameter	Value	Unit
Design fuel burnt	4.9670	t/h
New fuel burnt	5.7780	t/h
Dry air, design fuel	51.669	t/h
Dry air, new fuel	51.669	t/h
Flue gas, design fuel	56.636	t/h
Flue gas, new fuel	57.447	t/h
Flue gas ratio	1.0143	

Notes for this case

- A poorer fuel raises the fuel and ash handled and the flue gas a little; check mills, feeders, ash systems and fouling, not only the fans.
- The same air per MMBtu is used for both fuels; for a change of fuel class choose the new fuel's class.

Formula and method

$$W_f = \frac{Q_{out}}{\eta\, HHV}, \quad W_a = \frac{Q_{out}}{\eta} A_{SI}(1 + EA), \quad W_g = W_a + W_f$$

Variables

Q_{out}	Boiler duty	W
η	Efficiency (HHV)	-
A	theoretical dry air per MMBtu fired, design fuel (Ganapathy Table 2.4)	lb/MMBtu
EA	Excess air	-
HHV_1	Design fuel heating value	J/kg
HHV_2	New fuel heating value	J/kg
W_{f1}	Design fuel burnt	kg/s
W_{f2}	New fuel burnt	kg/s
W_a	Dry air, design fuel	kg/s
A_2	air per MMBtu of the new fuel (0 = same as the design fuel)	lb/MMBtu

W_{a2}	Dry air, new fuel	kg/s
W_{g1}	Flue gas, design fuel	kg/s
W_{g2}	Flue gas, new fuel	kg/s
W_{g2}/W_{g1}	Flue gas ratio	-

Method and standards

Ganapathy's MMBtu method applied to two fuels.

Assumptions and limits

- Same efficiency and excess air.
- The whole fuel mass, ash included, is added to the flue gas, as in Ganapathy's method; for a high-ash fuel the gas is slightly overstated.
- For a change of fuel class, choose the new fuel's air per MMBtu; otherwise the same value is used for both.

References

- Ganapathy
- Steam Plant Calculations Manual
- 2nd ed. (Marcel Dekker, 1993)
- Q2.14 and Table 2.4

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/combustion/fuel-change-flue-gas-effect

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.