Combustion Air and Flue Gas without a Fuel Analysis

Dry and wet combustion air and flue gas mass flows from heat input, excess air and heating value by Ganapathy's MMBtu method (constant air per unit heat fired).

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

Input parameters

Unit system: SI

Parameter	Value	Unit
Heat input (HHV basis)	21.980	MW
Fuel (Ganapathy Table 2.4: dry air per MMBtu fired, lb)	Natural gas (730)	
Excess air	10.000	%
Fuel higher heating value	46.520	MJ/kg
Air humidity (kg water per kg dry air)	13.000	g/kg
Ash in the fuel, as fired (subtracted from the flue gas) Leave 0 for gas and oil. For solid fuels the ash leaves as solids, not gas.	0	%

Calculated results

Parameter	Value	Unit
Theoretical dry air per unit heat	313.84	kg/GJ
Dry combustion air	27.318	t/h
Wet combustion air	27.673	t/h
Fuel	1.7010	t/h
Flue gas (wet air + fuel)	29.374	t/h
Wet air per kg fuel	16.269	kg/kg

Formula and method

$$A_{SI} = A \text{ lb/MMBtu} \rightarrow \text{kg/J}, \quad W_a = Q\,A_{SI}(1+EA), \quad W_{aw} = W_a(1+\omega), \quad W_f = \frac{Q}{HHV}$$

$$W_g = W_{aw} + W_f(1-A_f), \quad \frac{W_{aw}}{W_f} = A_{SI}(1+EA)(1+\omega)\,HHV$$

Variables

Q	Heat input (HHV basis)	W
A	theoretical dry air per MMBtu fired for the fuel chosen (Ganapathy Table 2.4)	lb/MMBtu
A_f	ash in the fuel as fired	-
EA	Excess air	-
HHV	Fuel higher heating value	J/kg
ω	Air humidity (kg water per kg dry air)	kg/kg
A_{SI}	Theoretical dry air per unit heat	kg/J
W_a	Dry combustion air	kg/s
W_{aw}	Wet combustion air	kg/s
W_f	Fuel	kg/s
W_g	Flue gas (wet air + fuel less ash)	kg/s
W_{aw}/W_f	Wet air per kg fuel	kg/kg

Method and standards

Ganapathy's MMBtu method.

Assumptions and limits

- HHV basis. The ash entered is subtracted from the flue gas; leave it 0 for gas and oil.
- The HHV entered is not checked against the fuel class chosen for A; keep them consistent (a gas A with a coal HHV gives a wrong fuel flow).

References

- Ganapathy
- Steam Plant Calculations Manual
- 2nd ed. (Marcel Dekker, 1993)
- Q2.10 and Table 2.4 (combustion constant A)

Report details

Report reference	FCC-6K1C-Q2VV (the same inputs always give the same reference)
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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/boilers-power-plant/combustion/combustion-air-flue-gas-per-mmbtu

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.