Adiabatic Flame Temperature Calculator

Adiabatic flame temperature of coal, oil or biomass from its ultimate analysis, excess air, air preheat and calorific value, by a flue gas enthalpy balance (NIST).

Method: NIST Chemistry WebBook Shomate equations; Energy balance of combustion (no dissociation)

Input parameters

Unit system: SI

Parameter	Value	Unit
Carbon	45.000	%
Hydrogen	3.5000	%
Oxygen	5.0000	%
Nitrogen	1.0000	%
Sulphur	0.50000	%
Ash	35.000	%
Moisture	10.000	%
Excess air	20.000	%
Air humidity (kg water per kg dry air)	0.013000	kg/kg
Gross calorific value, as fired	18,600	kJ/kg
Combustion air temperature	30.000	°C

Calculated results

Parameter	Value	Unit
Adiabatic flame temperature	1,749.5	°C
Net calorific value used	17,592	kJ/kg
Wet flue gas per kg of fuel	8.1695	kg/kg

Notes for this case

- No dissociation: above about 1800 °C real flames are cooler because CO_2 and H_2O dissociate. Ash heat is neglected.

Formula and method

$$m_g\,[h_g(T_{ad}) - h_g(T_0)] = NCV + m_a\,[h_a(T_a) - h_a(T_0)] + m_w\,[h_v(T_a) - h_v(T_0)], \quad T_0 = 25\ ^\circ\mathrm{C}$$

$$NCV = GCV - h_{fg,25}\left(\frac{M_{H_2O}}{M_{H_2}}\,H + M\right)$$

Variables

C, H, O, N, S, A, M	ultimate analysis as fired	–
EA	excess air	–
ω	air humidity	kg/kg
GCV	gross calorific value	J/kg
T_a	air temperature	K
T_{ad}	adiabatic flame temperature	K
NCV	net calorific value	J/kg
m_g	wet flue gas per kg fuel	kg/kg
m_a	dry air per kg fuel	kg/kg

m_w	air moisture per kg fuel	kg/kg
h_g, h_a, h_v	enthalpies of flue gas, dry air and vapour (Shomate)	J/kg
T_0	reference temperature	K
$h_{fg,25}$	latent heat of water at 25 °C (IF97)	J/kg
M_{H_2O}, M_{H_2}	molar masses of water and hydrogen (ratio about 8.94)	kg/kmol

Method and standards

Exact-ratio combustion balance and NIST Shomate enthalpies of the products and air; fuel enters at 25 °C; NCV from GCV with the IF97 latent heat at 25 °C; solved for the temperature where products hold all the heat.

Assumptions and limits

- Complete combustion, no dissociation, no heat loss; ash heat neglected.

References

- NIST Chemistry WebBook Shomate equations
- Energy balance of combustion (no dissociation)

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/adiabatic-flame-temperature

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.