Combustion Temperature without a Fuel Analysis

Adiabatic combustion temperature from LHV, HHV, excess air, air preheat and ash by Ganapathy's MMBtu energy balance, with a dissociation allowance.

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

Input parameters

Unit system: SI

Parameter	Value	Unit
Lower heating value	39.542	MJ/kg
Higher heating value	41.868	MJ/kg
Fuel (Ganapathy Table 2.4: dry air per MMBtu fired, lb)	Natural gas (730)	
Excess air	15.000	%
Combustion air temperature	148.89	°C
Reference (ambient) temperature	26.670	°C
Ash in the fuel	0	%
Air specific heat	1.0468	kJ/(kg·K)
Mean specific heat of the products	1.3398	kJ/(kg·K)
Allowance for dissociation and radiation	4.0000	%

Calculated results

Parameter	Value	Unit
Temperature rise of the products	1,921.4	K
Adiabatic combustion temperature	1,948.1	°C
Estimated actual combustion temperature	1,871.2	°C

Formula and method

$$\Delta t_c = \frac{LHV + A\alpha\, HHV c_{pa}(t_a - t_{ref})}{(1 - a + A\alpha\, HHV)\, c_{pg}}, \quad \alpha = 1 + EA$$

$$t_c = t_{ref} + \Delta t_c, \quad t_c{}' = t_{ref} + \Delta t_c\,(1 - \delta)$$

Variables

LHV	Lower heating value	J/kg
HHV	Higher heating value	J/kg
A	theoretical dry air per MMBtu fired for the fuel chosen (Ganapathy Table 2.4)	lb/MMBtu
EA	Excess air	-
t_a	Combustion air temperature	K
t_{ref}	Reference (ambient) temperature	K
a	Ash in the fuel	-
c_{pa}	Air specific heat	J/(kg·K)
c_{pg}	Mean specific heat of the products	J/(kg·K)
δ	Allowance for dissociation and radiation	-
Δt_c	Temperature rise of the products	K
t_c	Adiabatic combustion temperature	K
$t_c{}'$	Estimated actual combustion temperature	K

Method and standards

Ganapathy's Eq. (11), written as a rise above the reference temperature.

Assumptions and limits

- Mean product specific heat constant.
- Fuel sensible heat, air humidity and the sensible heat carried away by ash are neglected.
- The LHV must not exceed the HHV.

References

- Ganapathy
- Steam Plant Calculations Manual
- 2nd ed. (Marcel Dekker, 1993)
- Q2.15
- Eq. (11)
- and Table 2.4

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/boilers-power-plant/combustion/combustion-temperature-mmbtu-method

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Reopens the calculator with the inputs of this report.