

This document shows how **Thermo Utilities, MS Excel Add-ins** can be used for calculation of combustion.

A fossil fuel with the following composition by mass:

C 70%; H 18.5%; O 3%; N 4%; S 1.5%; ash 3%

has been burned in a boiler, when 100% excess air is supplied.

Combustion efficiency is 0.75 Calculate:

- 1- the stoichiometric air-to-fuel (A/F) ratio
- 2- the A/F ratio
- 3- analysis of combustion products (dry and wet)
- 4- temperature of exhaust gases

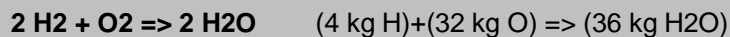
Air is supplied at atmospheric pressure and 18 C with 0.008 specific humidity. The fuel has an average temperature of 35 C when enters the boiler. Use Dulong formula to estimate the net calorific value of the fuel. The specific heat capacity of fuel is 3.2 kJ/kg.K.

Combustion Equations

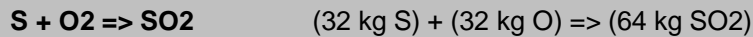
Combustion equation for coal:



Combustion equation for hydrogen:



Combustion equation for sulphur:



Fuel Analysis			
Constituent	Mass fraction	Required oxygen kg/kg fuel	Product mass kg/kg fuel
Carbon	0.700	1.867	2.567
Hydrogen	0.185	1.480	1.665
Oxygen	0.030	-0.020	0.010
Nitrogen	0.040	0.000	0.040
Sulphur	0.015	0.015	0.030
Ash	0.030	0.000	0.030
	1.000	3.342	4.342
Analysis of Supplied Air			
Specific Humidity	0.008		
Composition by mass			
Constituent	Dry Air	Humid Air	
N ₂	0.76280	0.75670	
O ₂	0.23290	0.23104	
CO ₂	0.00300	0.00298	
Ar	0.00130	0.00129	
H ₂ O	0.00000	0.00800	
SO ₂	0.00000	0.00000	
	1.00000	1.00000	

Combustion of fossil fuels.XLS

Air required per kg of fuel	14.46	Stoichiometric A/F ratio	kg/kg
Excess Air	1		
Actual A/F ratio kg/kg	28.92757		
Exhaust Gases		Wet Mass	Dry Mass
Constituent	Mass	Composition	Composition
N2	21.92942	0.73373	0.78344
O2	3.34167	0.11181	0.11938
CO2	2.65276	0.08876	0.09477
Ar	0.03730	0.00125	0.00133
H2O	1.89642	0.06345	0.00000
SO2	0.03000	0.00100	0.00107
	29.88757	1.00000	1.00000
Exhaust Gases			Volume
Constituent	Kg/kmol	Mole Fraction	Composition
N2	28	0.02620	0.74260
O2	32	0.00349	0.09901
CO2	44	0.00202	0.05716
Ar	40	0.00003	0.00088
H2O	18	0.00353	0.09990
SO2	64	0.00002	0.00044
		0.03529	1.00000
Mass balance			
Fuel	1.00000		
Supplied Air	28.92757		
	29.92757		
Exhaust Gases	29.88757		
Ash	0.03000		
	29.91757		
<p>Dulong suggests the following formula for gross calorific value (GCV) of fossil fuels when oxygen content is less than 10%</p> <p>GCV = 337 C + 1442 (H - O/8) + 93 S</p> <p>GCV is in (kJ/kg). C, H, O, S are percentages on weight basis for carbon, hydrogen, oxygen and sulphur. The net calorific value for a constant pressure combustion is:</p> <p>NCV = GCV - mc * hfg</p> <p>mc is the mass of condensate per unit quantity of fuel and hfg is the latent heat of steam at 25 degree Celsius which is 2442 kJ/kg.</p>			
Supplied Air Temp.	18		
Fuel Cp	3.2	kJ/(kg.K)	
Gross Calorific Value, GCV	49866	kJ/kg	
Net Calorific Value, NCV	49711	kJ/kg	
Combustion efficiency	0.75		
	Enthalpy	Mass Flow	m*h
	kJ/kg	kg/s	kJ/s

Combustion of fossil fuels.XLS

Supplied Air	38.31	28.93	1108.10
Fuel	64.00	1.00	64.00
Fuel Energy Supplied	49710.80	1.00	37283.10
			38455.21
Exhaust Gases	1284.94	29.93	38455.21
Exhaust Gases Temp	964.	C	
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