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:

$C + O_2 \Rightarrow CO_2$ (12 kg C)+(32 kg O) => (34 kg CO_2)

Combustion equation for hydrogen:

$2 H_2 + O_2 \Rightarrow 2 H_2O$ (4 kg H)+(32 kg O) => (36 kg H_2O)

Combustion equation for sulphur:

$S + O_2 \Rightarrow SO_2$ (32 kg S) + (32 kg O) => (64 kg SO_2)

Fuel Analysis			
Constituent	**Mass fraction**	**Required oxygen**	**Product mass**
		kg/kg fuel	**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**
N2	0.76280	0.75670
O2	0.23290	0.23104
CO2	0.00300	0.00298
Ar	0.00130	0.00129
H2O	0.00000	0.00800
SO2	0.00000	0.00000
	1.00000	**1.00000**

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		

Dulong suggests the following formula for gross calorific value (GCV) of fossil fuels when oxygen content is less than 10%

GCV = 337 C +1442 (H - O/8) + 93 S

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:

NCV = GCV - mc * hfg

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.

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**

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**	

Taftan Data
Email: support@taftan.com

If you want to know more about "Taftan Data" or other software developed by this company please visit our website:

http://www.taftan.com