This document shows how Thermo Utilities, MS Excel Add-ins can be used for calculation of combustion.
A biomass fuel with the following composition by mass:

C 54%; H 22%; O 12%; N 4%; S 1.3%; ash 6.7%
C1, percentage carbon on the dry ash-free basis 17%
has been burned in a boiler, when 150% 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 Vondracek 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	0.540	1.440	1.980
Hydrogen	0.220	1.760	1.980
Oxygen	0.120	-0.020	0.100
Nitrogen	0.040	0.000	0.040
Sulphur	0.013	0.013	0.026
Ash	0.067	0.000	0.067
	1.000	3.193	4.193
Carbon on dry ash-free basi	0.170		

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_2O	0.00000	0.00800
SO_2	0.00000	0.00000

	1.00000	**1.00000**	
Air required per kg of fuel	13.82	Stoichiometric A/F ratio	kg/kg
Excess Air	1.5		
Actual A/F ratio kg/kg	34.55077		
Exhaust Gases		**Wet Mass**	**Dry Mass**
Constituent	**Mass**	**Composition**	**Composition**
N2	26.18449	0.74001	0.79042
O2	4.78950	0.13536	0.14458
CO2	2.08282	0.05886	0.06287
Ar	0.04456	0.00126	0.00135
H2O	2.25641	0.06377	0.00000
SO2	0.02600	0.00073	0.00078
	35.38377	**1.00000**	**1.00000**
Exhaust Gases			**Volume**
Constituent	**Kg/kmol**	**Mole Fraction**	**Composition**
N2	28	0.02643	0.74275
O2	32	0.00423	0.11888
CO2	44	0.00134	0.03760
Ar	40	0.00003	0.00088
H2O	18	0.00354	0.09956
SO2	64	0.00001	0.00032
		0.03558	1.00000
Mass balance			
Fuel	1.00000		
Supplied Air	34.55077		
	35.55077		
Exhaust Gases	35.38377		
Ash	0.06700		
	35.45077		

Vondracek suggests the following formula for gross calorific value (GCV) of fossil fuels when oxygen content exceeds 10%

GCV = (337 -0.261 C1) C +1130 (H - O/10) + 105 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	41836	**kJ/kg**	
Net Calorific Value, NCV	41680	**kJ/kg**	
Combustion efficiency	0.75		
	Enthalpy	**Mass Flow**	**m*h**

	kJ/kg	kg/s	kJ/s
Supplied Air	38.31	34.55	1323.51
Fuel	64.00	1.00	64.00
Fuel Energy Supplied	41680.38	1.00	31260.28
			32647.79
Exhaust Gases	918.34	35.55	32647.79
Exhaust Gases Temp	671.	**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