

Combustion of biomass fuel

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

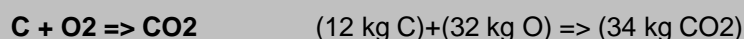
3- analysis of combustion products (dry and wet)

4- temperature of exhaust gases

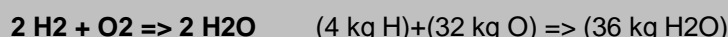
Air is supplied at atmospheric pressure and 18 C with 0.008 specific humidity. The fuel has an average temperature of 35 C when enters the boiler. Use Vondracek formula to estimate the net calorific value of the fuel. The specific heat capacity of fuel is 3.2 kJ/kg.K.

Combustion Equations

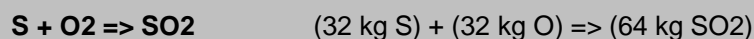
Combustion equation for coal:



Combustion equation for hydrogen:



Combustion equation for sulphur:



Fuel Analysis			
Constituent	Mass fraction	Required oxygen kg/kg fuel	Product mass kg/kg fuel
Carbon	0.540	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 basis	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 ₂ O	0.00000	0.00800	
SO ₂	0.00000	0.00000	

Combustion of biomass fuel

	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		
<p>Vondracek suggests the following formula for gross calorific value (GCV) of fossil fuels when oxygen content exceeds 10%</p> $\text{GCV} = (337 - 0.261 \text{ C1}) \text{ C} + 1130 (\text{H} - \text{O}/10) + 105 \text{ S}$ <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> $\text{NCV} = \text{GCV} - mc * hfg$ <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	41836	kJ/kg	
Net Calorific Value, NCV	41680	kJ/kg	
Combustion efficiency	0.75		
	Enthalpy	Mass Flow	m*h

Combustion of biomass fuel

	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			