Analyse Boiler Operation & Suggest an Eco-Friendly Fuel Solution for Boiler

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Abstract— Generally, coal is used largely as a fuel in boilers. Coal burning emissions containing Sulphur combines with air to create the poisonous gas Sulphur oxide. When this gas releases into the atmosphere, it causes polluting rain. Extracting coal from mines further damages soil and water resources, adding to the disadvantages of using coal burning boilers. Also coal is a costly fuel for local users such as in hotels in small towns, in villages, etc. They use wood as a fuel but that too is a very damaging factor for environment Also the transportation of wood is costly as well as a tedious process as it is a bulky fuel. This also makes the handling and storage difficult. Also the ash content is high and this also creates a disposal problem. Our main objective is to suggest cheaper water heating by studying various bio fuels and try to make it available on a local level mainly for the small hotels which use boilers in local industries.

Key words: Boiler, GCV (Gross Calorific Value), Fossil Fuels, Bio-Fuels, Briquettes, Pallets, Acacia Wood, Groundnut Shell, Efficiency, Eco-Friendly, Briquetting, Heat recovery steam generators, Coal

I. INTRODUCTION

It cannot be denied that coal leaves behind harmful byproducts upon combustion. These byproducts cause a lot of pollution and contribute to global warming. The increased carbon emissions brought about by coal fired plants has led to further global warming which results in climate changes.

As we saw further that by using Fossil fuel, a tremendous toxic gas is released in the atmosphere and damages it. So, to reduce these toxic gases and to prevent pollution a new type of fuel should be introduced that may not release the gases that contains high amount of carbon content. For example, fuel made up of agricultural waste such as Groundnut shell, Bagasse's etc. This fuel is known as Bio-Fuels.

Here we analyze different types of fuels made by agricultural wastes and take reading after combustion. Moreover we are going to discuss how we can make these types of fuel for boiler used in small industries and factories.

II. PROBLEMS ARISE BY THE USE OF COAL\

A. Greenhouse Gas Emissions

It cannot be denied that coal leaves behind harmful byproducts upon combustion. These byproducts cause a lot of pollution and contribute to global warming. The increased carbon emissions brought about by coal fired plants has led to further global warming which results in climate changes.

B. Mining Destruction

Mining of coal not only results in the destruction of habitat and scenery, but it also displaces humans as well. In many countries where coal is actively mined, many people are displaced in huge numbers due to the pitting of the earth brought about by underground mining. Places near coal mines are unsafe for human habitation as the land could cave in at any time.

C. Generation of Millions of Tons of Waste

Millions of tons of waste products which can no longer be reused are generated from coal fired plants. Aside from the fact that these waste products contribute to waste disposal problems, these also contain harmful substances.

III. PROBLEMS ARISING BY THE USE OF WOOD

You hear a lot about carbon footprint these days, meaning how much carbon a given activity adds or subtracts from the atmosphere. Wood burning creates more atmospheric CO_2 than biodegradation of wood in a forest. Inefficient and incomplete combustion of wood can result in elevated levels of greenhouse gases other than CO_2, which may result in positive emissions where the byproducts have greater Carbon dioxide equivalent values.

IV. PROBLEM DEFINITION

A. Problem: Harmful Toxic Gases Released by the Boiler in the Atmosphere when Fossil fuels are used. (I.e. Air pollution):

A flue-gas emission from fossil-fuel combustion in the boiler refers to the combustion-product gas resulting from the burning of fossil fuels. Most fossil fuels are combusted with ambient air (as differentiated from combustion with pure oxygen). Since ambient air contains about 79 volume percent gaseous nitrogen (N_2) which is essentially non-combustible, the largest part of the flue gas from most fossil-fuel combustion is uncombusted nitrogen. Carbon dioxide (CO_2), the next largest part of flue gas, can be as much as 10−25 volume percent or more of the flue gas. This is closely followed in volume by water vapor (H_2O) created by the combustion of the hydrogen in the fuel with atmospheric oxygen. Much of the 'smoke' seen pouring from flue gas stacks is this water vapor forming a cloud as it contacts cool air.

A typical flue gas from the combustion of fossil fuels contains very small amounts of nitrogen oxides (NOx), sulfur dioxide (SO_2) and particulate matter. The nitrogen oxides are derived from the nitrogen in the ambient air as well as from any nitrogen-containing compounds in the fossil fuel. The sulfur dioxide is derived

from any sulfur-containing compounds in the fuels. The particulate matter is composed of very small particles of solid materials and very small liquid droplets which give flue gases their smoky appearance.

Following are the various steps to analyze and examine the above given problem:

Fossil fuels are hydrocarbons, primarily coal, fuel oil or natural gas, formed from the remains of dead plants and animals.

V. VARIOUS FUELS THAT ARE USED IN THE INDUSTRY

A. The Constituents of Wood & its Proportions are as follows

Elements	Obtain value in%
Moisture	12.85
Ash Content	1.94
Volatile Matter	70.32
Fixed Carbon	14.39
Gross Calorific Value	3990 Cal/gm Approx.

Table 1:

B. The Constituents of Coal & its Proportions are as follows:

Elements	Obtain value in%
Moisture	9.43
Ash Content	13.99
Volatile Matter	29.79
Fixed Carbon	46.79
Gross Calorific Value	4300 Cal/gm Approx.

Table 2:

C. The Constituents of Bio-Coal (Company Briquette) & it's Proportions are as Follows

Elements	Obtain value in%
Moisture	9.68
Ash Content	9.39
Volatile Matter	66.27
Fixed Carbon	18.46
Gross Calorific Value	4150 Cal/gm Approx.

Table 3:

Fig. 1: Briquette

D. Calculation of Various Gases Released by boiler in atmosphere as per fuel used i.e. Fossil fuels. Burning a kilogram (2.2lbs) of wood

Whenever fossil fuels or any fuels are burnt it releases toxic gases such as Carbon monoxide, Hydrocarbons, Fine particulates etc.

So in order to lower down this toxic gases or the carbon content of released gases we have to measure the emission of gases from the boiler.

Various gases released by boiler in atmosphere and its proportion are as follows:

Constituents	Proportions
Carbon Monoxide	130 grams
Hydrocarbons	51 grams
Fine Particulates	21 grams
Poly Cyclic Organic Hydrocarbons	0 grams

Table 4: (WOOD)

Constituents	Proportions
Carbon Monoxide	148 grams
Hydrocarbons	89 grams
Fine Particulates	35 grams
Poly Cyclic Organic Hydrocarbons	grams

Table 5: (COAL)

Constituents	Proportions
Carbon Monoxide	103 grams
Hydrocarbons	70 grams
Fine Particulates	26 grams
Poly Cyclic Organic Hydrocarbons	grams

Table 6: (BIO-FUEL)

E. Comparison of Three Fuels

Sr No.	Description		Boiler		
			Wood	Indian Coal	Bio coal
1	Boiler Efficiency	%	72±	78±	78±
2	Fuel Calorific Value	kcal/kg	3990	4300	4150
3	Fuel Consumption	kg/hr	599	1372	1625
4	Fuel Cost	Rs/kg	10	17	7
5	Ash Generated	kg/hr	190	137	163
6	Power Consumption for utilities	kW	300	300	300
7	Rate of Power	Rs/unit	7	7	7
8	Labor for fuel feeding per hour	Nos.	4	4	4
9	Man hour rate of labor	Rs/hr	25	25	25

Table 7

VI. SOLUTION-HOW TO MAKE ACACIA WOOD BRIQUETTES

Introducing new types of fuels i.e. Bio-fuels, to provide more efficient Eco-friendly solutions:
Acacia commonly known as mimosa, thorn tree or wattle, is a wide-ranging genus grow in open, tropical to subtropical areas. It is widely develops in Australia, Indonesia, Malaysia and Vietnam. Acacia wood is usually used for making furniture or other purposes in these places; however the acacia sawdust can be used to make acacia wood briquettes.

As to wood briquettes making, building and labor requirements are relatively low, the important element for acacia wood briquettes making is to choose the right equipment and capacity. Our company's pellet production equipment and technology is advanced and cost effective. It is specially suitable for farms, agro-products processing industry, such as rice industry, sawdust, oil palm mill, wood processing factory, etc. Acacia wood briquettes production line mainly includes wood crusher, drying machine, acacia pellet mill, acacia cooling equipment and packing machine.

Fig. 1: ACACIA WOOD

A. Crushing

Acacia needs to be crushed by crushing machine before drying process. The crusher is equipped with cutters and rotors to grind acacia. Acacia crusher is featured by stable performance and high working efficiency. Hammer mill is required to crush acacia into small particle sizes if the acacia do not reach the required size after crushing.

B. Drying

In order to get high density acacia wood briquettes, the moisture content of raw material should be contained at 8-12%. Moisture content of your raw material is very significant for the overall content of final briquettes. Sawdust dryer can reduce moisture content level to your desired standard by blowing hot air over or through the acacia.

C. Briquetting

Wood pellet mill is adopted in this process to compress acacia into biomass briquettes. It has wide application, such as sawdust, forest understory, crop straw, agricultural residues, etc. Under high temperature and pressure condition, acacia can be squeezed into briquettes.

D. Cooling

Acacia wood briquettes have high temperature and moisture content when they discharged from the pellet making machine, therefore cooling and drying is very necessary before they are ready for use and packing. With our specially modified cooling equipment, heat and moisture are removed; the final moisture content of acacia should not be higher than 8%.

E. Packing

The last step for briquettes making goes for packing. After packing acacia wood briquettes would become easy to store and transport. In order to avoid deterioration, briquettes should be kept in dry places.

VII. WHY ACACIA WOOD?

Compared with wood chips, cord wood and sawdust; wood briquettes are an efficient source of heat which can offer better heating properties per unit volume for their low levels of moisture content and ash. In fact all of the feedbacks are burned and converted to heat.

As an unlimited fuel source, wood briquettes are a biomass product made of wood wastes, logs, sawdust, etc. It can realize locally produced due to its wide application. It can not only provide new ways to efficiently use raw material, but also increase overall profit.

After packing, wood briquettes will become very easy to store and transport. Briquettes in bags can pour directly into the stove hopper.

Fig. 2: ACACIA Wood Briquette

VIII. DATA TAKEN AFTER COMBUSTION OF ACACIA WOOD

The constituents of Briquette (Acacia Wood) and its proportions are as follows: (Briquettes that are suggested by students). (Readings are obtained by LAB TEST).

Sr. No.	Element	Proportion
1	Moisture	1.87
2	Ash Content	0.35
3	Volatile Matter	86.28
4	Fixed Carbon	11.3
5	Gross Calorific Value	4385 Cal/gm Approx.

Table 8:

Various gases released by boiler in atmosphere and its proportion are as follows. (When Acacia wood is used):

Constituents	Proportions
Carbon Monoxide	96 grams
Hydrocarbons	55 grams
Fine Particulates	20 grams
Poly Cyclic Organic Hydrocarbons	grams

Table 9:

IX. PEANUT SKIN OR GROUNDNUT SHELL

Buy Any Agricultural or farming residues like groundnut shell, corn hub, coconut shell, coffee waste, tea waste, wood waste etc. and store it in a shed where it can be away from rain, moisture etc.

Bio waste must be between 20–25mm in size so cut it using biomass cutting machine like Crusher machine also known as crushing machine or shredding machine. Crusher machine cut bio waste of size up to 3'' diameter to 10mm size and it gives 2 to 2.5 Ton/hr production.

Moisture level in bio waste must be between 8–12% and if it is not then Biomass Turbo Dryer is used to remove moisture from Bio waste. Biomass Turbo Dryer Machine's Evaporation capacity is 450 kg/hr and its remove up to 35% moisture contain to 15%.

Bio waste with 20–25mm and moisture contain between 8–12% is used for Briquetting process using biomass Briquetting machinery. Briquetting machinery is available in different model. Briquetting model available are Jumbo 90, Supreme 75 and Super 65. Briquettes produce by this model is also different in size. Briquetting machinery doesn't need any type of binder to join Bio waste into rock-solid coal briquettes. So, Briquetting process is also known as binder less technology.

So, this is few steps to produce bio coal briquettes and it's very easily operating system. Bio coal briquettes are best bio fuel and as all biofuel it's not producing pollution and it's totally Eco-friendly and environment friendly fuel.

Fig. 3: Pallets made up of Groundnut Shells

A. Data taken from Groundnut Shell Lab test

Sr. No.	Element	Proportion
1	Moisture	6.56
2	Ash Content	2.27
3	Volatile Matter	76.55
4	Fixed Carbon	14.42
5	Gross Calorific Value	4530 Cal/gm Approx.

Table 10:

Constituents	Proportions
Carbon Monoxide	100 grams
Hydrocarbons	61 grams
Fine Particulates	25 grams
Poly Cyclic Organic Hydrocarbons	grams

Table 11:

X. COMPARISON & RESULT

Following graph shows the Efficiency, Fuel Cost and Ash Generated by all the types of fuels:

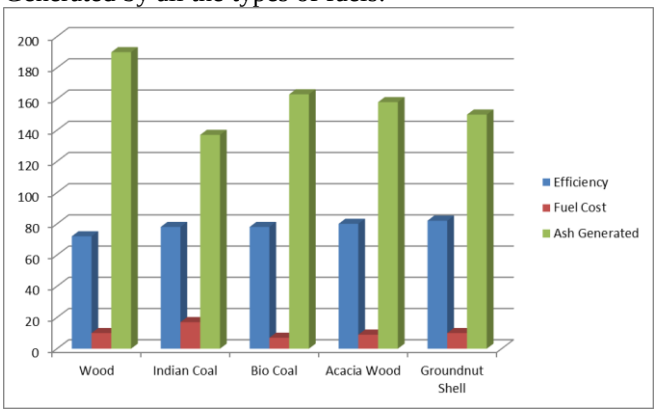

Fig. 4: Graph Shows The Efficiency, Fuel Cost & Ash Generated By All The Types of Fuels.

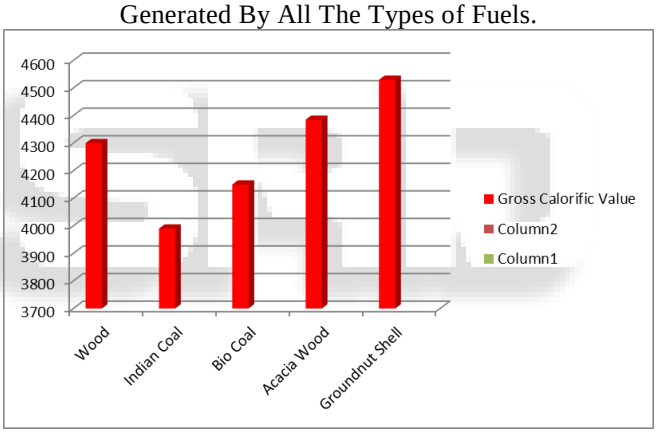

Fig. 5: Graph Shows the GCV (Gross Calorific Value) of All the Types of Fuels

Sr No.	Description		W	IC	BC	AW	GS
1	Boiler efficiency	%	72±	78±	78±	78 to 80±	80 to 82±
2	Fuel Calorific Value	Kcal/kg	3990	4300	4150	4385	4530
3	Fuel Consumption	Kg/hr	599	1372	1625	1538	1493
4	Fuel Cost	Rs/kg	10	17	7	8 to 9	10
5	Ash Generated	Kg/hr	190	137	163	158	150
6	Power Consumption for utilities	kW	300	300	300	300	300

7	Rate of Power	Rs/unit	7	7	7	7	7
8	Labor for fuel feeding per hour	Nos.	4	4	4	4	4
9	Man hour rate of labor	Rs/hr	25	25	25	25	25
10	Steam Enthalpy at 10 kg/cm^2 pressure	Kcal/hr	663	663	663	694	721

Table 12: Comparison of all Fuels

Where,

- W-Wood
- IC-Indian Coal
- BC-Bio Coal
- AW- Acacia Wood (Briquette)
- GS-Groundnut Shell (Briquette)

XI. CONCLUSION

As we saw further that by using Fossil fuel, a tremendous toxic gas is released in the atmosphere and damages it. So to reduce these toxic gases and to prevent pollution a new type of fuel should be introduced that may not release the gases that contains high amount of carbon content. For example fuel made up of agricultural waste such as Groundnut shell, Bagasse's etc. This fuel is known as Bio-Fuels. Biomass briquettes are a bio-fuel substitute to coal and charcoal.

So, by comparing various fuels with each other we can conclude that the Bio-Fuels such as briquettes and pallets can be used instead of fossil-fuels

1) To reduce the pollution,
2) To increase the efficiency of the internal parts of the boiler,
3) To reduce fuel cost,
4) To increase Fuel Calorific Value,
5) To utilize the waste to prepare bio-fuels,
6) To give Eco-friendly solution.

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