Preparation and Characterization of Bio Fuel from Industrial Waste

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Abstract

Disposal of biomass becomes often an environmental issue. A novel method has been developed to convert biomass into solid bio-fuel. Experiments were carried out on preparation of solid fuel pellet from industrial biomass wastes. A maximum calorific value of 22,593KJ/kg has been obtained for the bio-fuel prepared in the present investigation and compared with the fossil fuel coal. The bio-fuel pellets were burnt and the emitted green house gases were critically analyzed.

Keywords: Bio-fuel, Solid waste, Coir pith, Sawdust, Colorific value

1. Introduction

Biomass can be converted into fuels through physical, chemical and biological conversion processes. Basically, the biomass has low energy, less density, bulking occupy large volume of space and difficult in transportation. Conversion biomass into fuel transforms the waste into a carbonaceous material, which may be a substitute for the conventional/fossil fuel. In fact the bio energy meets 14% of the total energy demand and the percentage will go up in the future. The biomass absorbs and emits carbon dioxide during growth combustion respectively and no contribution to the greenhouse effect. Some of the current biomass technologies are: gasification, pyrolysis, supercritical fluid extractions, liquefaction hydrolysis, biological conversion, conversion of biomass to a pyrolytic oil fuel (Olsson *et al*., 1996; Alejandro *et al*., 2007).

In recent year there has been increased interest among the researchers/industries to convert the industrial solid waste for effective utilization. Wood saw dust, sugar cane bagasse and leather waste are some of the biomass available in large quantities which are bulky and heterogeneous in nature. Several authors have attempted to convert the biomass into solid-fuel pellet for effective utilization. Among the biomass resources, the wood pellets become gained attraction for power generation and residential application. Conversion of wood waste into solid biomass fuel will have both

economic and environmental advantages (Palchonok *et al.,* 2002). Olsson *et al.,* (2007) analyzed the emissions from wood pellets from various sources and reported large differences in the emissions from pellets from different manufacturers. The other contributors on wood biomass are due to Ndiema *et. al.,* (1998); Maria *et al.,* (2003); Catharina *et al.,* (2006); Fabienna *et.al.,* (2006). The objective of the present investigation is to convert biomass waste from coir pith and saw industries into potential solid bio-fuel and analyze their characteristics.

2. Experimental

Experiments were carried out on fuel pellet preparation from industrial waste under various compositions. Raw material such as sawdust of *Tectona grandis, Pterocarpus indicus* and coir pith were collected from nearby industries. The cleaned raw materials were kept in an over at 110°C for overnight to remove the free moisture and then subjected for solar drying. Solid particles of 1.5mm were sieved from the powdered waste for the pellet preparation. The moisture content and calorific value of the processed raw materials were estimated. Neem gum was used as an additive for pellet preparation. The Table 1 shows the combinations raw materials chosen for pellet preparation. The samples were blended well in mortar and pestle then passed through a die. A high pressure of 10,000N/cm² was applied using mechanical press. The pellets obtained were again heated at 120°C for one hour to remove lignin and cellulose materials. The prepared pellets were subjected for calorific value, ash content and density. Approximately 10grams of sample was burned and the gas emitted during burning analyzed for green house gases and VOC.

3. Results and discussion

Table 2 gives the moisture content of raw material before and after the processing. It can be noticed from the table that the moisture content of the raw materials were decreased during the processing. This can be due to the fact that the raw materials tried to adjust with the relative humidity of its surroundings. A reduction in moisture content increases the mechanical strength of the raw materials and promotes hydrogen bridge cross-bonding between adjacent cellulose chains in regions of low spatial order which are primarily responsible for stiffness and rigidity.

The Table 3 shows the physical characteristic of solid pellets prepared in the present investigations. It can be noticed that the calorific values were increased from the raw material due to mechanical processing. Noticed that a maximum of 22593KJKg^{-1} with 27% increment for the mixing ratio of 1:1:1:3. It can be noticed further that the material density increased during processing. The analysis of gas emitted from the pellet combustion is presented in Table 4. It can be ascertained that the gases released during gasification match with fossil fuel.

4. Conclusion

Biomass has lower heating value than fossil fuel due to higher moisture content and high oxygen content. Experiments were carried out on preparation of solid fuel pellet from various biomass wastes such as coir pith and sawdust. The colorific values of the developed solid bio-fuel pellets have been estimated and compared with fossil fuel. It has been observed that the solid bio-fuel pellet prepared in the present investigation showed good calorific values. A maximum calorific value of 22,593KJ/kg has been obtained.

References

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Table 1. Combination of raw material and additives and their mixing ratio

Sample/ Combinations	Raw material			Additive	Mixing ratio
	Tectona grandis saw	*Pterocarpus indicus* saw	coir pith	Neem gum	
Sample 1	√			√	1:3
Sample 2		√		√	1:3
Sample 3	√	√		√	1:1:3
Sample 4			√	√	1:3
Sample 5	√		√	√	1:3
Sample 6		√	√	√	1:1:3
Sample 7	√	√	√	√	1:1:1:3

Table 2. Moisture content of raw material before and after seasoning

Sl.No	Raw material	Moisture content (%)	
		Before seasoning	After seasoning
1	Tectona grandis	11	6
2	Pterocarpus indicus	12	7
3	Coir pith	20	11

Table 3. Characteristics of Solid pellet prepared at various combinations

Sample	Raw Material		Pellet			% increase	
	ρ_r gcc^{-1}	CV (KJKg^{-1})	ρ_P gcc^{-1}	CV (KJKg^{-1})	% ash content	ρ	CV
Sample I	0.22	13045	0.8	14697	1.5	72.5	11.2
Sample II	0.25	14500	0.87	16047	1.5	71.2	9.6
Sample III	0.27	14183	1.09	18046	1.2	75.3	21
Sample IV	023	15500	0.87	18061	4	73.56	14.18
Sample V	0.26	15887	0.84	18893	2.1	69	15.91
Sample VI	0.27	16167	0.97	19061	1.8	72.16	15.18
Sample VII	0.29	16500	1.3	22593	1.6	77.69	26.96

Table 4. Emission analysis of solid pellets during gasification

Sample/Gases		CO	CO_2	NO_2	SO_2	VOC	Trace gases
Sample I	Raw	0.54	98	0.19	0.04	0.43	0.1
	pellet	0.53	52.2	0.1	0.004	0.21	0.06
Sample II	Raw	0.46	98.36	0.23	0.07	0.12	0.16
	pellet	0.23	53.88	0.13	0.009	0.09	0.11
Sample III	Raw	0.62	98.51	0.23	0.06	0.41	0.15
	pellet	0.41	42.96	0.09	0.004	0.2	0.08
Sample IV	Raw	1.27	97.5	0.29	0.12	0.59	0.2
	pellet	1.2	53	0.23	0.09	0.29	0.14
Sample VII	Raw	1.02	98	0.2	0.1	0.4	0.16
	pellet	0.4	39.79	0.14	0.06	0.2	0.1