COMPARISON STUDY ON FUEL BRIQUETTES MADE OF ECO-FRIENDLY MATERIALS FOR ALTERNATE SOURCE OF ENERGY

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Abstract. The access to energy is necessary to sustain human life and to achieve overall economic, social and environmental aspects of human development. Always there is a shortage of energy and hence there is constant need to search for alternative form of energy, which is new and totally different form from conventional traditional fuel types. The worldwide continued utilization of fossil fuels has in turn increased the environmental pollution which has become a threat to human kind. For the production of energy the biomass of plants can be used as an alternative source. There is a lot of demand for energy since many years and the biodegradable briquettes are frequently used as an alternate source of energy for small industries and domestic cooking applications. Normally for producing briquettes we follow a process called densification where the waste biomass is densified. This work is a step to deal with energy crisis and effective utilization of agricultural wastes. In this study manual densification of rice husk, saw dust, and coconut shell powder were tested with three different binding agents; dry cow dung, wheat flour, and paper pulp. Briquettes are made using different biodegradable materials and tests were conducted to compare the calorific value of the briquette. Coconut shell powder has been added along with saw dust and other binders which has increased the calorific value of the briquette significantly. It can be stated that briquettes made using the correct mixture of rice husk, saw dust, binders and coconut shell powder possibly will be able to address the energy crisis and environmental issues by increasing the calorific value of the briquettes.

1. Introduction

From many years, fossil fuels like petroleum products and natural gas has been used as energy resources by human kind and because of which a lot of environmental issues are arising. The extensive use of petroleum products, has tremendously increased the cost and there is still a large difference in the demand and supply as wood is still being cheap has resulted again for deforestation[1,2]. A major part of agricultural residues is being consumed world-wide in traditional uses such as fodder for cattle, domestic fuel for cooking, industrial fuel for boilers,
construction material for rural housing, etc. The burning of agricultural residues directly in industrial as well as domestic applications is highly inefficient. The process of compacting of residues into a product of higher density than the original raw materials is called as densification of briquettes[3]. The properties of handling the material for wrapping, shipping and storage is also improved by giving a shape to the raw materials[4]. If briquettes are formed at low cost and made easily available to people it can readily serve as alternative fuel for firewood and charcoal which people were using for both domestic and industrial operations since many decades, thereby decreasing the high demand for petroleum by products. Besides this, briquettes have higher heat intensity, cleanliness, convenience in use and handling and relatively occupy smaller space for storage compared to fuel wood. The briquettes are generally made in cylindrical or rectangular shapes as these shapes can be easily handled and transported.

Several techniques are employed for making briquettes one of the method is low pressure compression with binder which is being followed in making briquette.

In high pressure methods a piston press and screw extrusion types are employed. In the briquettes made using piston press the shape is totally solid while briquettes made using screw press there is a concentric hole in centre of the briquette provides more specific area and improves combustion properties [6, 7]. By employing piston press briquettes having 1200kg/m$^3$ density can be produced compared to lose biomass density of 100-200kg/m$^3$. Because of more density a higher heat value and combustion is being obtained [1, 8]. The calorific value can still further be enhanced by adding coconut shell powder, since many years people in different parts of the world are using coconut shell as a fuel for water heating, firing ceramics and bricks.

Briquettes are employed in number of areas both in domestic and small scale industries as a replacement for firewood and other solid fuels like charcoal. Due to present fuel shortage and increasing prices for fuels people are in search of alternate fuels and hence briquettes can fill this gap for all domestic and industrial applications such as water heating, curing of tobacco, tea and fruits drying, fuel for boilers respectively[9].

There are many advantages of briquettes being used as fuels which includes mainly improve the efficiency of agricultural residues[8]. Since briquettes are densified product they can be easily handled, stored and transported when compared to raw agriculture wastes. Briquettes also solve the problem of biomass disposal in a more efficient manner.

A few disadvantages are also with briquettes like they are strictly solid fuels and can not be used in IC engines, also they absorb moisture when not stored properly. Maximum temperature which is attainable by combustion of briquette is 1000 degrees which may not be suitable for high temperature industrial applications as they have low calorific value ratio due to low carbon content[11].

2. Methodology of Briquette making
A lot of investigations were been done on rice husk and is been used as major constituent with saw dust combining with binding agents such as cow dung [5], starch, paper pulp. Along with these materials some of the study has also been done with coconut husk, palm kernel shells [5,8]. Already work has been carried by using rice husk and saw dust along with the binders like cowdung, paper pulp and starch [12]. Coconut shell is also considered to be one of the good sources of energy from ancient ages hence in our study along with rice husk, saw dust and coconut shell powder was also taken and combined with three binding agents cow dung, starch and paper pulp.
The rice husk, saw dust, and coconut shell powder, starch powder were collected from local suppliers are shown in figure 1,2,3 respectively. Cow dung from local farming people and paper pulp was made in house by soaking the waste paper in water for 72-80 hours. As particle size plays an important role in combustion process a sieve size of 1700 microns was used to sieve all the materials and remove any foreign matter. If you don’t wish to use the Word template provided, please set the margins of your Word document as follows.

![Figure 1. Rice husk](image1)
![Figure 2. Saw dust](image2)
![Figure 3. Coconut Shell Powder](image3)

### 3. Specimen Preparation

The materials were sieved were mixed in a required proportions using three different binders. The binders selected to give better results were cow dung, paper pulp, and starch. All the sieved raw materials and binders were carefully mixed one by one and compressed to a cylindrical shape of diameter 50mm and length 50 mm using a hand jolting machine. 10 gms Rice husk, 10 gms saw dust and 10 gms of coconut shell powder was maintained in all the nine samples. Keeping rice husk powder, saw dust sawdust powder and coconut shell powder as common ingredient, the binder quantity was increased to 15gms, 25gms and 35gms. The combination quantity used is shown in Table 1.
Table 1 composition1 (Rice husk+ saw dust+ binder)

| Composition 1 | Weight of Rice husk (gms) | Weight of Saw dust (gms) | Weight of Binders used (gms) |
|---------------|----------------------------|-------------------------|----------------------------|
| 1             | 15                         | 15                      | 15                         |
| 2             | 15                         | 15                      | 25                         |
| 3             | 15                         | 15                      | 30                         |

Table 2 Composition2 (Rice husk+ saw dust+ Coconut shell powder + binder)

| Composition 2 | Weight of Rice husk (gms) | Weight of Saw dust (gms) | Weight of Coconut shell powder (gms) | Weight of Binders used (gms) |
|---------------|----------------------------|-------------------------|-------------------------------------|----------------------------|
| 1             | 10                         | 10                      | 10                                  | 15                         |
| 2             | 10                         | 10                      | 10                                  | 25                         |
| 3             | 10                         | 10                      | 10                                  | 30                         |

The three types of briquettes made showed almost similar texture on the surface but surface texture was good for starch with coconut shell powder of briquettes when compared to cow dung and paper pulp. The colour of almost all the specimens was having shades of brown depending on the amount and type of binder used are shown in the figure 4,figure 5, figure 6 respectively. To compare the calorific value of the briquettes and to study the performance Calorific value test was conducted. The Test method followed was IS 1350.

Figure 4. Cow Dung Briquette

Figure 5. Paper Briquette
4. Results and Discussion

All the tests as stated earlier were conducted on the 9 samples made and the results noticed are shown in the figure 7, figure 8, figure 9, figure 10. C11 represents that the binder is cowdung, P11 represents that the binder is paper pulp and S11 represents that the binder is starch respectively for composition 1 and C21, P21, S21 represent the composition 2 with same binders with coconut shell powder respectively.
Figure 8. Calorific Value Analysis for Paper Pulp Briquettes

Figure 9. Calorific Value Analysis for Starch Briquettes.
The following conclusions can be made from the work that has been carried out:

The highest calorific values were observed for specimen made with paper pulp as binder second was for starch and the last was the cow dung [12].

Adding coconut shell powder resulted in significant increase in calorific value compared to compositions with rice husk powder and saw dust as base materials.

The calorific values of briquettes made are comparable to calorific values of traditional fuels that are used in boilers or firewood which is an indication that the briquettes can be chosen to replace these traditional fuels.

Finally it can be concluded that the energy crisis which the people are facing can to some extent be addressed by these alternate fuels [13,14] and also that the eco-friendly briquettes made using rice husk, saw dust along with coconut shell powder with proper quantities of binders like paper pulp, starch and cow dung have the potential to be an efficient substitute for traditional fuels used in boilers and for domestic purposes.

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