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Development & Investigation of Briquettes Using Organic & Inorganic Binders

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Abstract— The paper presents the results of a project focused on the development of briquettes obtained from agricultural waste, domestic waste, forest wastes and the charcoal using Organic and Inorganic binders. Considering the type of binder used i.e. Organic Binder(Starch) and Inorganic Binder (Sodium Silicate), briquettes are produced under same pressure. Physical and Proximate analysis are performed on formed briquettes and found Organic binder starch is more effective respect to most cases compared to Inorganic sodium silicate was considered.

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1 INTRODUCTION

ENERGY resources are classified as renewable and non-renewable. Well renewable sources can have replenished and thus will not get exhausted like diesel, petrol, gasoline etc., so renewable resources are the better option [1]. Additionally, effects of result of emissions of CO_2, SO_2, NOx etc. during the combustion of non-renewable resources, prompted the use of renewable for cooking and heating purposes [2]. Well Biomass energy helps in providing basic energy for space heating, power generation and cooking and heating of rural and urban households particularly in developing countries. It contributes to about 52% of the population in developing countries it acts like a primary fuel [3]. Coming to the agricultural wastes different species come under it showing large variations in its composition and fuel characteristics [4]. But the Percentage Composition of the combustible elements in the agricultural waste either in briquette form or loose form are very low compared to fossil fuels [5]. Since there is low emission of the oxides of the combustible elements it results in low emission of CO2 from the combustion of biomass (agricultural waste) making it equivalent to the amount of CO_2 absorbed during its growing cycle. Thus, the net CO_2 released is approximately zero by mass [6]. Well Agricultural and forest residues remain the most effective way to resolve the challenges of emissions, deforestations and energy crisis which has been largely contributed by reliance on fossil fuels. Well the processing methods and technologies for accessing energy in its loose form remains the major drawback which is to be given more importance [7]. Good densified briquettes obtained from loose biomass depends on several factors such as type of binder used, moisture content, particle size, shatter index, density and compaction temperature and pressure. Research indicates compaction pressure remains one of the main and critical parameter influencing the quality of loose biomass briquettes [8]. Although without the help of binders it is difficult to keep together the raw material intact. So, by taking binder into account Organic and Inorganic binder analysis on briquettes by taking 35% of the both binders in making briquettes. The physical and proximate analysis are made on briquettes and values proved organic binders found to be better than inorganic.

2 EXPERIMENTATIONS AND TESTING ANALYSIS

2.1. Materials and Briquette Preparation

For this study, four potential areas where waste are produced in bulk Agricultural, Domestic, Forest were considered and charcoal which gives very good heat value was also considered. Firstly, from Agriculture, Rice husk and Sugarcane were taken, the squeezed sugarcane which is commonly found at sugarcane juice stalls was dried for 3days & then it is used in briquetting. Next from domestic department Coconut shell and chilly stalk were taken. From the forest department dried acacia and mango leaves were used to form briquettes. Same pressure is applied in making briquettes. Two types of binders used in making the briquettes Organic binder (starch) and Inorganic binder (Sodium Silicate). Briquettes were prepared by mixing Organic binder in ratio 35% and Inorganic binder by 30%-35%. Starch is prepared by mixing 35 gram starch with 250 gram water and boiled till get thickened.

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Fig.1 Showing briquettes made from organic and inorganic binder.

2.2 Physical Properties

2.2.1 Moisture Content

Moisture content was measured by oven dry method. Samples with known weight was taken and kept in oven at 105 for one hour. Then the oven dry sample weighed (ASTM D-3173). The moisture content of sample calculated by using Eq. (1):

$$MC(\%wb) = \frac{(W_2 - W_3)}{(W_2 - W_1)} * (100) \quad (1)$$

Where W_1 = weight of crucible (g),
W_2 = weight of crucible+sample (g),
W_3 = weight of crucible+sample, after drying (g).

2.2.2 Shatter Index Test

Shatter index is used for determining the hardness of briquettes. The briquette is dropped on concrete floor from a height of one meter. The weight of the disintegrated briquette and its size is noted down. The percentage loss of material is calculated by Eq. (2):

$$\text{Percentage of weight loss} = \frac{(W_1 - W_2)}{W_1} * (100) \quad (2)$$

where W_1, W_2 are weight of briquette before and after shattering in grams.

2.2.3 Impact Resistance Test

This test is used to investigate the strength and hardness of briquette. Each briquette sample is repeatedly dropped from a stationary starting point at 2 m height into a concrete floor until it gets fractured. The impact resistance is value of number of drops.

2.2.4 Water Resistance Test

The briquette is immersed in water maintained at the atmospheric temperature for 30 s to determine the percentage of water resistance to penetration. It shows that, how the briquettes will respond during rainy seasons or while in contact with water. The value of shatter index, impact resistance, durability index and water resistance should be higher to ensure the strength of the briquettes.

2.3 Proximate Analysis

2.3.1 Percentage Volatile Matter (PVM)

The percentage volatile matter (PVM) was determined by pulverising 2 g of the briquette sample in a crucible and placing it in an oven until a constant weight was obtained. The briquettes were then kept in a furnace at a temperature of 550 °C for 10 min and weighed after cooling in a dessicator. The PVM was then calculated using Eq. (3):

$$PVM = \frac{(A - B)}{A} \quad (3)$$

where A is the weight of the oven-dried sample (g), B is the weight of the sample (g) after 10 min in the furnace at 550 °C.

2.3.2 Percentage Ash Content (PAC)

The percentage ash content (PAC) was also determined by heating 2 g of the briquette sample in the furnace at a temperature of 550 °C for 4 h and weighed after cooling in a dessicator to obtain the weight of ash (C). The PAC was determined using Eq. (4):

$$PAC = \frac{C}{A} * (100) \quad (4)$$

2.3.3 Percentage Fixed Carbon (PFC)

The percentage fixed carbon (PFC) was computed by subtracting the sum of PVM, PAC and PMC from 100 as shown in Eq. (5):

$$PFC = 100\% - (PAC + PMC + PVM) \quad (5)$$

3 RESULTS AND DISCUSSIONS

3.1 Physical Properties of Briquettes

3.1.1 Moisture Content

shows the moisture content of different briquettes. The lowest moisture content was in Inorganic binder since it does not require water during the mixing process. Well in case of organic binder involves large amount of moisture present in it.

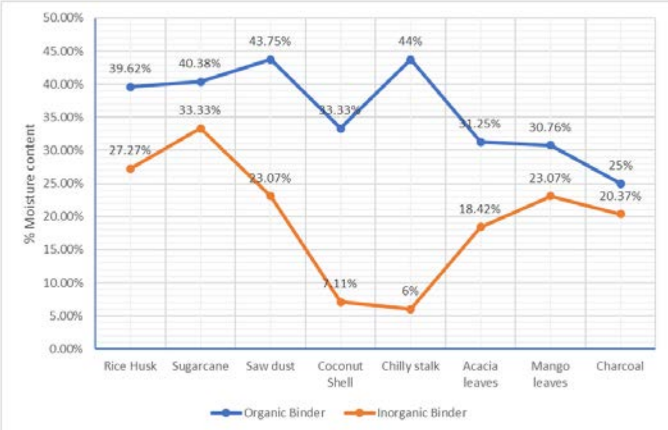


Fig. 2 Moisture content in weight %.

3.1.2 Compressive Strength

Fig.3 shows the compressive strength of briquettes prepared using both organic binder and inorganic binder. Briquettes prepared using organic binder showed good compressive strength when compared to inorganic. In both the cases rice husk showed the lowest value and saw dust did well in both.

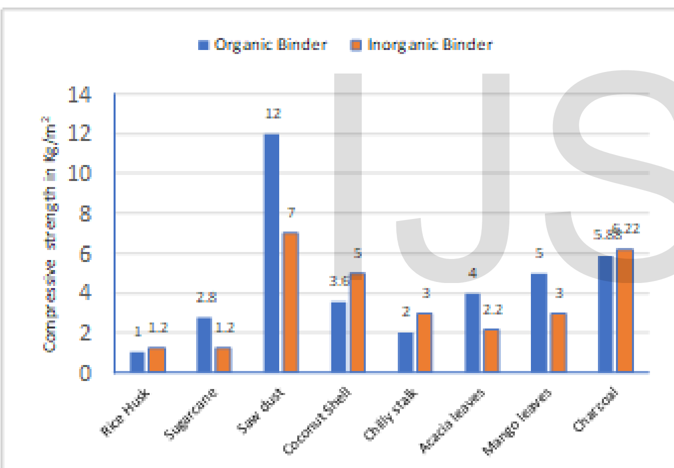


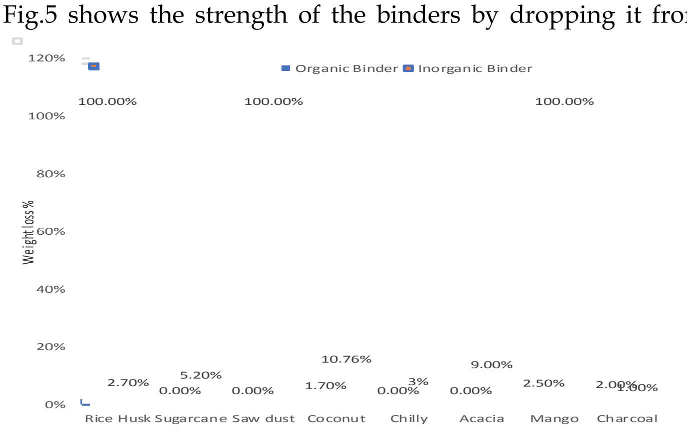
Fig.3 Compressive strength of Organic and Inorganic Briquette.

3.1.3 Shatter Index

Fig.4 shows the values of weight loss of the briquettes. Organic binder performed very well.

3.1.4 Impact Resistance

Fig.5 shows the strength of the binders by dropping it from height of 2 m.



3.1.5 Water Resistance Test

Briquettes with good smooth outer surface provided good resistance to water. Fig.6 shows organic binder did well better than the inorganic binder.

Fig.4 Weight loss% of different briquettes.

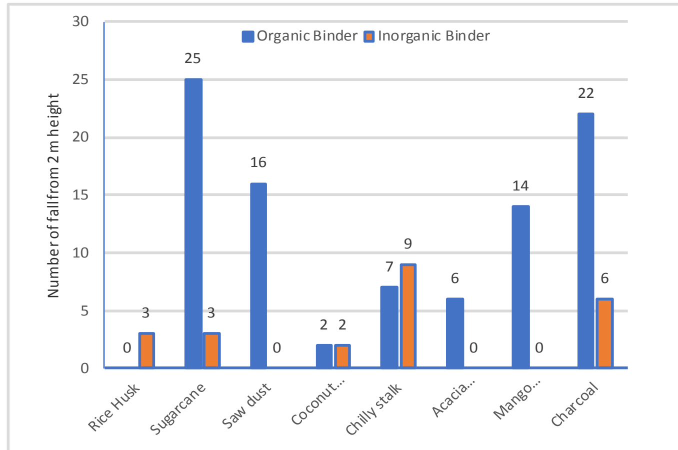


Fig.5 Impact Resistance of different briquettes.

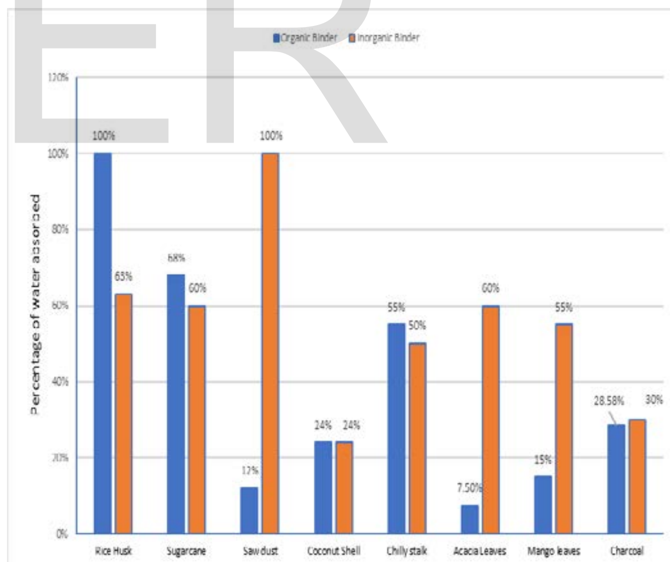


Fig.6 Percentage water absorption of briquettes.

3.2 Proximate Analysis

Briquettes were prepared by mixing organic binder starch in ratio 30% and inorganic binder sodium silicate by 30-35%. The
values of volatile matter,fixed carbon and ash content was almost the same in both the cases, but the final ash content weighed more in case of inorganic binder. Since organic

binder will contribute to burning were as it is not in the case of sodium silicate and also it inhibits the volatile matter from getting out of the briquette. Using sodium silicate caused problem while burning i.e it forms a whitish layer which prevents further burning that promote the burning of the raw material. That is why the fixed carbon content seemed higher in case of inorganic briquette.

Table 1 shows volatile, fixed carbon, ash content of briquettes made from organic and inorganic binder.

Raw materials	Organic Binder			Inorganic Binder		
	Volatile %	Fixed carbon %	Ash %	Volatile %	Fixed carbon %	Ash %
Rice husk	86%	10%	4%	82%	6%	12%
Sugarcane	86%	12%	2%	66%	28%	6%
Coconut shell	84%	12%	4%	78%	14%	8%
Chilly stalk	94%	4%	2%	70%	16%	14%
Acacia leaves	84%	8%	8%	56%	28%	16%
Mango leaves	92%	4%	6%	72%	13%	15%
Saw dust	82%	8%	10%	78%	6%	16%
Charcoal	52%	38%	10%	70%	16%	14%

4. Conclusion

From the experiments performed on the developed briquettes using organic and inorganic binders it was found –

- Briquette produced from organic binder was superior in quality than the inorganic.
- Although organic briquettes were superior in terms of physical and thermal properties it lacked in prolonged storage since it invovled water in the process which promotes microbial growth,but if the inorganic binders is promoted by some additives it can also take the place of organic binder.

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