Characterization and Evaluation of Biomass Briquettes using Babul Tree Dust

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Abstract- *This project is solving energy crisis in rural area via fuel briquettes from locally available biomasses by a well proven technique called wet briquetting.The objective of the present work is to characterization and evaluation of the biomass briquettes using babul tree dust blended with paper pulp. This briquettes are a replacement of coal and charcoal briquettes and it also replace the other biomass briquettes such us sawdust and cashew nut briquettes with higher calorific value. Paper pulp is used as binder in the babul tree briquettes were used in various ratios. The briquettes were evaluated for the properties of moisture content, ash content, volatile matter, calorific value and crushing strength.*

Keywords- Biomass Briquettes, Babul tree, Paper pulp, Calorific value

I. INTRODUCTION

Biomass briquettes, mostly made of green waste and other organic materials, are commonly used for electricity generation, heat, and cooking fuel. These compressed compounds contain various organic materials, including rice husk, bagasse, ground nut shells, municipal solid waste and agricultural waste. The composition of the briquettes varies by area due to the availability of raw materials. The raw materials are gathered and compressed into briquette in order to burn longer and make transportation of the goods easier. These briquettes are very different from charcoal because they do not have large concentrations of carbonaceous substances and added materials. Compared to fossil fuels, the briquettes produce low net total greenhouse gas emissions because the materials used are already a part of the carbon cycle.

II. MATERIALS AND METHODS

2.1 FABRICATION OF BRIQUETTING SETUP

The setup is fabricated by using cylinder, metal rod and plates. The cylinder and rod were cutted with dimensions. The plate is used to weld with the rod and make it as a plunger by arc welding. Another plate is used for hold the material from the cylinder at bottom during briquetting process and the plate has the three holes for water extraction.

Table-1 Specification of Briquetting Setup

Parameters	Plate	Plunger	Cylinder
Material	MS	MS	SS
Length	-	230mm	155mm
Small dia	6mm	28mm	48mm
Bigger dia	116mm	45mm	50mm
Thickness	7mm	-	1mm

Figure-1 Briquetting Setup

2.2 RAW MATERIAL SELECTION

Acacia nilotica (Hindi name – Babool or Babul) is a tree 5m – 20 m high preferring sandy or sterile regions, with the climate dry during the greater part of the year. The crown is somewhat flattened or rounded, with a moderate density. The branches have a tendency to droop downwards if the crown is roundish. Acacia nilotica is a slow - growing species but is moderately long-lived. The species can withstand extremely dry environments and can also endure floods. Acacia nilotica makes a good protective hedge because of its thorns. In part of its range small stock consume the pods and leaves, but elsewhere it is also very popular with cattle. Pods are used as a supplement to poultry rations in India. In India branches are commonly lopped for fodder. In the wild, the pods-especially when dried-and leaves are consumed by small animals like sheep, but cattle also seem to find them very tasty. The pods are toxic to goats. They are best fed dry as a supplement, not as a green fodder.

2.3 RAW MATERIAL PRODUCTION

Babul tree dust from surroundings have been collected. Its timber is valued by rural folks, its leaves and pod are used as fodder, gum has a number of uses and it has greater heating value than others. The paper pulp used as binders collected from the waste papers.

The paper pulp binders were varied at 20%, 30% and 40% of mass of the mixtures (babul dust). In this case, the mixtures of raw materials were maintained at different ratios due to higher calorific value and low ash content in the produced briquettes.

Figure-2 Raw Materials

2.4 BRIQUETTE PRODUCTION AND QUALITY EVALUATION

The proportions of binder in the mixture were 20%, 30% and 40%. Thus, the component ratio (Babul tree dust-binder) in each charge for briquetting were 80:20, 70:30 and 60:40. The babul dust-binder mixture was then hand-fed into the stainless steel pipe that served as a mould and covered at ends with the MS disk.

The babul tree dust-binder mix inside mould was later placed under the press and compacted at a pressure and was kept under pressure for 5 minutes. At each level of binder, 4 replicates were produced. The diameter of the briquettes was thereafter taken at two differentpoints with the aid of Vernier calipers while the thickness and length were also recorded immediately.

Table-2 Specification of Briquettes

Parameters	80:20	70:30	60:40
Length	60mm	60mm	60mm
Diameter	48mm	48mm	48mm

Figure-3 Briquettes

III. RESULT AND DISCUSSION

3.1 PHYSICAL PROPERTIES OF BRIQUETTES

For physical properties determination, briquettes were randomly selected from each production batch for evaluation. To determine dimensional stability, the length of respective briquetteswas measured at 0 min, 30 min, 1 hour, 1 day and 7 days intervals. Equilibrium moisture contents (E.M.C) of the briquettes after 19 days of sun-drying were determined at an ambient temperature of (22±3) ºc, respectively. The relaxed density and relaxation ratio of the briquettes were also determined in the dry condition after 19 days. The briquette samples were dropped repeatedly from a specific height of 1.5 m onto a solid base (metal plate). The fraction of the briquette retained was used as an index of briquette breakability. The durability rating of the briquette was expressed as a percentage of the initial mass of the material remaining on the metal plate.

3.2 MOISTURE CONTENT

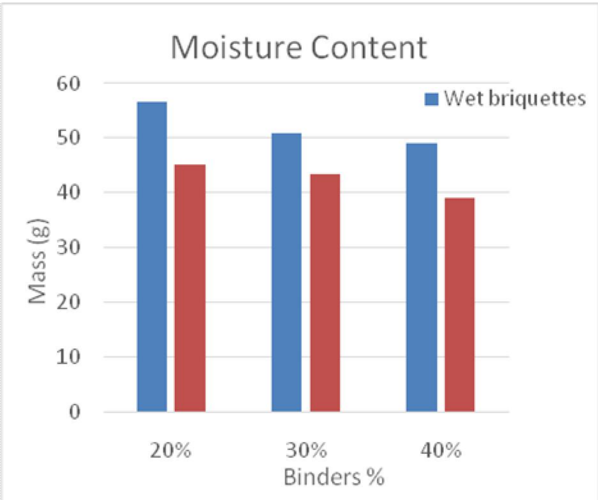
The moisture content of biomass is the quantity of water in the material, expressed as a percentage of the material's weight. This weight can be referred to on wet basis and on dry ash free basis. If the moisture content is determined on a 'wet' basis, the water's weight is expressed as a percentage of the sum of the weight of the water, ash, and dry-and-ash-free matter. Similarly, when calculating the moisture content on a 'dry' basis (however contradictory that may seem), the water's weight is expressed as a percentage of the weight of the ash and dry-and-ash-free matter. Finally, the moisture content can be expressed as a percentage of the "dry and-ash-free" matter content. In that last case, the water's weight is related to the weight of the dry biomass. Because the moisture content affects the value of biomass as a fuel, the basis on which the moisture content is measured must always be mentioned.

This is particularly important because biomass materials exhibit a wide range of moisture content (on a wet basis), ranging from less than 10 percent for cereal grain straw up to 50 to 70 percent for forest residues.

The E.M.C. of the briquettes is also depends on nature of binder materials. For example, briquette bonded with paper pulp was higher than that of briquettes bonded with starch. Also EMC will differ to the nature of the material and differ in climatic condition since equilibrium moisture content is a function of relative humidity and temperature of the surrounding air. The low E.M.C. is expected to influence the durability and storability of the briquettes.

Table-3 Moisture content (Babul Tree Dust-Paper Pulp)

Binder(paper pulp)	20(%)	30(%)	40(%)
Wet briquettes(g)	56.5	51	49
Dry briquettes(g)	45.2	43.35	39.2



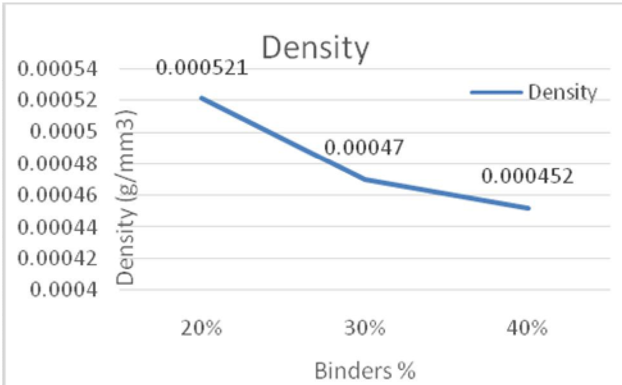
Graph-1 Moisture content (Babul Tree Dust-Paper Pulp)

3.3 DENSITY

Weight briquette in an analytical balance. Record the weight in grams. Place briquette in a sealed plastic bag. Prepare a graduated container where the briquette may be immersed. Fill this container with two-thirds full of water. Record the initial volume of water. Immerse the briquette in the container until it is 50 mm below the water surface. Record the volume of water with the briquette immersed. Density is calculated using the following formula: Density= Mass/Volume

Table-4 Briquette density (Babul Tree Dust-Paper pulp)

Binder (Paper pulp)	**20%**	**30%**	**40%**
Mass(g)	56.5	51	49
Volume(mm^3)	108518.4	108518.4	108518.4
Density (g/mm^3)	$5.21*10^{-4}$	$4.7*10^{-4}$	$4.52*10^{-4}$



Graph-2 Density (Babul Tree Dust-Paper Pulp)

3.4 COMPRESSION STRENGTH

Compression strength is the capacity of a material or structure to withstand loads tending to reduce size, as opposed to tensile strength, which withstands loads tending to elongate. In other words, compressive strength resists compression (being pushed together), whereas tensile strength resists tension (being pulled apart).

In the study of strength of materials, tensile strength, compressive strength, and shear strength can be analysed independently. Some materials fracture at their compressive strength limit and others deform irreversibly, so a given amount of deformation may be considered as the limit for compressive load. Compressive strength is a key value for design of structures.

Compressive strength is often measured on a **Universal Testing Machine**, these range from very small table-top systems to ones with over 400KN capacity. Measurements of compressive strength are affected by the specific test method and conditions of measurement. Compressive strengths are usually reported in relationship to a specific technical standard.

Table-5 Compressive Strength (Babul Tree Dust-Paper Pulp)

Samples	Yield point	Breaking point	Ultimate
80:20	2KN	15KN	60KN
70:30	2KN	20KN	60KN
60:40	1KN	15KN	60KN

IV. COMBUSSION CHARACTERISTICS

4.1 ASH CONTENT

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

Ash content= Weight of ash / Original weight of sample*100

Table-6 Ash content (Babul Tree Dust-Paper Pulp)

Binder (%)	Ash(g)
20	0.33
30	0.24
40	0.13

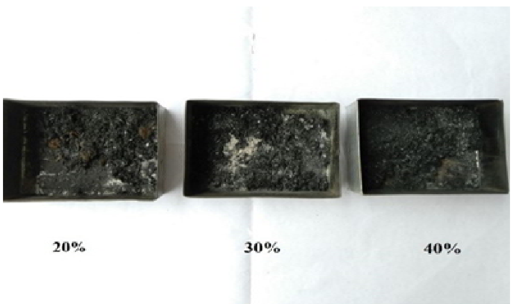


Figure-4 Ash (Babul Tree Dust-Paper Pulp)

4.2 PERCENTAGE VOLATILE MATTER

The volatile matter was determined by placing 2g of pulverized briquette sample in a crucible oven to obtain constant weight after it was kept in the furnace at temperature of 300°C for 10minutes and brought out to be cooled in the desiccator and weighed to determine the percentage volatile matter.

Percentage Volatile Matter
= ([Initial Mass]-[Volatile Mass])/ [Initialmass])*100

4.3 PERCENTAGE FIXED CARBON

Calculated by subtracting the sum of percentage volatile matters and percentage ash content from 100%.
Percentage Fixed Carbon = 100 – (%V + %A)
Where, %V = Percentage Volatile Matter
%A = Percentage Ash Content

4.4 HEATING VALUE

Heating value was calculated using the formula:
HV = 2.326(147.6C + 144V) Kj/kg
Where,
HV = Heating Value
C = Percentage Fixed Carbon
V = Percentage Volatile Matter

Table-7 Heating Value (Babul Tree Dust-Paper Pulp)

Binder(%) paper pulp	20%	30%	40%
Fixed carbon (%)	14.75	19.25	18.5
Volatile matter (%)	68.75	68.75	75
Heating value (kj/kg)	28079.26	29623.52	31458.65

The heating value of the babul tree dust was found to be 31.45 MJ/kg. This value was found to be increased in the babul tree dust with higher concentration of paper pulp. In fact, heating value of briquettes depends on the fixed carbon content, ash content and moisture content. Briquetting is the physical transformation of biomass in to densified product. Therefore, fixed carbon content and ash content remains as the original raw material. Fixed carbon content basically depends on the cellulose content of the selected biomass. For the moist fuel, heating value decreases because a portion of the combustion heat is used to evaporate the moisture in the biomass and this evaporated moisture has not been condensed to return the heat back to the system.

4.5 CALORIFIC VALUE

Calorific value of briquetting material is determined using IKA-C5000 type bomb calorimeter.

Table-8 Calorific Value of Briquettes

Briquette Composition	Calorific Value (Kcal/Kg)
80-20%	4369
70-30%	4021
60-40%	3744

This result shows that the calorific value is higher in sample 80:20 than other samples and also higher than the other biomass briquettes such as sawdust briquettes and agro waste briquettes like that.

V. CONCLUSION

The results from this project is briquette can be produced from babul tree dust .The quality ofthe briquettes was influenced by the level of binder used. A direct relationship was observed between briquette density and moisture content. The bonding strength of paper pulp was higher in the briquette. The best strategy for producing briquette from woodresidue include pressing a blend of babul tree dust with paper pulp at a ratio of 20%, 30% and 40% in weight. Maximum amount of heating value obtained in 30% and 40% for paper pulp.

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