Combustion Characteristics of Briquettes Produced from Saw Dust and Delonix Regia

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Abstract

Briquette density is the primary metric used to assess briquette quality. From the perspective of manipulation, burning speed, briquette durability, etc., briquette density is crucial. The current study examines the physical and combustion properties of sawdust and herbal waste (delonix regia) briquette, including their length, diameter, mass, density, moisture content, total ash content, fixed carbon, volatile matter, and gross calorific values (both on a dry and on a basis). The parameters that affect the quality of briquettes were theoretically analyzed during our investigation .The density and strength characteristics of the produced briquette were ascertained in order to assess its quality. The test was conducted in specialized testing services centre coimbatore to ascertain the calorific value and proximate analyses of briquettes. The results were analyzed and shown graphically.

Keywords: saw dust; oil ; herbal waste ;calorific value.

1.Introduction

Wood has historically been the world's largest renewable energy source, making up 14% of global energy consumption in the form of fuel wood, twigs, and charcoal. The remaining energy sources include petroleum products (41.3%), hydroelectricity (3.1%), and natural gas (5.2%). The shortage of fuel wood and the steadily rising costs of cooking gas and kerosene in Nigeria highlight the necessity of looking into alternate energy sources for both home and cottage-level industrial use in the nation.[1]

These energy sources ought to be renewable and available to the underprivileged. The developing world urgently has to switch to a sustainable energy system, as Stout and Best correctly pointed out[2]. The current subsistence level of energy use, which is reliant on diminishing firewood resources, should give way to a scenario where human and formation activities are based on diverse and sustainable energy sources.

It is impossible to overstate how vital energy is to a country's progress. This is due to the fact that energy is the basis of both social and economic growth. Every year, agriculture produces 140 billion metric tonnes of biomass worldwide. It is possible to transform this quantity of biomass into roughly 50 billion tonnes of oil's worth of raw materials and energy[3].

Briquetting, which is defined as the process of compacting leftovers into a product with a higher density than the original material, is one of the most promising technologies for turning these residues into biomass energy, despite the fact that there are numerous conversion pathways. Briquetting is another definition of it as a densification procedure. Briquettes can significantly cut down on the requirement for wood, which will lessen deforestation. Briquetting can be applied to a variety of forestry wastes and agro-residues, including those from corn, beans, groundnuts, rice, cotton, sugarcane, wood, guinea and maize[4].

The conversion of agricultural biomass, which is waste, into energy can reduce greenhouse gas emissions, replace fossil fuels in a sustainable manner, and give renewable energy to the 1.6 billion people in developing nations who do not yet have access to electricity. Animal waste, leftover stalks, roots, leaves, husks, and shells are examples of biomass. Waste biomass is a valuable, widely accessible, renewable resource that is essentially free.

Many of these residues that have been subjected to the process of briquetting are those of wood, cotton, rice straw, cashew nut shell, tamarind shell, bran and banana peel. Others are waste paper and a mixture of coconut husk, rattan furniture waste and maize cob. Generally, techniques of briquetting are grouped into two major classes.

High-pressure methods Lower pressure method Additionally, briquettes can be made in two different ways: either with or without binders. Any shape, including spherical, rectangular, pellet, and so forth, can be produced using the two methods described above[5]. Technology related to biomass energy is a naturally adaptable range of alternatives that can be employed in much higher base-load power production capacity while also providing heat, or it can be applied at a small, localised scale primarily for heat. Thus, biomass generation can be used in commercial, industrial, or residential settings and adapted to rural or urban settings.

This work's main goal is to use a piston press mechanism to examine the physical and combustion properties of briquettes made from agricultural and forest wastes.

Then herbal waste collection (Delonix regia).Delonix regia, commonly known as the Royal Poinciana or Flamboyant tree, has various uses, including ornamental planting, traditional medicine, and potential applications in industries like tanning and soap-making.

Proximate composition of D. regia is presented in Table 1. Moisture, crude fibre, ash, crude fat, crude protein and carbohydrate are 10.12 ± 0.59 %, 8.75 ± 0.04 % and 48.34 %, respectively.

2.Methodology

2.1 Sawdust and herbal waste briquette production

Sawdust, a by-product of wood processing, is a form of biomass, a renewable organic material, and can be collected and used as a fuel source or for other applications[6]. Then herbal waste collection (Delonix regia).Delonix regia, commonly known as the Royal Poinciana or Flamboyant tree, has various uses, including ornamental planting, traditional medicine, and potential applications in industries like tanning and soap-making.

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Methods for Extracting Bael Fruit Oil:

Solvent Extraction:This method involves using a solvent (like diethyl ether) to dissolve the oil from the bael fruit pulp or leaves.

Process:Chopped bael leaves are heated with water for a few hours. The essential oil is separated using a separating funnel with diethyl ether.

Water is removed with anhydrous sodium sulfate, and the mixture is evaporated overnight. Traces of ether are removed with a hot water bath, and the pure essential oil is seale[7].

To make briquettes using a universal testing machine (UTM), you'd prepare your biomass material, mix it with a binder, and then compress it into a mold using the UTM's press, typically with a piston attachment, to achieve the desired density and shape[8].

1. Material Preparation:
   Raw Material:
   Gather your biomass source, such as agricultural waste (e.g., rice husk, bagasse, corn cobs), sawdust, or charcoal powder.
   Cleaning and Drying:
   Clean the raw material and ensure it's dried to a suitable moisture content.
   Grinding/Crashing:
   Reduce the size of the biomass to a fine powder or granules using a grinder or mill.
   Mixing:
   Combine the biomass powder with a binder (e.g., starch, clay, molasses) to improve cohesion and strength.
   Water Addition:
   Add water to the mixture to achieve the desired consistency and facilitate binding.
2. Briquette Formation using UTM:
   Universal Testing Machine (UTM): Use a UTM equipped with a briquetting press (piston attachment).
   Mold: Place a cylindrical mold or die with the desired dimensions (diameter and height) onto the UTM's platen.
   Filling the Mold: Fill the mold with the prepared biomass mixture.
3. Post-Processing:
   Drying:
   Dry the formed briquettes to reduce moisture content, which improves their storage and combustion properties.
   Testing:
   Evaluate the properties of the briquettes, such as compressive strength, density, and calorific value, using appropriate testing methods.
4. Key Considerations:

Pressure:
The pressure applied during briquetting significantly affects the density, strength, and durability of the briquettes.
Dwell Time:
The dwell time influences the densification process and the final properties of the briquettes.
Binder Type and Ratio:
The type and amount of binder used affect the briquette's binding strength and combustion characteristics[9].
Raw Material Type and Preparation:
The type and preparation of the raw biomass material (particle size, moisture content) influence the briquetting process and the final product quality.

2.2 Research flow diagram

Preparation of tools and materials Biomass collection (Sawdust)

↓

Herbal waste collection (Delonix Regia)

↓

Extracting oil from Bael fruit

↓

Making Briquettes using Universal testing machine

↓

Determine the physical and combustion characteristics

↓

Density and Shatter resistance test

↓

Determining combustion characteristics

↓

Compare result in graphical representation

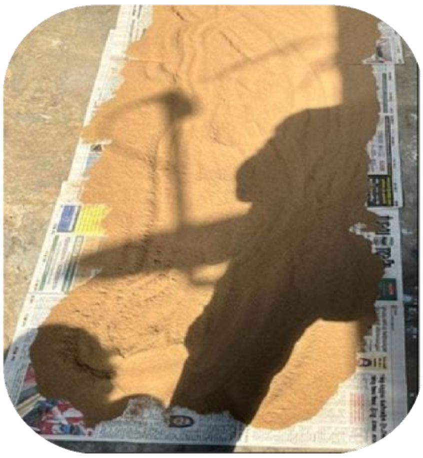
↓

using soft tool analyze the result

3. Raw materials

Sawdust and Ayurvedic waste briquettes have been successfully made by using the compression pressing techniques. the further details have been discussed on the following .

3.1 Sawdust

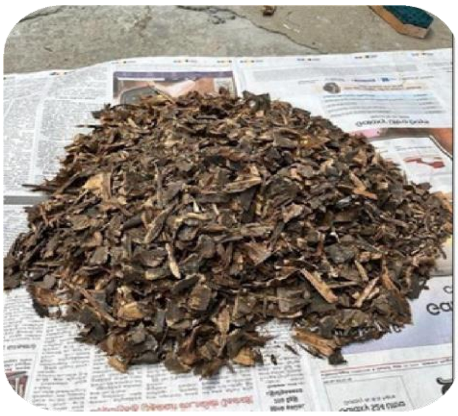


- In the world many types of trees and woods are available. Here only discuss about woods, so each and every woods have various properties.
- Here we select the Neem Tree Wood Powder, because Neem Wood has high Lignin Property.
    - Lignin Property is used to increase the
    - bonding and burning capacity of the
    - sawdust.

Calorific Value of the saw dust is 3155.30 KJ/Kg[10].

It is easily available in the market at a lower price.

3.2 Herbal waste



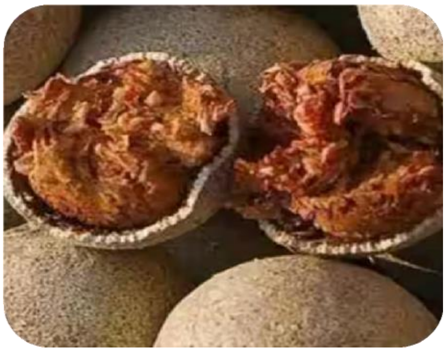
It is
- available in all the ayurvedic industry
- Ayurvedic Waste is a type of herbal
- Waste.

It is is
- a material which can easily burn and
- less weight.

Calorific value of an average ayurvedic waste 4795 KJ/Kg[11].

There are several types of ayurvedic waste,here in our

3.3 Bael fruit



- As the materials can not be bind in normally , so we require external material which can able to bind and hold the materials .
- The material used for binding ayurvedic waste and sawdust is the oil extracted from Beal fruit[12].

The • process of extracting the oil is done in a • traditional way

The process Includes the following steps;

Step 1 : Drying the Bael fruit in sunlight

Step 2 : Burning the dried fruit

Step 3 : Now collect the fruit and remove dust particles

Step 4 : Then Squeeze the fruit and collect the oil in a bowl

4. Result and Discussion

The Table presents the proximate analysis and calorific value of five different samples with varying blend ratios. The parameters analyzed include moisture content, ash content, volatile matter, fixed carbon, and calorific value.

Moisture Content:

The moisture content varies from 4.91% to 6.83%. Sample 2 (70:30) shows the lowest moisture content (4.91%), while Sample 5 (10:90) has the highest (6.83%). Moisture content generally affects the combustion efficiency, and lower moisture is preferable for higher energy yield.

Ash Content:

Ash content decreases with a decrease in the proportion of the first component in the blend. Sample 1 (90:10) has the highest ash content at 15.3%, while Sample 5 (10:90) has the lowest at 6.51%. A lower ash content is desirable as it indicates fewer non-combustible materials and reduces slagging and fouling in combustion systems.

Volatile Matter:

Volatile matter increases with a higher proportion of the second component in the blend. The highest value is observed in Sample 3 (50:50) at 75.14%, indicating a more reactive material suitable for processes like gasification or pyrolysis.

Fixed Carbon:

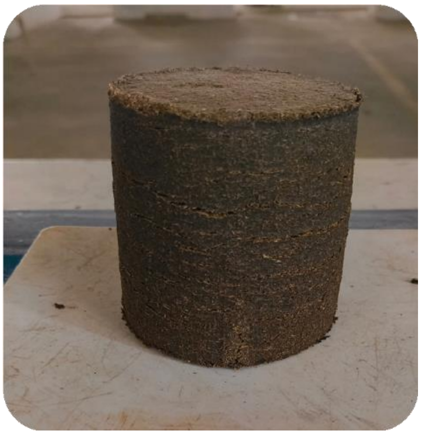
Fixed carbon ranges from 6.12% to 8.1%, with Sample 1 having the highest and Sample 5 the lowest. This trend shows that increasing the second component reduces the fixed carbon content, which can impact the burning characteristics and energy density of the sample.

Calorific Value:

The calorific value follows a similar trend to fixed carbon. Sample 3 (50:50) exhibits the highest calorific value at 5020 kcal/kg, suggesting an optimal balance of components. The lowest value is in Sample 5 (10:90), at 4041 kcal/kg, reflecting the impact of lower fixed carbon and higher moisture and ash contents.

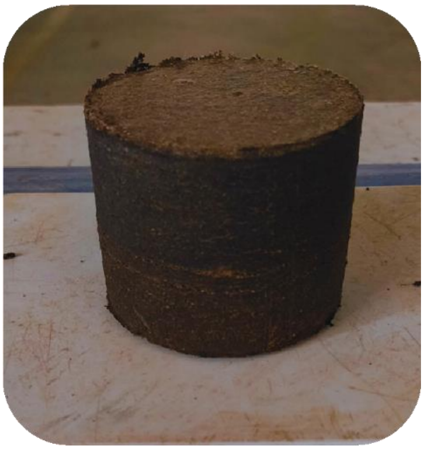
Table 4.1Result o the parameters

PARAMETER	Sample 1 90 : 10	Sample 2 70 : 30	Sample 3 50 : 50	Sample 4 30 : 70	Sample 5 10 : 90
Moisture content	5.63	4.91	6.12	5.84	6.83
Ash content	15.3	12.41	10.97	7.65	6.51
Volatile matter	70.10	72.67	75.14	74.21	72.11
Fixed carbon	8.1	7.14	7.8	8	6.12
Calorific value	4502	4645	5020	4562	4041

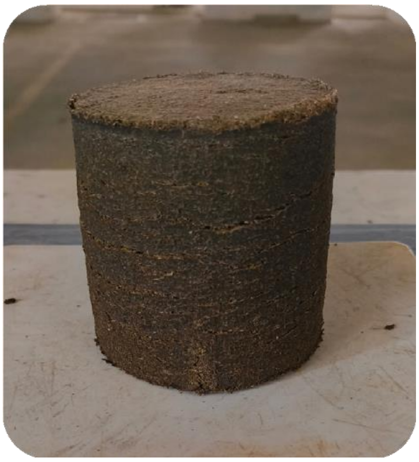


50:50
Sample 3

90:10
Sample 1



30:70
Sample 4



70:30
Sample 2

5. Conclusion

The sample S2 has less moisture content and sample S5 has high moisture content. A good briquette has no moisture content

The sample S5 has less ash content and sample S1 has high ash content.

As compared to all briquettes sample S3 has the highest volatile matter and sample S1 has the lowest volatile matter.

According to the literature review if the briquettes having less than 15 % fixed carbon, the briquette has high heating value. So the sampleS5 has less fixed carbon content and the sample S1 has the highest fixed carbon content.

The sample S3 has the highest calorific value compared to all other samples.

From the above parameters we have concluded that the sample S3 (50 : 50) has the highest calorific value and high volatile matter and moderate moisture content.

So we have taken sample S3 is the good briquette

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