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Biomass Briquette from Agriculture Waste

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Abstract— *Global energy demand is expected to increase in the next few years due to the corresponding increase in the world's population. The world's increasing energy demand is the ultimate reason to utilize alternate sources such as renewable energy. There are various forms of renewable energy sources. However, biomass is the always widely available source of renewable energy worldwide. Agricultural wastes such as rice husks, corn cobs, and bagasse results from various agricultural activities. These wastes are commonly left piled in the field to decompose or burn in open fires which consequently provide risks to the environment and animal and human health. The bio-briquettes product is suitable as an energy source commonly used for electricity generation, heat, and cooking fuel. They are the perfect replacement for wood logs. Hence, this review paper provides an overview of the utilization of various agricultural wastes into bio-briquettes. This review discusses the production, characterization, processing (preparation, size reduction, pyrolysis, binder addition, and densification - shaping and sizing), and quality evaluation methods of briquettes. This comprehensive review also presents the technology advancements, challenges, and future trends in the bio-briquetting industry.*

Keywords: Coconut shell, Pigeon stick, Cotton waste, Wheat waste, Cow dung

INTRODUCTION

The use of renewable and non-renewable energy sources is increasing all around the world. Over the years, the growth in energy needs by constituents has been efficiently exploited day after day. Each country's community needs an alternative energy source in order to reduce fossil fuel usage that is ecologically friendly and ready for long-term use. Renewable energy sources such as solar, biomass, wind, and geothermal are abundant in nature. Solar energy comes from the sun, which supplies our entire planet with the energy we need to survive. Using solar panels, we can harvest energy directly from sunlight and convert it to electricity that powers our homes and businesses. Wind turbines capture the wind's power as they spin and convert it to electricity. Geothermal energy within the earth can be harnessed to generate electricity. It is a renewable energy source that has the potential to enhance our environment, economy, and energy security dramatically (Uzun & Kanmaz, 2013). On the other hand, non renewable resources such as coal, oil, fossil fuels, and natural gas, have been depleted. These constraints will lead to fuel scarcity and an increase in price (Sirajudin et al., 2013). There are various forms of renewable energy sources. Biomass is one of the important sources of renewable energy. Bio-briquettes provide a solution that is mostly made of green waste and other organic materials, and is commonly used for electricity generation, heat, and cooking fuel. They are the perfect replacement for wood logs. In the present time, the increasing energy needs of the world and the continually growing population tend to result in a bunch of waste and higher energy demands. The consumption of several agricultural products has regularly left the stems, leaves, and peels from the tree either being wasted or thrown away. Producing bio-briquettes can also intensively help to address the increasing demand for energy.

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There are numerous researches have been carried out in sourcing for solutions to reutilize these organic wastes by turning them into something beneficial to mankind. Large quantities of vegetable and fruit wastes are left unused or allowed to decompose creating serious environmental problems. Nonetheless, these problems can be overcome by generating bio-briquettes that are affordable, renewable, and sustainable. Global communities such as Asia and Africa have the highest domestic supply of biomass and the majority of it is primary solid biofuels. Asia and Africa hold the majority share of biomass because of the extensive use of charcoal and wood as fuel for heating, cooking, and other domestic uses (World Bioenergy Association, 2019). Over the previous years, biomass has been considered the third largest energy source in the world. Additionally, biomass can be defined as any organic matter that is available on a renewable or recurring basis that includes energy crops and trees, agricultural food and feed crops, agricultural crop wastes, wood wastes, aquatic plants, animal wastes, municipal wastes, and other waste materials, which recognized as one of the major potential sources for energy production (Sivakumar & Mohan, 2010).

Furthermore, the exploitation and utilization of biomass resources can solve the disposal problems caused by a large amount of agricultural and forestry waste annually and eliminate the potential environmental pollution (Tan et al., 2017). Utilizing biomass wastes into a consumable and sustainable outcome can diminish environmental issues due to improper disposal of some agricultural wastes. The advantages of using the biomass bio-briquettes are as follows: (1) cost effective; (2) renewable source; (3) no sulphur and therefore it is unable to pollute the environment; (4) it has a higher calorific value than other solid fuel sources; (5) ash content in bio briquettes is lower than coal at 2–10% and 20–40%, respectively; (6) its combustion is more uniform compared to coal; (7) they produced near the consumers; therefore, supplies are not dependent on transportation over long distances; and (8) due to the low moisture content and higher density, it provides much higher boiling efficiency compared to firewood or waste biomass (Sharma et al., 2015). Therefore, bio briquettes generally have better energy parameters, higher density, calorific value, and lower water content than other raw materials (Stolarski et al., 2013).

Over the past ten (10) years, there have been several researches about the development of biomass briquettes from different organic wastes. There are limited existing comprehensive studies about the process, methods, and utilization of biomass from different agricultural waste. Say, for instance, Ifa et al. (2020) focused on bio-briquette from cashew nutshell waste; Nuriana et al. (2014) widely discussed the durian peel bio-briquettes as an alternative fuel; and Ahmad et al. (2018) mainly focused on the characterization of fuel briquettes from banana tree waste. However, there has been no inclusive review conducted focusing on the processes and methods involved in briquetting the various agricultural wastes. Bio-briquettes are more sustainable and energy-efficient for heating energy due to its affordability, accessibility, and versatility for meeting people's needs. It offers a low cost for cooking, heating homes, and powering industrial activities that are more beneficial than other products. However, the production and quality evaluation process differ depending on the waste being utilized. Thus, it is the primary goal of the present study to give a comprehensive overview of the production of bio-briquettes from agricultural wastes including its methods, processes and quality. Additionally, this paper will be a great help in the agricultural sector, particularly farmers and biomass fuel producers to know about briquette production and utilization methods.

Likewise, this specific review will be beneficial to researchers who get involved and are concerned with the utilization of bio-briquettes as an alternative source of energy. 2. Overview of agricultural waste production Agriculture is one of the largest biological sectors with the highest biomass production (European Commission, 2015), which becomes an essential input for the bio-economy,(Bracco et al., 2018; European Commission, 2017b). This represents a great opportunity because it contributes to the development of new green markets and jobs by promoting the conversion of agricultural waste that includes vegetable and fruit waste into value-added products such as food, feed, bio-products and bio energy (European Commission, 2017a; Scarlat et al., 2015).

However, as the population gradually grows day by day, the food and energy demand continues to increase. Agricultural production has increased more than three times over the last 50 years because of the expansion of soils for agricultural use; the technological contribution of the green revolution which influenced productivity; and the accelerated growth of population (FAO & OECD, 2019). By this, it is expected that the more growing numbers of production, the more agricultural wastes will surmount. Agriculture produces an average of 23.7 million food tons per day worldwide (FAO, 2017). Additionally, agricultural waste is defined as wastes during the production and processing of food and fiber on farms, feedlots, ranches, ranges, and forests

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which may include animal manure, crop residues, and dead animals; and also agricultural chemicals(residues and containers) that to contribute contaminants to surface and subsurface water (Quartey, 2011). Moreover, a significant increase in agricultural wastes is e-ISSN: 2716-6236 observed globally as developing countries intensify their farming systems. It is estimated that 998 million tons of these wastes are produced annually (Obi et al., 2016). The composition and amount of agricultural residue produced vary on different biomass; and many more.

Fig. 1.1 Collecting Raw Material Image

Methodology

Study Site and Raw Material Study was carried out at Forest College and Research Institute, Mettupalayam, Tamil Nadu Agriculture University, India and College of Agriculture, Coimbatore, Tamil Nadu Agriculture University, India. A Briquetting unit was installed in FC and RI during 2009, which is running regularly. All type of forest and agricultural waste were the major raw materials used for the briquetting production. These were collected from industries around Mettupalayam to run the machinery. The process of compaction of residues into a product of higher density than the originalraw material is known as densification or briquetting. Densification has aroused a great deal of interest in developing countries all over the world lately as a technique for upgrading of residues as energy sources. Following raw materials were used to production of briquettes (Table 1 and Figure 1) (Tripathy et al., 1998).

Method Following steps were adopted to prepare briquettes at the department. 1. Drying: Drying is essential part of briquetting production as per used raw material. A moisture content of 8-12% is normally ideal for agricultural wastes and wood densification. The maximum allowance of moisture content in mechanical piston presses is 15%, whereas hydraulic systems can handle moisture contents up to 15-30 %, depending on design of machine. Used model was Random Piston Type model. 2. Comminuting (sizing raw material): The raw material used in production of briquettes must be of a suitable particle size before it enters the densification process. The particle size should not exceed 25 % of the diameter of the final product for most densification equipments (Bhattacharya, 1989).

3. Conditioning: To make the raw material softer and easier to work within the densification process, superheated steam added in the stage between comminuting and densification (Hirsmark, 2002). A softer raw material contributes to binding the material together and results in briquettes that do not fall apart easily.

4. Densification: There are a few different technologies for production of briquettes; mechanical- or hydraulic piston press densification, screw press densification and roll press densification units.

5. Cooling: To allow the briquette to cool off in an optimal way, most piston press systems need a cooling track where the material slowly can drop in temperature before they fall apart into desired lengths (3 metre).

6. Storing and transporting: After cooling, the briquettes are normally stored before combustion. Storing may take place outdoor under roof, indoor, in container or in other ways. The transport from production unit to combustion is by truck and tractor.

7. Combustion: Most of the combustion plants for solid fuels can utilize briquettes. Industrial boilers though are most suitable for and convenient with the task. In the cases where the briquettes are turned into powder after transport to the heating plant, combustion takes place. Used model for briquetting production was Random Piston Type model (Figure 1).

8. Calorific Value: The calorific value was determined by using Oxygen bomb calorimeter in accordance with Standard Method by the Bioenergy Department, Tamil Nadu Agricultural University, and Coimbatore (Tamil Nadu) India. Calorimetry is the science of measuring quantities of heat, as distinct from “temperature”. The instruments used for such measurements are known as calorimeters. The calorific value (heat of combustion) of a sample may be broadly defined as the number of heat units liberated by a unit mass of a sample when burned with oxygen in an enclosure of constant volume. In this

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reaction the sample and the oxygen are initially at the same temperature and the products of combustion are cooled to within a few degrees of the initial temperature; also the water vapor formed by the combustion is condensed to the liquid state. The initial and final temperatures are not the same – differing by the amount of temperature rise in the calorimeter – but the effect of this difference is small and usually it is neglected. Thus the term calorific value (or heat of combustion) as measured in a bomb calorimeter denotes the heat liberated by the combustion of all carbon and hydrogen with oxygen to form carbon dioxide and water, including the heat liberated by the oxidation of other elements such as sulfur which may be present in the sample (Parr Instrument Company, 2013)

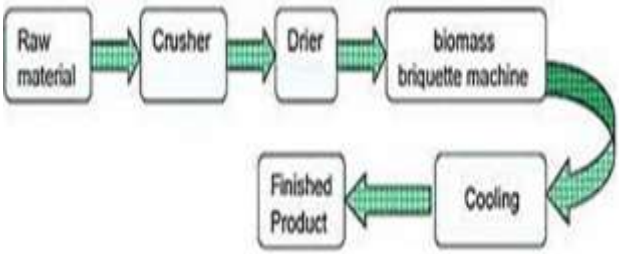

Fig. No. 1.1 Preparation Method of Composite Briquettes From Agriculture Waste.

The process of converting residues into a densified form has the following advantages - it helps to solve the problem of residue disposal, thereby reducing pollution due to waste disposal; usage of briquettes instead of coals results in reducing considerable amount of emission of pollutants into the environment; the process is cost effective because raw materials for this process are derived from waste resources; it creates employment opportunities to the rural people[12,13]; transportation of the above fuels is very safe and easy to handle compared with other form of fuels, such as coal, petroleum products, etc.; and briquette can be used in various fields, such as hotels, dairies and various industries for burning purpose instead of firewood, coal, LPG, etc.

CONCLUSION

This experimental work focuses on developing a method to manufacture briquettes of consistent quality at low pressures by employing a wet technique and suggests a way to burn them in a controlled manner. These techniques were used to carry out a study on cylindrical-shaped briquettes, observing the result of process variables (density, moisture content and size) on briquette burn rate with different volume fractions of waste paper. The physical, chemical and thermal analyses were carried out using a bomb calorimeter. Therefore, the products of briquetting can be compared with coal and firewood materials and also the results can formulated. The hand press type can be improved with the help of pneumatic air supply, which will be useful in small-scale applications such as hostels and schools.

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