

Exploring the Potentialities and Future of Biomass Briquettes Technology for Sustainable Energy

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Abstract

This paper finds meaning for organic wastes and its management in a way that the resultant method provides a sustainable solution. Facts reveal that 60% of wastes discarded in landfill are organic and could have been recycled. The ignorance on available recycling technology and its popularity is a threat to mankind. In an era where industries are growing Multifold so as the population, the dependable fuel resources are depleting and alarming. The available fuels are also in an expensive way thus giving research opportunities to explore innovative energy sources. In this manuscript, the sustainable solution of briquetting the bio-mass has been addressed so that the scholars, research fraternity and entrepreneurs will be motivated for their contribution thereby restoring the balance in nature.

Keywords: Biomass; Briquette; Organic waste; Waste management; Recycling; Briquetting

Introduction

Increasing solid wastes is a major threat in the world today. It is a bigger concern in Least Developing Countries (LDC) due to the health and environmental concerns associated with the waste disposal. Observing 52% of organic waste and 26% of recyclables both of which can actually be upcycled, this ignorance on waste recycling and ineffectiveness in the existing waste management system is the focal point of this article [1]. In the current scenario of ever-growing fuel prices we can see that firewood and LPG is getting too expensive and in-case of former material it is a pollutant. We cannot afford to take more risk with already alarming greenhouse gas and ozone changes [2]. Over exploitation of natural resources is result of the increasing human population which implies a thrust on demand for new sources of energy. Multifold increasing price of the fuel is yet another major driving force that kindles the need to explore innovative sources of energy.

Biomass

Biomass is a material from nature, which can be used a source of fuel. Such an organic waste can either be decomposed by micro-organism (bio-chemical) or thermally compacted (thermo-chemical) to be converted into a form of energy. The latter is chosen in bio-mass briquetting. The advantages of utilising bio-mass include the use of loose biomass and thereby preventing air pollution. Such a bio-mass will be more oxygen and low carbon which is a good property for briquette [3]. The process helps in increasing the density and durability of the briquette since a pressure of 1000 kg/m³ is involved. Also, a major factor is that various industries around the globe are using coal for thermal/heating purpose that emit greenhouse gases which will be a reason for climatic change. This bio-mass briquetting will be a good source of income generation for the rural people in addition to providing clean energy with sustainability.

Nature of biomass

Wastes from nature like the leaves, wood, wood waste, crop wastes from agriculture, animal waste and aquatic wastes have potential to be used as bio-mass briquettes (Figure 1). These are usually available for free or sourced at a cheap rate. In a country like India, with wide range of flora and fauna, the unlimited source of natural resources opens

vistas in recycling the organic waste into a source of energy. Usually materials from nature will be made of cellulose, hemi cellulose, lignin and ash [4].

In general bio-mass cannot be used directly as they are fluffy, uneven in shape and low in density. Post harvesting period, the farmers find them to be a huge trouble, considering the time taken for decomposing, burning or dumping on landfill to the and space it takes during storing the wastes [5]. The choice of raw materials is huge and varied. It includes saw dust, sander dust, secondary pieces of wood, tree barks and twigs, pine needles, wild grass, coffee husk, sunflower waste, rice husks, groundnut shell, almonds shell, cotton stalks, sugarcane bagasse, leaves, trash and the endless possibilities from nature. Other bamboo dust, mustard husk/stalk, pine needles, sugar mill waste, jute waste, coir pith and other wastes & residues like castor shell, red gram stalk, tobacco stem, tea waste, sander dust, tree bark, wild grasses & shrubs.

Briquetting

Biomass briquette is used in poor developing countries as an alternate to cooking fuel. Due to technical constraints and lack of knowledge the briquetting technology is not very popular in various parts of the world. Encountering operational problems and varied quality of raw materials are important issues for less popularity of briquetting technology. It is a technique which involves compression of small particles of organic waste with a binder for a specific period of time resulting in a pellet or a briquette block (Figure 2).

Advantages of briquetting

Briquettes have higher thermal value, low ash content and uniform

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Figure 1: Bio-mass briquettes of various shapes and sizes.



Figure 2: Briquettes made from various sources.

rate of combustion along with being cheaper than coal. Low moisture and high density of briquettes gives it better boiler efficiency. Oil, coal, lignite once used cannot be replaced, but bio-mass briquettes can be recycled as compost. The absence of sulphur, fly ash in briquettes makes them eco-friendly [6]. The ideally sized structure for complete combustion is an added merit. The briquettes have low smoke with no odour and a steady flame. There is a good will to carry an eco-friendly label because of reducing the hitherto polluting waste forms a major quote for marketing and its popularity.

On the other hand, briquettes can be an alternative to diesel, kerosene, furnace oil, lignite, coal and firewood [7]. Every industry and domestic use fuel and energy, a means of using an alternative fuel like the bio-mass briquette can be very encouraging for the renewable energy sector of the world. The ready market, high profit, good growth potential, wide choice of raw materials, easily available of raw materials make briquetting easy choice. Ease in storage and transportation, substitute for coal is major reasons to consider bio-mass briquettes as an energy alternative.

Process of briquetting

The moisture in the raw material is expected to be less than 12%. In order to lower the value in case of high moisture it can be dried in sun or a biomass rotary/turbo dryer can be employed [8]. The collected agro wastes will be usually the collected and subjected to crushing, then drying and further briquetted. The journey transcends from screw conveyor to hopper then to kupy through motor. As compression

Methods of briquetting

There are three methods of briquetting namely hydraulic, stamping and screw press briquetting machine (Figure 4). Each of them has raw material of different size and moisture, density, capacity, energy, lifetime of mould, PLC, noise, working environment and users which are listed as in Table 1 below.

Testing of Biomass Briquetting

Moisture content of raw material is the most important parameter in selecting the source for bio-mass briquette. Proximate analysis and moisture content at 100 degree Celsius. Calorific value represents the heating value of the bio-mass briquette. It can be found by using bomb calorimeter. Other tests include flame temperature, thermogravimetric analysis, ignition time, burning time, absence of toxic gases in the burnt bio-mass briquette, fixed carbon, density of briquette, ash content, volatile compounds in the gas [4,9].

Applications of Biomass Briquettes

Biomass briquettes can be used in textile dyeing industry, printing mill, milk industry, Ceramic, chemical and solvent extraction units, leather industry, brick making and thermal units. Lehra Fuel Tech Pvt. Ltd, Punjab (approved by IREDA) is one of the largest briquetting manufactures in India [10].

Companies Dealing with Briquetting

Biomass can be made into pellets or briquettes. There are many successful companies who ae working with this namely German Pellets, Enviva, Pinnacle Renewable Energy Group, Pacific BioEnergy

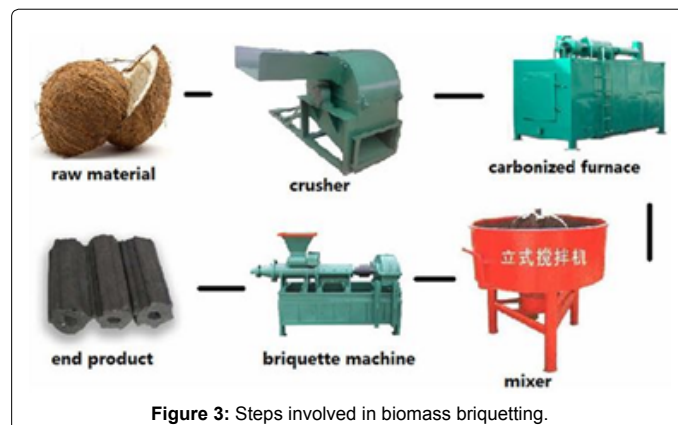


Figure 3: Steps involved in biomass briquetting.

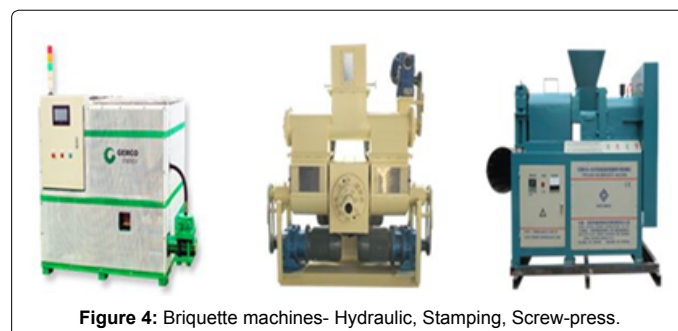


Figure 4: Briquette machines- Hydraulic, Stamping, Screw-press.

increase, pressure increase and temperature raise, lignin acts as a natural binder and helps in compaction. The product will be ejected out, and then cooled to get the finished product (Figure 3).



Figure 5: Briquette from husk-bran-charcoal in rocket and charcoal stove.




	Hydraulic briquetting machine	Stamping Type Briquetting Machine	Screw Press Briquetting Machine
Raw material size / mm	3-20 mm	3-20 mm	3-5mm
Raw material moisture required	6%-18%	10%-20%	8%-12%
Product profile	 Φ=70 mm	 Φ=70 mm Pellet: 8 mm, 10 mm, 22 mm, 30 mm	 Φ=40 mm, 50 mm, 60 mm, 70 mm
Product density/ g/cm3	0.8-1.2	0.9-1.3	1-1.3
Capacity/ kg/h	125	800-1200	180-1000
Energy consumption/ kW/t	40-60	40-50	70-80
Mould lifetime	1000 h-1500 h, cooling not required to mould	1000 h-1500 h, cooling required to mould	1500-2000
PLC	yes	Yes, and vibration resistance	N/A
Noise	Lower than 70 db	Higher than 85db	Around 80db
Working environment	Dust free	Dust free	With smoke and ash
Users	High requirement with automatic control and working environment, complicated raw material component.	High requirement with capacity (1-5 t/h)	Typically, the briquettes will be further processed to charcoal briquettes

Table 1: Different types of briquetting machine and the characteristics features of each.

Corporation, Vyborgskaya Cellulose, Rentech, Graanul Invest Group, RWE Innogy, Lignetics, E-pellets, Drax Biomass, General Biofuels, BlueFire Renewables, Pfeifer Group, Biomass Secure Power, Viridis Energy, Westervelt, Energex, Fram Renewable Fuels, Protocol Energy, Premium Pellet Ltd., Granules LG, Enova Energy Group, Corinith Wood Pellets, Maine Woods Pellet, Appalachian Wood Pellets, Bear Mountain Forest Prod, Agropellets, West Oregon Wood Prod, Bayou Wood Pellets, Neova Vaggeryd, Aoke Ruifeng, DEVOTION, Sinopeak-bioenergy, Senon Renewable Energy, Equstock, Weige Bio-tech Energy, New Biomass Holding LLC, Verdo Renewables and Binderholz [10,11].

Explorative Researches on Energy through Briquetting

Many researches are done on utilising the organic wastes into briquetting. Water hyacinth, the fastest growing plant can be economical, eco-friendly considered as an effective material for briquetting. The material can be used as a cofiring agent in power plants involved in energy production. Biomass residues as briquettes have progressive future as the ash after burning can be used as compost for plants soil amendment with better chemical and hydro-physical properties [12]. The exploration of briquetting technology enables in economically viable and environmentally friendly solution. The research was done

using cotton ginning waste for briquetting and found that 52% of the company's thermal requirement was able to be met by this new source alternative to the fuel oil [6,13].

Particle size, compacting pressure and briquette quality can also be compared. Reduced particle size and increased pressure reduced the combustion rate. Instead of using a potential energy source by burning off and releasing greenhouse gases, studies can be done to improve the efficiency and quality of the manufactured bio-mass briquette. Since bio-mass is made from materials that help in reducing CO₂ from air, they are claimed to be CO₂ neutral. It is also hygiene to handle wastes in this technique [5,12].

A study on straw, rice husk and saw dust can also be combined into a briquette using compound lever (made of wood) press technology, which is compacting without the help of heat energy. The combination of binder and bio-mass was varied, and tested. The binder and bio-mass ration decrease calorific value decrease, volatility decrease, moisture content decrease, ash content increase (wood has minimum ash), fixed carbon increase [11]. The researches not only focused on straw and husk but also on the twigs that fall off the trees. Another study on the use of twigs of *Pterocarpus indicus* for briquetting explains that the twigs were mixed with tapioca starch in various proportions of which the 90:10 has highest calorific value. It was proved that the smaller the particle size the better the briquette quality. Experiments also confirmed higher the pressure better the quality of briquette. The particles of 60 mesh size were compacted at a pressure of 2 MPa. Flame temperature was 515°C, ignition time 251 seconds, burning time of 6590 seconds and combustion rate of 0.00303 gram/second [5].

Rice and coffee husk cassava and clay as binders were made into briquettes. Physical properties, drop strength and calorific value are influenced by the type of binder used. Mechanical and storage integrity of the briquette can be found by drop test briquette. The HHV of cassava with coffee husk and rice husk were 22-23 MJ/kg and 16-17 MJ/kg. The value for clay with coffee husk and rice husk were 13-20 MJ/kg and 10-14 MJ/kg. Compared to clay and cassava, the latter had performed as excellent binder with drop strength up to 94%.

The groundnut shell and sugarcane waste (bagasse) were mixed with cassava (tapioca) flour and wheat flour as binders. Two types namely carbonised and non-carbonised were taken and compared in two different pressure levels. The selected sources (agro-wastes) were carbonised and 1000 grams the resulting material (bio-char of groundnut shell and bagasse) was mixed with 30, 50, 70, 90 g of binders and briquetted in low pressure. Another set of briquettes in high pressure was developed with and without binder. Sample 1 had 1000 grams of groundnut shells at without binder, sample 2 with 250 grams of cassava flour binder, sample 3 with 250 grams of wheat flour binder briquetted at a high pressure of 230 MPa. Thermo-physical properties were evaluated using thermo-gravimetric analysis. Bomb calorimeter for determining the calorific value. Flame temperature was also tested. Drop test was done to check the compaction of the particle in the briquette. The heating value and drop strength was found to be good in non-carbonised briquettes with values as 16 MJ/kg and 99%. Carbonised briquettes of ground nut shell waste and bagasse has

heating value of 21-23 MJ/kg [9].

The rice bran, husk and palm were briquetted using locally fabricated multi-piston press. The husk-bran and all three bran-husk-palm had good fuel properties (Figure 5). The results conveyed that the calorific value is less than charcoal and low start up time too [9].

Conclusion

Briquetting or pelletizing is the process to improve the characteristics of biomass as a renewable energy resource by densification. Densification means less volume needed for the same amount of energy output. Briquetting raw material should have the goal to give a higher value to an existing product. This might be to lower transportation costs or to enable the use of a material as fuel, the aim should be clear. The tiny particle size (from 60 reduced to 1200 kg/m³), 40% better burning efficiency, smoke and ash free nature and ease in transportation are key factors for promoting briquettes for energy conservation.

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