A Review on Briquettes as an Alternative Fuel

Shaikh Ateek Ahmed
Department of Chemical Engineering
Thadomal Shahani Engineering College, Mumbai, Maharashtra, India

Anita Kumari
Department of Chemical Engineering
Thadomal Shahani Engineering College, Mumbai, Maharashtra, India

Ketan Mandavgane
Department of Chemical Engineering
Thadomal Shahani Engineering College, Mumbai, Maharashtra, India

Abstract- In India, millions of tons of agricultural wastes are generated which are either destroyed or burnt in loose form which cause environmental pollution. These wastes can be recycled and can provide a renewable source of energy by converting biomass waste into high density fuel briquettes with or without addition of any binder. In comparison to wood or coal the biomass briquettes have low ash content as well as low moisture level. Various technologies are used for biomass briquetting. Among those, reciprocating ram/piston press and screw press technology is used widely. Although both the technologies have their merits and demerits, the screw press briquettes are more superior than ram pressed briquettes due to their storability and combustibility. These briquettes are used in gasifiers and the end products of gasifiers are used as fuel gas in burners.

Keywords – Agricultural Waste, Briquetting, Alternate Energy, Gasifiers

I. Introduction

In India a large quantity of agricultural waste is generated every day. These are either dumped off or burned inefficiently causing extensive pollution to the environment. This results in large amount of transportation costs and man power. If it is used for some other productive purpose then the burning produce low thermal efficiency and pollute the environment. To overcome these problems, the concept of "Biomass Briquettes" is used. Biomass briquettes are made from agricultural waste and are a replacement for fossil fuels such as oil or coal. Briquetting of residues takes place with the application of pressure, heat and binding agent on the loose materials to produce the briquettes. The briquettes can be used for domestic purposes (cooking, heating, barbequing) and industrial purposes (agro-industries, food processing) in both rural and urban areas.

II. Factors Affecting Densification/ Briquetting

There are many factors which are to be considered before a biomass is to be qualified as feedstock for briquetting. For different briquetting machines, the required parameters of raw materials like their particle size, moisture content, and temperature are different.

A. Effect of particle size –

Particle size plays an important role in the densification process. Fine particles give larger surface for binding. The biomass material of 6 – 8 mm size with 13 – 15 % powdery component (<4 mesh) is best suited. If the particles are oversized, then the briquetting will not be smooth and it will result in clogging at the entrance of die which ultimately leads to jamming of machine.

B. Effect of moisture–

Moisture content plays an important role since it facilitates heat transfer. Generally when the feed moisture content is 8 – 10 %, the briquettes will have 6 – 8 % moisture content. If this amount of moisture content is maintained, then the briquetting process is smooth. But when the moisture content exceeds 10%, the briquettes are poor and weak and the briquetting process is not feasible**.** Also at high moisture content, excess steam is produced leading to the blockage of incoming feed from the Hooper. Hence it is necessary to maintain the optimum moisture content.

C. Effect of Temperature–

The temperature of biomass has variation with the briquette density, briquette strength and moisture stability. Hence unlike above mentioned parameters, temperature also has a critical effect in densification process. The temperature of biomass, however, should not be increased beyond its decomposition temperature which is around 300 °C. If the temperature is higher than this value, then the friction between the raw material and die wall decreases such that compaction occurs at lower pressure which results in poor densification and inferior strength. On the contrary, low temperature will result in higher pressure and power consumption and lower production rate.

III. Biomass Briquetting Process:

The raw materials used in briquetting process are as follows:

Rice husk: Rice husk is available with 10% moisture and the ash contains lesser alkaline minerals.

Groundnut shell: Because of low ash (2-3%) and a moisture content of less than 10%, it is also an excellent material for briquetting.

Cotton sticks: This material is required to be chopped and then stored in dry form.

Coffee husk: An excellent material for briquetting having low ash and available with 10 percent moisture content.

Mustard stalks: Like cotton sticks, it is also an appropriate material for briquetting.

The process to make briquettes is may not compulsorily require binders. But in some cases binders are added to give proper shape. The natural binder lignin is readily available in wood. In some cases starch is added in little quantity as a binder.

This process involves two major steps:

(a) Semi fluidizing of the biomass through the application of high pressure (at the range of 1200-1400 kg/cm^2) under which condition the residue gets heated to about 182°C, and the lignin (material of which cell walls are made) begins flow and act as a binder.

(b) Extracting the diversified material around the room temperature. When densification is done in the above manner (semi fluidizing), there is no need to add external agent like glue or binder. The machines are available in the capacity range of 100-3000 kg/h operating on electric power.

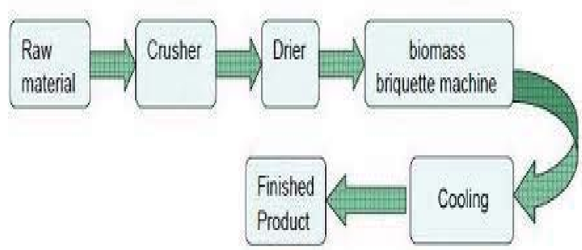

Figure 1.Steps involved in briquetting

IV. BIOMASS BRIQUETTING TECHNOLOGIES

There are different types of technologies available for briquetting process. The technologies differ from each other on the basis of equipments used. The most commonly used technology in India is Piston Press and Screw Press technology. These are the high compaction technology i.e. the biomass is compacted very tightly to form a briquette. In Piston Press Technology the power consumption is high as compared to Screw Press Technology. Though Screw Press Technology consumes more power, the quality and method of production of briquettes is superior on comparison with Piston Press Technology.

A. Piston press Technology-

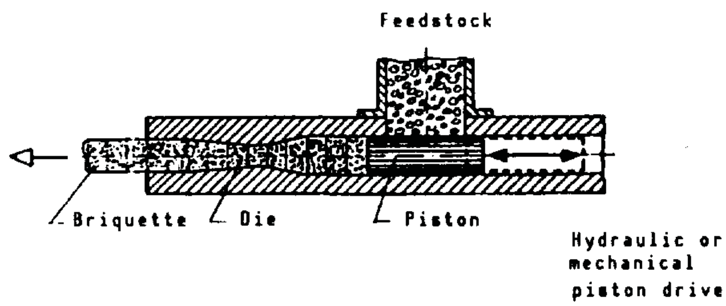

Figure 2.Piston press machine

The piston press technology is also known as ram and dies technology. Here the biomass is punched into a die by a reciprocating ram with very high pressure ultimately compressing the mass to obtain briquettes. The briquettes produced have external diameter of 60 mm. This machine has a 700 kg/hr capacity and the power requirement is 25 kW. The ram moves approximately 270 times per minute in this process. The hydraulic press process consists of first compacting the biomass in the vertical direction and then again in the horizontal direction. The standard briquette weight is 5 kg and its dimensions are: 450 mm x 160 mm x 80 mm. The power required is 37 kW for 1800 kg/h of briquetting. This technology can accept raw material with moisture content up to 22%.

B. Screw press Technology-

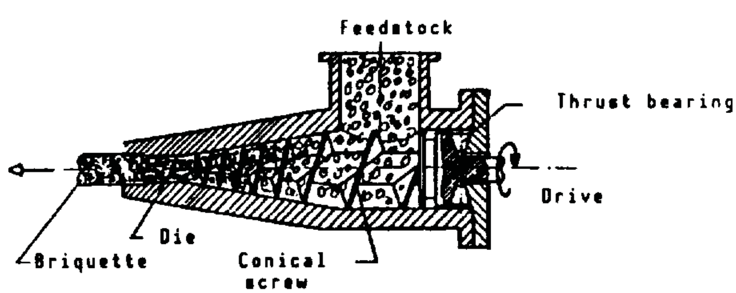

Figure3.Screw press machine

The dry raw material free from foreign matter (like iron pieces, stones, etc.) is fed into the hopper of the Screw Extruder. From the hopper, the raw material flows into the compressing zone (screw extruder) where from it enters into the heating chamber (barrel). The heating chamber is controlled thermostatically at a pre-set temperature. From the heating chamber the briquette is formed and extruded out continuously. The process requires no binder or any other material. However it is essential that the initial moisture content and size of biomass is less than 12% and 4mm respectively. The capacity of the machine employed is 100 – 150 kg/hr. The diameter of briquettes produced is 75mm.

V. APPLICATION OF BIOMASS BRIQUETTES

The briquettes are utilized in gasifiers. Gasification is a process in which combustible materials are partially oxidized or partially combusted. The process is carried out in oxygen lean environment.

Gasifier:

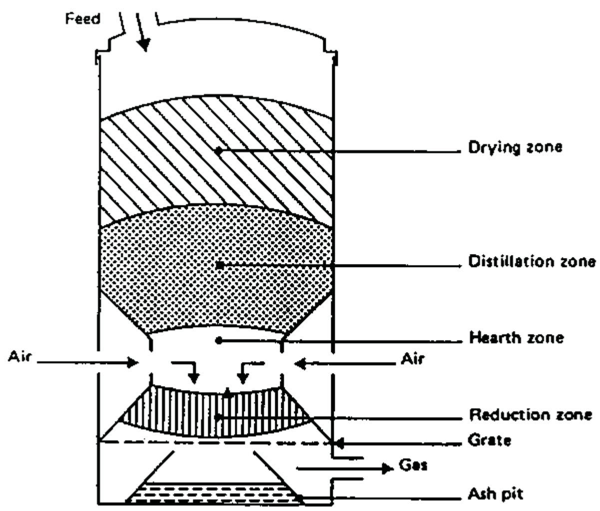

Figure 4.Gasifier

The working of gasifier can be understood by dividing it into various zones.

A. Drying zone-

Briquettes are introduced into the gasifier at the top. Due to heat transfer from the lower parts of the gasifier, drying of the wood or biomass fuel occurs in this section. The water vapour flow downwards and add to the water vapour formed in the oxidation zone. Part of it may be reduced to hydrogen and the rest will end up as moisture in the gas.

B. Pyrolysis Zone-

At temperatures above 250°C, the briquettes start pyrolysing. The large molecules such as cellulose, hemi-cellulose and lignin break down into medium size molecules and carbon (char) during the heating of the feedstock. The pyrolysis products flow downwards into the hotter zones of the gasifier. Some will be burned in the oxidation zone, and the rest will break down to even smaller molecules of hydrogen, methane, carbon monoxide, ethane, ethylene, etc. if they remain in the hot zone long enough. If the residence time in the hot zone is too short or the temperature too low, then medium sized molecules can escape and will condense as tars and oils, in the low temperature parts of the system.

C. Oxidation Zone-

A burning (oxidation) zone is formed at the level where oxygen (air) is introduced. Reactions with oxygen are highly exothermic and result in a sharp rise of the temperature up to 1200 - 1500 °C. The important function of the oxidation zone, apart from heat generation, is to convert and oxidize virtually all condensable products from the pyrolysis zone. In order to avoid cold spots in the oxidation zone, air inlet velocities and the reactor geometry must be well chosen.

D. Reduction zone-

The reaction products of the oxidation zone (hot gases and glowing charcoal) move downward into the reduction zone.

In this zone the sensible heat of the gases and charcoal is converted into chemical energy of the producer gas. The end product of the chemical reactions that take place in the reduction zone is a combustible gas which can be used as fuel gas in burners and after dust removal and cooling is suitable for internal combustion engines. The ashes which result from gasification of the biomass should occasionally be removed from the gasifier. Usually a moveable grate in the bottom of the equipment is considered necessary. This makes it possible to stir the charcoal bed in the reduction zone, and thus helps to prevent blockages which can lead to obstruction of the gas flow.

VI. ADVANTAGES AND DISADVANTAGES OF BRIQUETTES

A. Advantages of biomass briquetting-

- Briquettes have a consistent quality, high burning efficiency, and are ideally sized for complete combustion.
- The process helps to solve the residual disposal problem.
- It provides additional income to farmers and creates jobs
- There is no sulfur in briquettes.
- There is no fly ash when burning briquettes.
- The briquette is easy to ignite.

B. Disadvantages of biomass briquetting-

- High investment cost and energy consumption input to the process
- Undesirable combustion characteristics often observed e.g., poor ignitability, smoking, etc.
- Tendency of briquettes to loosen when exposed to water or even high humidity weather.

VII.CONCLUSION

In this paper a thorough study on biomass briquetting is done. The various briquetting technologies along with their merits and demerits are studied. It is concluded that briquettes produced from biomass are fairly good substitute for coal, lignite, firewood and offer numerous advantages. . The energy content of briquettes range from 4.48 to 5.95 kilojoules per gram (kJ/g) depending on composition, whereas the energy content of sawdust, charcoal and wood pellets ranged from 7.24 to 8.25 kJ/g.

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