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Briquetting of Agricultural Biomass: An Overview

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Abstract: Briquetting is a good idea to utilize low grade combustible materials obtained from biomass sources. Biomass is the third largest primary energy resource in the world, after coal and oil. In all its forms, biomass currently provides about 1250 million tonnes oil equivalent (mtoe) of primary energy which is about 14% of the world's annual energy consumption. The technology converts the biomass waste into forms, which are combustible in typical burners.

The basic concept of Briquetting is not new in India, as the preparation of cow dung cakes and balls of coal dust have been in use for many decades. Briquetting of biomass has been found to be a viable technology for upgrading biomass material, including agricultural residues, particularly in India where there are abundant bio waste resources. A reduction in the volume of the material provides its technological benefit i.e. the material could be transported and stored more economically than is possible at present.

Studies demonstrated that wheat straw, cotton stalk, olive refuse, molasses, pipe cone, saw dust, rice husk, bagasse, groundnut shells, waste paper and lignite blends or their mixtures can be compressed to a relative density greater than unity and stabilized at that density with or without binder material.

The advantages of briquetted fuel include: the ease of charging the furnaces, increase in calorific value, improvement of combustion characteristics, reduction of entrained particulate emissions, uniformity in size and shape and good substitution for natural fuel wood. The use of biomass feedstock for the substitution of fossil fuel has an additional importance from climate change considerations since biomass has the potential to be CO2 neutral.

I. INTRODUCTION

A. Overview

Some biomass waste from saw mills and agro processing industries can be readily used as fuels. These include wood off cuts and leftover slabs from saw mills, coconut shells, corncobs, cotton stalks, coffee husks and wheat and rice straws. The majority of other residues comprise smaller particles in loose form, which makes them unsuitable for direct combustion. Furthermore, their bulk density or heating value per unit volume is much lower, thus making it technically unfeasible for direct use due to combustion and handling problems [1].

Briquetting (densification) of loose and smaller biomass waste is an attractive option for fuel utilization in industrial stoker furnace combustion systems. It is known that in most developing countries, the demand for wood fuels is increasing faster than the sustainable supply, the consequence of which is the deforestation of vast woodlands. An application of briquetting technology for biomass waste conversion appears to be an attractive solution, especially in areas where the bio waste resources are substantial and unutilized [1].

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B. Background

In India about 46% of total energy consumption is estimated to be met from various biomass resources, i.e. agricultural residues, animal dung, forest wastes, firewood, etc. India produces a huge quantity of agricultural residues and a major part of it is consumed in traditional uses (such as fodder for cattle, domestic fuel for cooking, construction material for rural housing, industrial fuels for boilers etc.). The direct burning of agricultural residues in domestic as well as industrial applications is very inefficient. Moreover, transportation, storage and handling problems are also associated with its use. One of the approaches that is being actively pursued worldwide towards improved and efficient utilization of agricultural and other biomass residues is their densification in order to produce pellets or briquettes. The briquetting of biomass improves its handling characteristics, increases the volumetric calorific value, reduces transportation costs and makes it available for a variety of applications [3].

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Table: 1 Agricultural residue availability (kg) per tonne of grain produced and its alternative uses [9]

Crop	Crop Residue	Residue to Crop ratio	Agricultural residue availability (kg) per tonne of grain produced	Potential alternative uses
Groundnut	Groundnut shell	0.33	330	Domestic fuel, cattle feed
Wheat	Wheat straw	1.47	1470	Cattle feed
Paddy	Rice husk	0.33	330	Domestic fuel, cattle feed,
	Paddy straw	1.53	1530	Domestic fuel, cattle feed,
Sugarcane	Bagasse	0.25	250	Energy feedstock in sugar
Cotton	Cotton stalk	3.00	3000	Domestic fuel
Arhar	Arhar stalk	1.32	1320	Domestic fuel
Corn	Corn cobs	0.30	300	Domestic fuel
	Corn stalks	1.56	1560	Cattle feed, domestic fuel
Jute	Jute sticks	2.30	2300	Domestic fuel
Mustard	Mustard stalks	1.85	1850	Domestic fuel

C. Objective

Diesel oil powered irrigation pumps presently irrigate millions of small farms in India. These dispersed diesel irrigation pumps can potentially be fuelled by producer gas obtained from gasifying biomass feed stocks. The most common size of these diesel engine operated pumps falls between 5 and 10 bhp. Most of the gasifiers installed in India are of down draft type and properly sized wood pieces are commonly used as the fuel. In the present energy scenario, the forest resources are diminishing and the requirement for wood is increasing day by day due to the increase in population. However, the production of firewood is decreasing due to the destruction of our forest cover. The gap between consumption and recorded production of fuel wood seems to be widening. Urgent steps are needed to stop unscrupulous felling of trees to prevent more damage to environment and destruction of our forests. Fortunately availability of agricultural and agro-industrial residues is increasing day by day due to increase in agricultural production. In spite of very high-energy potential of these residues, it cannot be in small / medium gasifiers [2]. The ideal answer in this situation is to convert these residues into High Density (1200 kg/m^3) and High Value solid fuel (14650 to 20929 KJ/kg), i.e. \

D. Briquettes.

According to a survey of Gujarat state, it was found that most of the briquetting plants situated in the state have Die and Punch mechanism. The Diameter of briquettes produced is 60 and 90 mm size. These size of briquettes are difficult to us in small / medium gasifiers. There is a need to produce biomass briquettes of smaller diameter [2].

Agricultural residues have acquired considerable importance as biofuels for domestic cooking, industrial process heating, electrical power generation, etc. and are used directly as well as in Briquetted form for a variety of energy end uses. To formulate and implement long-term strategies for efficient and economic utilization of agricultural residues as feed stocks for energy conversion and utilization, it is important to estimate their monetary value [2].

Some coals tend to form enormous amount of dust. When coal dust is not taken under control properly, it is transferred into ground water and to even far places by natural means, leading serious environmental problems. Therefore, utilisation of coal dust is extremely significant considering both disposal and benefit. Production of briquettes from coal dust is one of the important techniques to use coal dust, and it has been applied for a long time. However, it is difficult to obtain strong briquettes from hard coals without using any binding agent. For this purpose, various binding agents, some of them is even non-combustible or some of them are directly harmful to the environment, have been used. Well-known binding agents are molasses, fibrous and oily organic wastes, sawdust, bitumen, pitch, sulphite liquor, starch, limestone, dolomite, etc. Biomass has fibrous structure, and it is one of the important renewable energy sources. However, it has low density and high moisture compared with fossil fuels [5]. Consequently, combustion of biomass without any pre-treatment is not favorable. Moisture content must be decreased before combustion, and its density should be increased to a degree at which transportation expenses becomes less.

Principal techniques applicable to biomass to gain its energy potential are pyrolysis and anaerobic digestion. On the other hand, a few investigations have taken place focusing on the briquetting capacity of biomass. Biomass usually has fibrous structure and contains oily or sticky components, which facilitate to form a more dense bulk. Biomass may behave as a binder during briquetting when it is mixed with hard coal. In this study, some biomass samples such as molasses, pine cone, olive remnants from oil production, sawdust, refuse of paper industry, and cotton refuse were blended with Turkish lignite and briquetted together. Effects of the ratio of biomass to lignite, moisture content, and briquetting pressure on the strength of the briquettes were investigated [7].

II. BRIQUETTING

A. Raw Materials for Briquetting

Essentially all agricultural residues, woody biomass, sawdust from timber mill, etc. can be briquetted. Agricultural residues that do not pose collection and drying problems are also suitable for briquetting. The factors that mainly influence the selection of raw materials are moisture content, ash content, flow characteristics and particle size. Moisture content in range 10 – 15 % is preferred because grinding of high moisture content materials is problematic, and more energy is required for drying. The ash content of biomass affects its slagging behaviour together with its operating temperature and mineral composition of ash. Biomass feedstock having up to 4% of ash content is preferred for briquetting. The granular (preferably 6-8 mm in size) homogeneous materials that can flow easily in conveyors, bunkers and storage silos are suitable for briquetting [3].

Commonly used raw materials for briquetting in India include sawdust, groundnut shells, cotton stalks, maize stalks, rice husks, mustard stalks, sunflower stalks, bagasse, wood chips and forest residues [3]. A combination of raw materials can also be used. The raw materials suitable for briquetting can be broadly divided into three categories:

In each of these categories it is possible to make use of both dry and wet raw materials. Another classification stems from the fact that besides raw biomass, briquettes of pyrolysed biomass are also made. Finally, briquettes can also be categorized on the basis of whether or not a biding material is used in briquetting. Briquetting of raw biomass without binder is more commonly practiced in India [3].

B. Briquetting Technologies and Processes

The briquetting technologies used for biomass without binder include briquetting machines based on screw – and piston – press technology. In screw – a screw through a taper die, which is heated externally to reduce friction, extrudes press technology the biomass continuously. The outer surface of briquettes obtained through this technology is carbonized and has a hole in the center. With piston – press technology biomass is punched into a die by a reciprocating ram by high pressure. The briquettes obtained through this technology have neither the central hole nor carbonized outer layer. In both the piston – and screw – press technologies the application of high pressure increases the temperature of the biomass and lignin present in the biomass is fluidized and acts as a binder. In the present work attention has been focused on piston – press technology, which is commercially available in India [3].

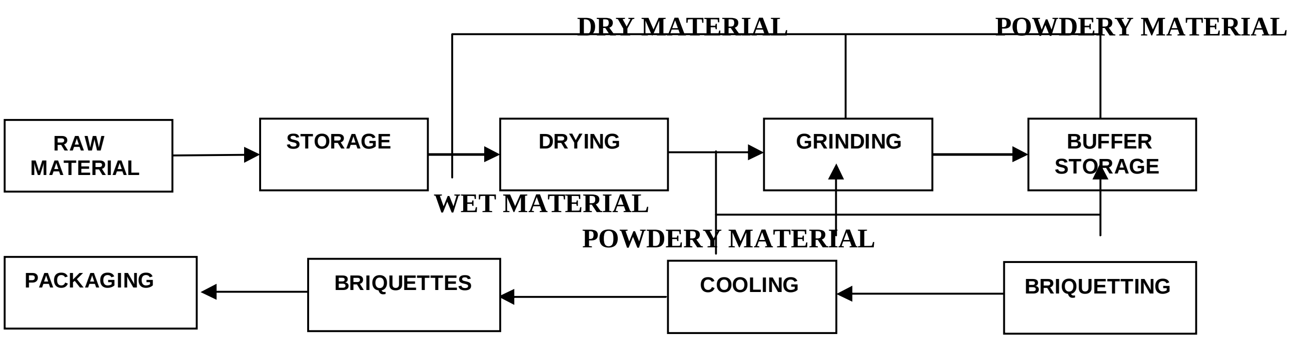

Fig.2.1. Flow diagram of Briquette production process

The briquetting process (Fig. 2.1) primarily involves drying, grinding, sieving, compacting and cooling operations. Any moisture in the raw material is first removed in a dryer, and the dried material is ground in a hammer – mill grinder. The ground material is then passed through a screen for sieving and thereafter stored in a bin placed over the briquetting press to ensure a regular flow of materials into the press. The ram in the press continuously packs the material through a taper die and the briquettes are produced. Fig. 2.2 shows the schematic diagram of the plant and machinery set up of a Briquetting unit.

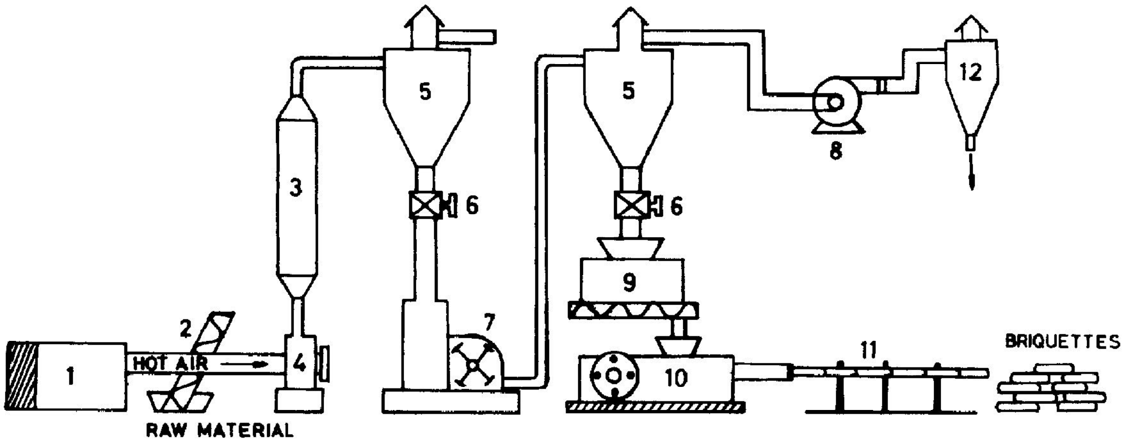

Fig.2.2. Schematic diagram of the plant and machinery set up of a Briquetting unit

1. Furnace / Hot Air Generator
2. Inclined screw feeder
3. Drying column
4. Turbo mill
5. Cyclone separator
6. Air locks
7. Hammer mill grinder
8. Fan
9. Holding bin
10. Briquetting press
11. Cooling line
12. Secondary cyclone

III. CONCLUSION

The briquetting technology in India has not yet reached maturity and there is considerable scope for research and development leading to design improvements, increased reliability and reduced energy consumption for the briquetting of agricultural residues into improved quality fuels in the form of Briquettes. Also this can reduce the negative impacts caused by fluctuation of prices of basic fuels. An improvement of self-sufficiency of the state in the sphere of fuels can be achieved. This will enable a supply of fuel from local sources, yielding savings in coal transportation, especially to remote regions. A wider and more efficient utilization of biomass as fuel will affect ecology as well as the economy. The physical and combustion characteristics the briquettes formed depend on several factors among which the die pressure is prominent. From the review it is found that the best indicators of additive quality of briquettes are the physical parameters such as density, moisture content and compressive strength. Both the solid and liquor components have binding ability, with the solid component's binding ability being stronger. Concentration of different chemical agents, heating time and heating temperature has influence on briquette binders. For a given die size and storage conditions, there is a maximum die pressure beyond which no significant gain in cohesion of the briquette can be achieved

REFERENCES

[1] C.K.W. Ndiema, P.N. Manga, C.R. Ruttoh, "Influence of die pressure on relaxation characteristics of briquetted biomass", Energy conservation and management, 43(2157-2161), 2002.
[2] R.N. Singh, P.R. Bhoi, S.R. Patel, "Modification of commertial croqueting machine to produce 35mm diameter briquettes suitable for gasification and combustion", Renewable energy, 2006.
[3] Arun K. Triphati, P.V.R. Iyer and Tara Chandra Kandpal, "A techno economic evaluation of biomass briquetting in India", Biomass and bio-energy, 14(497-488), 1998
[4] S. Yaman, M. Sahan, H. Haykiri-acma, K. Sesen, S. Kucukbayrak, "Production of fuel briquette from olive refuse and paper mill waste", Fuel processing technology, 68(23-31), 2000
[5] S. Yaman, M. Sahan, H. Haykiri-acma, K. Sesen, "Fuel briquettes from biomass-lignite blends", Fuel processingtechnology, 72(1-8), 2001
[6] A Demirbas, "Physical properties of briquettes from waste paper and wheat straw mixtures", Energy conservation and management, 40(437-445),1999
[7] P. Purohit, Arun K. Triphati, T. C. Kandpal, "Energetics of coal substitution by briquettes of agricultural residues", Energy, 31(1321-1331), 2006.
[8] Jan Illavsky, Milan Oravec, "Utilisation of biomass in Slovakia", Ecological engineering, 16(S83- S89), 2000
[9] National Productivity Council. Report on improvement of agricultural residues and agro-industrial by-products utilization, National Productivity Council (NPC), New Delhi, India; 198
[10] Heinz j.k. koser, Werner Siemers and UweStuven"Technical And Economic Assessment Of Charcoal And densifiedFueFrom Water Hyacinths And Cotton Stalks" Fuel Processing Technology, 7 (1983).

[11] P. B. Onaji and R. V. Siemons, "Production of charcoal briquettes from Cotton stalk in malawi: methodology for Feasibility studies using experiences in sudan", Biomass andBioenergy, Vol. 4, 1993.
[12] M.C. Mayoral*, M.T. Izquierdo, M.J. Blesa, J.M. Andres, B. Rubio, J.L.Miranda, "DSC study of curing in smokeless briquetting,"ThermochimicaActa 371 (2001).
[13] Xianglan Zhang, DepingXu, ZhihuaXu and Qingru Cheng, "The effect of differenttreatment conditions on biomass binder preparation for lignite briquette", Fuel Processing Technology 73 (2001).
[14] M.J. Blesa, V. Fierro, J.L. Miranda, R. Moliner and J.M. Palacios, "Effect of the pyrolysis process on the physicochemical and mechanical properties of smokeless fuel briquettes", Fuel Processing Technology 74(2001).
[15] P. Purohit, Arun K. Triphati, Santosh Rana, and T. C. Kandpal, "An approach to the estimation of the value of agricultural residues used as biofuels", Biomass and Bioenergy 22 (2002).
[16] AkashayUrja (Renewable enegy) magazine by MNES.