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Research Article

GROUNDNUT SHELLS BRIQUETTING TO MEET FUEL ENERGY REQUIREMENTS

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Abstract: India stands second in producing groundnut after China. Groundnut shell is the waste product of groundnut processing which is one-fifth of the dried product. Generally, these groundnut shells are either burnt or buried, or disposed of inefficiently. Apart from the problems of transportation, storage, and handling, the direct burning of loose groundnut shells in conventional grates is associated with very low thermal efficiency and widespread air pollution. Rich in lignin, groundnut shells undergo slow degradation in the natural environment. An alternate better use may be converting low bulk-density groundnut shells into high-density energy-concentrated solid fuels termed briquettes and pellets. These briquettes or pellets have higher thermal value, low ash content, and combustion is more uniform. Briquettes are ready substitutes for coal/wood in industrial boilers and brick kilns for thermal applications. There is no fly ash when burning bio-briquettes. The use of briquettes/pellets as a coal co-firing solution saw a boost in mid-2021 when India's power ministry set up a national mission on the use of these solid biofuels in coal-based power plants. The residue compaction methods are the screw press, piston press, roller press, and palletizing machines. A review of groundnut shell briquetting and major constraints being faced by the industries have been presented in this paper.

Keywords: *Groundnut shells, Bulk Density, Briquetting, Piston Press, Thermal Applications, Economic Feasibility*

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Introduction

Groundnut botanically known as *Arachis hypogeae* belongs to the Leguminosae family. In India, groundnut stands at first place in the area and second only to soybean production as far as oil seed crops are concerned. Its production during 2022-23 is 836.9 million tonnes. As per the all-India *Rabi* crop coverage report, Government of India, as on 30th January 2023, groundnut was sown in around 4.98 lakh hectares during 2022-23 [1]. In India it is grown in *Kharif* and *Rabi* seasons, but *Kharif* produces much higher than *Rabi*. Groundnut shells account for approximately 20% of the dried peanut pod by weight and are either burnt, buried, or disposed of inefficiently, which causes a lot of air pollution [2]. However, these shells can be compressed and produce a form of solid fuel popularly known as white coal, briquettes, or pellets.

Biomass briquetting was first used in parts of Nepal for cooking purposes. These were then commercialized in 1982. In the late 80's this technique was put more to use. Before India, Japan started using the briquetting technique. In 1925, Japan developed a technology to harness biomass energy using sawdust briquettes. At that time, this was known as Ogalite. In the 1960's Japan started using screw press and piston press technology to increase production and also to make the process organized. The briquettes produced by the Japanese using the new technology were of high quality which led to other countries using their technique. Most of the European countries bought the licensing agreement and started manufacturing Japanese-designed machines [3]. India has huge potential when it comes to briquetting. There is an abundance of crop waste that serves as the raw material to create briquettes. Demand and use of biomass briquettes is increasing constantly due to a number of reasons like; a hike in costs of commercial fuels like coal, diesel, natural gas, coal, fire-wood, and electricity; the need for energy resource security; and pollution control measures. Biomass briquette or bio-coal is made from agricultural, wooden, and forestry wastes by a high compression process without adding any chemicals, glue, or binder. It is thus a 'binder-less' technology product resulting in 100% natural eco-friendly, pollution-free solid fuel.

Biomass briquettes are a renewable source of energy and avoid adding fossil carbon to the atmosphere. Briquetting has a huge market opportunity. The current global biomass briquette market has been valued at US$ 372.1M The market is still very new and has the capacity to grow exponentially, it is assumed that the market size will reach US$ 612.6M by the end of 2026, growing at a CAGR of 7.3% during 2021-2026. The most recent studies indicate that about 650MTyear-1 of agricultural biomass is generated in India, while about one-third of this is surplus for energy application [4].

SAMARTH (Sustainable Agrarian Mission on Use of Agro residue) has powered the amount of biomass briquettes used in coal co-firing. As per the Indian Ministry, till July 2022, around 80,525 MT of biomass had been co-fired in 35 thermal plants with a cumulative capacity of 55,335 MW. From 2020 to 2022 the number of thermal power plants co-firing briquettes has increased seven-fold. Biomass briquettes production projection associated with electricity generation [5].

The annual biomass briquettes production and electricity generation. As the production is projected to increase in coming years it will also have a favorable impact on the electricity generation. So, India needs to move towards a way to increase briquette production in order to serve future electricity needs [6].

Biomass Briquetting

Biomass-based energy generation is one of the major focus areas of renewable energy programs in India. The strength of India's biomass resources lies in the agricultural sector. A large quantity of crop residue biomass is generated in India. However, crop residue biomasses are distributed resources with variations in spatial-temporal availability and its characteristics. Competing uses of residues also vary geographically. Therefore, local biomass databases are important for decentralized bio-energy programs [7]. Briquettes can substitute coal and charcoal for cooking in developing countries, but it is seldom available. It can also be used with coal in boiler to get electricity from steam [8].

Effectively utilizing agro residues, when abundantly available, can help energy conservation efforts. The combustion characteristics of briquettes not only depend on the type of feedstock but also on the density, moisture content, binder percentage, and method used for briquetting. Higher ash content lowers the calorific value. Ash during combustion causes slagging and fouling leading to corrosion. We come to the conclusion that it can meet the energy needs. Research needs to be focused on emissions [9].

Soni [10] worked out the proximate and ultimate analysis of 5 biomass residues including groundnut shells for their energy value as clean fuel. The results of the proximate analysis revealed that the groundnut shells contain volatile matter 72.02 %, moisture content 7.27 %, fixed carbon 18.21%, and ash content 4.21%. The calorific value of groundnut shells was worked out to be 4249 kcal/kg. The results of the ultimate analysis were carbon content 45.79%, hydrogen 6.64%, oxygen 41.42%, nitrogen1.28%, and Sulphur 0.03%. These results support the use of groundnut shells in the single energy conversion process to produce clean fuel for heating and co-firing for electricity generation. Compared to fossil fuels, the briquettes produce low net total greenhouse gas emissions because the materials used are already a part of the carbon cycle.

A number of companies in India have switched from furnace oil, firewood, and coal to biomass briquettes to save costs on boiler fuels. Many companies are using biomass briquettes as fuel to earn carbon credit which is an indirect advantage. Being one of the major groundnut production districts of Rajasthan, Bikaner district offers the potential of establishing groundnut shell-based briquetting industries, and many industries have been established in the district. The present study is aimed to evaluate their economic viability and constraints in this field.

Mainly piston type, screw-compaction-type, and roller-type machines are used for biomass briquetting. The reciprocating ram/ piston press technology has its origin from Europe and US while the screw press technology came up from the Far East Japan. In piston type, there are two options: mechanical piston press and hydraulic piston press. Biomass briquetting plants are of various sizes and convert biomass into solid fuels. Briquettes have a high bulk density (800 kg/m3) compared to 60 to 180 kg/m³ of loose biomass. These can be transported over long distances. Briquettes are easy to transport and occupy less space when compared with firewood.

The major source of procurement of raw material is through oil mills. In Bikaner, there are more than 100 processors available for groundnut. The briquetting industries are using piston presses for the densification of groundnut shells due to their historical presence and less initial investment. A piston-type machine with sleeve or hydraulic cylinder are used for compaction and thus briquette is produced. A big pressure is generated as the movement of the flywheel punches the briquette time after time in a short time; it raises the temperature of the raw material. With the movement of raw material friction heat is generated which raises the temperature to melt the lignin. Particles bind and become strong. Briquettes coming out of the machine have temperatures around 200°C, so these are to be cool down before packing. The briquetted once cooled down are stored in polypropylene bags.

However, with the changing time, screw extruder technology is also gaining importance in the Indian market due to less wear and tear of the die. The density and homogeneity of briquettes are also more as compared to piston press technology. But the power requirement is more as compared to piston press technology.

In a screw extruder press, the raw material is extruded continuously by a screw through a heated taper dye. As the pressure is being put by the screw, the final briquettes have a hole in the center.

Groundnut shells characteristics for briquetting

For densification, it is imperative to have knowledge of the feed parameters that impact the process. The particle size of raw shells and moisture content are important parameters. For the piston press, the ideal size of the raw material should be 6-8 mm to get the optimum results. If the materials are oversized the briquettes will not be smooth as clogging will take place at the entrance of the dye. However, in a screw extruder, the large particle size does not affect that much in the final product as in this process the material is pressed with utmost pressure (1000-1500 bar). But if the size is less than 1 mm it will have an impact due to less density. The moisture content of the raw shells should not be more than 8-10%. This ideal percentage of moisture is of utmost importance as it produces briquettes of 6-8 mm in size. This size is ideal as the briquettes are not brittle and have no cracks.

Temperature of the dye

The required temperature of the dye is 280-290°C. If the temperature is more than the above limit it causes the dye to wear out more quickly. Hence, there is a need to make sure that the prescribed temperature is being maintained. Low temperatures will result in high-pressure, high-power consumption, and lower production.

Fishbone Diagram of the Briquetting Production

After interviewing 20 manufacturers of groundnut shells briquettes around Bikaner (Rajasthan), a fishbone diagram has been prepared to present the causes responsible in hampering the quality of the final briquettes.

Economic analysis of a groundnut shells briquetting industry of capacity 600 kg/hr

The fixed cost components, operational cost, and income from the sale of briquettes have been analyzed.

Land requirement : 3000 m²
Covered area
Operating shed : 200 m²
Storage : 175m²
Cost of the plant including electricity connection of 70 KW: 25 lakhs
Running capital needed: Rs 7 lakhs
Electricity consumption per hour: 35 units
Raw material cost per ton
Manpower requirement Rs 7500
Manager : 1 (Rs 20000 per month)
Skilled person : 1(Rs 15000 per month)
Labour: 3 (Each Rs 12000 per month)

No of operating shifts : 2, each of 8 hours
Operational maintenance (Wear & Tear): Rs 2500 per day
Plant depreciation : 10% annually
Sale price per ton : Rs 10500

Considerations

In a normal working day, a single dye is operated for 2 shifts before getting clogged. So, each day the dye needs to be replaced with a new one. The cost of each dye is Rs. 2,500.

During the peak season, the price of raw materials is low and during the off-season, the price of raw materials is high.

The briquettes produced in the winter/rainy season would have abundant moisture which would soften the briquettes leading to easy breakage.

Future is of solid biomass fuel

Briquetting technology is yet to get a strong foothold in India because of the technical constraints involved and the lack of knowledge to adapt the technology to suit local conditions. Due to fast-increasing energy demand and the skyrocketing price of traditional fuels like coal and natural gas, more emphasis is being given on biomass-based solid fuel production. Solid biomass fuel is a kind of renewable, clean, and environmentally friendly energy source for agricultural countries. There is no sulfur in Briquettes, thus does not pollute the environment. The use of biomass briquettes can earn carbon credits for reducing emissions in the atmosphere. The calorific value of groundnut shells is 4000 Kcalkg-1. Biomass briquettes due to high calorific value per kg save around 30-40 percent of boiler fuel costs. Briquettes have much lower ash content (2-10% as compared to 20-40% in coal). Briquettes are usually produced near the consumption centers and supplies do not depend on erratic transport from long distances.

The importance of this technology lies in conserving wood and the widespread destruction of forests.

Application of research: Briquettes made of groundnut shells have been successfully used in boilers which not only supplemented conventional electricity but also mitigated CO2 emission to a great extent.

Research Category: Renewable energy

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Study area / Sample Collection: Swami Keshwanand Rajasthan Agricultural University, Bichhwal, Bikaner, 334006, Rajasthan, India

Cultivar / Variety / Breed name: Groundnut

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

References

[1] Bhusanar S.B., Meena S.S. and Mathur A. (2022*) Asian Journal of Agricultural Extension, Economics & Sociology*, 40(7), 103-168 Article no. AJAEES.85761.
[2] Duc P.A., Dhranipriya P., Velmurugan B.K. and Shanmugavadivu M. (2019) *Bio catalysis and Agricultural Biotechnology*, 20.
[3] Grover P.D., and Mishra S.K. (1996) *Regional wood energy development programme in ASIA GCP/RAS/154/NET* (FAO Vol. 46).
[4] Biomass Briquette Market Research, 2023-2030 (2023) https://www.marketwatch.com/press-release/biomass-briquette-market-research-2023-2030-2023-04-27 April 27, 2023.
[5] https://www.gep.com/blog/mind/biomass-briquettes-industry-and challenges#:~:text=Biomass%20briquettes%20have%20mostly%20been,generation%20in%20thermal%20power%20plants.
[6] How Biomass Briquettes Are Fueling Thermal Power Generation in India (2022) https://www.gep.com/blog/mind/biomass-briquettes-industry-and-challenges October 18, 2022.
[7] Hiloidhari M., Das D., and Baruah D.C. (2014) *Renewable and Sustainable Energy Reviews*, 32, 504-512.
[8] Sharma M.K., Gohil P., and Sharma N. (2015) *American Journal of Engineering Research (AJER),* 4(02), 44-50.
[9] Dinesha P., Kumar S. and Rosen M.A. (2019) *Energy Technology, Generation, Conversion, Storage, Distribution, Willey online library*.
[10] Soni R. (2021) *Geography & Nature Disasters*, 11(4), 784.