# Utilisation of Bagasse Briquettes as Alternative Source of Fuel

*In a sugar mill 30 to 35 % of crushed cane forms bagasse*

**1. What is the source and characteristics of bagasse?**

Bagasse is the crushed outer stalk material formed after the juice is squeezed from sugar cane, in sugar mills. Bagasse characteristics vary in composition, consistency, and heating value depending on the climate, type of soil, variety of cane, harvesting method, amount of cane washing, and the efficiency of the milling plant. In general, bagasse has a high calorific value 4400 Kcal/kg[1] on a wet, as-fired basis. Most bagasse has moisture content between 45 and 55 percent by weight.

**2. What are the environmental concerns if bagasse is not managed properly?**

Bagasse if not managed properly (utilised /disposed) can lead to odour nuisance, dumping of bagasse on land can lead groundwater contamination, potential breeding ground for disease carrying vectors and reduces the aesthetic value of the neighbourhood.

*Characteristics of bagasse*

| | |
|---|---|
| Calorific Value | 4400 Kcal/Kg |
| Moisture content | 45-55 % by weight |
| Ash Content | 2 – 10 % |

**3. What are the different uses of bagasse?**

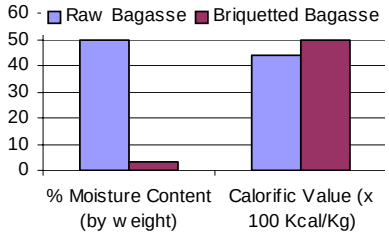
Bagasse is among the world's most widely used and available nonwood fibres along with cereal straw and bamboo. Bagasse is used as a directly as a fuel and as a raw material (fibres) in pulp and paper mills. *This FAQ sheet will focus on utilising bagasse as a fuel.* The characteristics of bagasse allows it to be used as a potential fuel. In many countries bagasse generated from the sugarcane crushing units in the sugar mills is directly or in briquetted form is used as a fuel in the boilers.

**4. What are the benefits of using bagasse as a fuel?**

The main benefits of using briquetted bagasse as a fuel are;

- Emissions of sulfur dioxide ($SO_2$) and nitrogen oxides (NOx) are lower than conventional fossil fuels due to the characteristically low levels of sulfur and nitrogen associated with bagasse.
- Helps in reducing the greenhouse gases (GHGs) in the atmosphere.
- Low ash content of 2-10% as compared to 20-40% in coal
- The indiscriminate disposal of bagasse and/or the disposal cost/fees are eliminated.
- Bagasse is a renewable resource can play a major role in substituting fossil fuel for future power generation.

*Comparison of raw and briquetted bagasse*




**5. What is briquetting of bagasse and what are the advantages of using bagasse in a briquetted form?**

Briquetting technique is densification of the loose biomass; this is achieved by subjecting the biomass to heavy mechanical pressure to form compact cylindrical form known as briquettes.

Owing to high moisture content direct burning of loose bagasse in conventional grates is associated with very low thermal efficiency and widespread air pollution. The conversion efficiencies are as low as 40% with particulate emissions in the flue gases in excess of 3000 mg/ $Nm^3$ In addition, a large percentage of unburnt carbonaceous ash has to be disposed off.

*Comparison of bagasse briquettes with conventional fossil fuels*

| *Fuel* | *Calorific Value (Kcal/Kg)* |
|---|---|
| *Bagasse briquettes* | *3,500 – 5,000* |
| *Hard Coal* | *5322* |
| *Mazout* | *9697* |
| *Gas LP (butane)* | *11822* |

[1] P.D. Grover, S.K. Mishra, 'Biomass Briquetting: Technology and Practices' Food and Agriculture Organization of the United Nations, Bangkok, April 1996.

Briquetted bagasse has low moisture content and densified form which overcomes the above mentioned problems with direct firing of bagasse. Thus briquetted bagasse can be used as a potential fuel to substitute the fossil fuels.[2]

Following are the benefits of briquetting bagasse;[3]

- High calorific value ranges between 3,500-5,000 Kcal/Kg[4]
- Moisture percentage is very less (2-5%) compared to lignite, firewood & coal where it is 25-30%
- Economic to users compared to other forms

- Briquettes can be produced with a density of 1.2 g/cm³ from loose biomass of bulk density 0.1 to 0.2 g / cm³.
- Easy in handling and storage due to its size.
- Consistent quality

**6. What are the different techniques for briquetting bagasse?**

The two techniques of briquetting bagasse/biomass are the binderless and charred binder briquetting techniques.

In the binderless technique the biomass is finely divided to uniform size and subject to heavy mechanical pressure to form briquettes. The *lignin*[5] in the agro waste acts as a natural binder, there is no need to add chemicals or any other foreign substance to the process.

In the charred briquetting technique the biomass is finely divided and charred to increase the carbon concentration and reduce the moisture. The charred material is then subjected to heavy mechanical pressure to form briquettes. Due to the absence of the binding properties in char, binding agents like starch are added to form briquettes.

Usually the binderless technique is used for commercial application of the briquettes (fuel for industrial boilers) the charred briquettes are used for domestic application.

*Briquettes made using*

*Ram reciprocating*

*Screw extrusion machine*

**7. What are the different machines available for biomass/bagasse briquetting?**

The main two main type of briquetting machines are the screw extrusion and the reciprocating ram/piston press (briquetting press). The Prepared homogenous raw material is fed to briquetting press by screw conveyor for regular feeding. In briquetting press it passes through toper die and due to high pressure & heat, powder form is converted into solid cylindrical briquettes.

Although both technologies have their merits and demerits, studies have shown that the screw pressed briquettes are superior to the ram pressed solid briquettes in terms of their storability and combustibility. However the screw extrusion machines have low production capacity (150 – 200 kgs/hr)[6] and high operational cost, due to the possibility of screw breakages.

*Screw type briquetting machine*

Piston press (ram) machine has higher production capacity (above 1000kgs/hr)[5] as compared to screw machines, the briquettes are completely solid and screw press briquettes on the other hand have a concentric hole which gives better combustion characteristics due to a larger specific area. The screw press briquettes are also homogeneous and do not disintegrate easily. Having a high combustion rate, these can substitute for coal in most applications and in boilers.

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[2] Refer the comparison table. Source: www.helcom.fi/dps/docs/documents/ Land-based%20Pollution%20Group%20(HELCOM%20LAND)/LAND%206/3-8.pdf

[3] Source: www.apctt.org/database/to7007.html

[4] Briquetting doesn't increase the calorific value of bagasse, it only allows the complete utilisation of the calorific value, which otherwise would had been wasted.

[5] Lignin is a naturally occurring component in plants/trees; they are complex natural polymers with many random couplings that helps provide strength in plants.

[6] As discussed with briquetting machine manufacturers in India.

*Ram type briquetting machine*

Refer the table below for comparing the two techniques;[7]

| | **Piston press (Ram)** | **Screw extruder** |
|---|---|---|
| Optimum moisture content of raw material | 10-15% | 8-9% |
| Wear of contact parts | low in case of ram and die | high in case of screw |
| Output from the machine | in strokes | Continuous |
| Power consumption | 50 kWh/ton | 60 kWh/ton |
| Density of briquette | 1-1.2 gm/cm³ | 1-1.4 gm/cm³ |
| Maintenance | high | Low |
| Combustion performance of briquettes | not so good | very good |
| Carbonization to charcoal | not possible | makes good charcoal |
| Suitability in gasifiers | not suitable | Suitable |
| Homogeneity of briquettes | non-homogeneous | homogeneous |
| Economically feasible production capacity | Normally high (500 – 2000 Kgs/hr) | Normally low (100 – 250 Kgs/hr) |
| Approximate cost of briquetting machine (with pulveriser and flash drier in India) | 14,60,000 INR (for an average capacity of 800kgs/hr)[8] | 6,05,000 INR (for an average capacity of 200 Kgs/hr) |

**8. Where is bagasse briquetting practised commercially?**

Bagasse briquetting is commercially practised in a majority of the south east region countries; India, Philippines, Indonesia, Bangladesh, Nepal, Thailand, China, Malaysia with some pilot projects in Vietnam and Sri Lanka and in the African continent; Tanzania, Cuba, Kenya and Brazil. However its not practiced in Egypt. The two models of manufacturing briquettes for commercially use in Egypt can be as follows;

- Sugar mills can procure the technology and manufacture briquettes for their personal usage and the excess can be sold in market.
- Sugar mills can set up joint venture with technology providers to set up manufacturing units, by providing land. The briquettes can be purchased by the sugar mills, the excess can be sold in market.

**9. What are the manpower requirements for a typical briquetting machine?**

Manpower requirement for a 2 machine unit (ram/screw type) having capacity to produce 1300 to 1500 Kgs/hr of briquettes are as follows:

| | |
|---|---|
| Plant supervisor | One |
| Shift technicians | Three (1 for each shift) |
| Welder and maintenance technician | One (as and when required) |
| Electrician | One (as and when required) |
| Semi skilled machine operators | Three (1 in each shift) |
| Labourers: | |
| For feeding raw material & storing briquettes | Six (2 for each shift) |

The above listed staff is only indicative and actual deployment will-depend on the specific location of the plant and degree of automation incorporated into the plant. For example, deployment of a small size loader would change the staffing pattern.

[7] P.D. Grover & S.K. Mishra, 'Biomass Briquetting: Technology and Practices', Food and Agriculture Organization of the United Nations Bangkok, April 1996.

[8] 1 LE = 7.43 INR, Cost of the machines provided here are as discussed with briquetting machine manufacturers in India.

**10. Whom do I contact for further information?**

1. **Asia Pacific Centre for Technology Transfer**
   P.O.Box 4575
   Qutab Institutional Area
   New Delhi - 110 016
   URL: www.apctt.org
   Email: infocentre@apctt.org

2. **Regional Wood Energy Development Programme in Asia**
   C/o FAO Regional Office for Asia and the Pacific Maliwan Mansion,
   Phra Atit Road,
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3. **African Energy Policy Research Network**
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