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Densification of Bamboo Residues

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Abstract

India is blessed with good bamboo resources. Bamboo has many advantages over other woody plants such as fast growth, high production and high ecological value. The area under bamboo cultivation in India is estimated to be more than 13.96 million hectares with more than 136 distinct species, according to National Bamboo Mission. Bamboo, poor man's timber is cultivated for making furniture and construction material. Bamboo processing waste, fallen bamboo sheath and leaves are potential lignocellulosic waste that could be subjected to briquetting to get densified products. In this process, the bamboo residues are pressed together at an elevated temperature and pressure which make the material bond with the help of its own lignin. Briquetting produce homogeneous, uniformly sized solid pieces of high bulk density. These briquettes have proved to be an improved and efficient fuel which burn as good as coal with zero sulphur emission.

Key words: Bamboo residues, Briquetting, Densification

Introduction

Bamboo is a perennial evergreen plant species of the Gramineae grass family, distributed mainly in tropical and subtropical areas and their growing harmonizes with the principles of sustainability, due to their fast growth and annual stalk production. Many Asian species of bamboo have strong, light and flexible woody stems, which lend themselves to applications as a construction material, paper production, fishing tools, handicrafts, musical instruments, furniture, scaffolding poles etc. Presently, the demand of bamboo in India is around 26 million metric tonnes. In order to meet this demand, the Indian government launched the "National Bamboo Mission" under the Ministry of Agriculture for expanding the bamboo industry. In its natural form, fallen sheath and leaves from bamboo are often an inefficient fuel because it is bulky and dispersed. Density can be increased by compacting the loose residues by adopting proper densification technologies.

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Need of densification

In bulk form, the density of the bamboo residues is very low and hence cost of transportation becomes very high and also has less combustion efficiency. In order to convert these residues into energy intensive fuels, densification is an economically viable solution. Densification may be defined as compression or compaction to remove inter and intra particle voids. It involves compression, deformation and self-bonding between adjacent particles of agricultural residues. When heated above the plastic temperature range, agricultural residues lose their elasticity and the thermally softened lignin allows the creation of adhesion between adjacent particles and produce densified products. The significant increase in density of products result in a better handling, increases the calorific value by volume, reduces transport costs and produces a uniform, clean and stable fuel.

Process of densification

The densification process involves four steps viz., collection of raw materials, preparation of raw materials, compaction and cooling and storage. Almost all agricultural residues can be densified. The preparation of raw materials comprises drying, shredding, mixing of various residues in right amount to yield high calorific value, addition of binder etc. Permissible moisture content of agricultural residues for densification is less than 15%. The raw materials with higher moisture contents are need to be sun dried or dried in solar driers. After drying, residues are size reduced by shredding, chopping, crushing, hammering, milling, grinding, cutting *etc.* to yield 5 to 10 mm particle size. It is desirable to make briquettes with more than one raw material to get product of good compaction, higher calorific value and less ash content.

Compaction can be done by pelleting, cubing, briquetting or extrusion methods depending on the demand of the end user. Binders are required in low pressure compaction technologies whereas the high-pressure compaction technologies may not require binders as the high pressure and temperature generated during the compaction favours lignin to melt and bind. The two commercially viable binderless briquetting methods are piston press and screw press methods. In piston press method, a reciprocating piston pushes the raw material into a tapered die to get briquette of desired size and shape. On the other hand, in screw press method, the residues are extruded continuously by a screw through a taper die which is heated externally by an electric heater. Briquettes produced by the presses are hot with

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temperatures exceeding 200^{o}C. Hence, briquettes are to be cooled in air before transport or storage.

Piston Press

In piston press technique, pressure is applied intermittently on the residues packed inside the cylinder using a piston energized by a flywheel. The piston of the press reciprocates and compresses the residues supplied from the feed hopper. The residues are taken into the conical die, compressed by the piston, and the briquetted part is extruded through the die opening. During compression process the residue material is heated to around 150°C to 300°C due to friction.

Fig. Piston Press Briquetting Machine

Screw Press

In screw press technique, the residue material is extruded continuously by a screw through an electrically heated taper die. Quality of briquettes and production procedure is superior to piston press technique. Briquettes are carbonised and have a central hole which helps to achieve uniform and efficient combustion.

Briquetting of bamboo residues

For briquetting, bamboo processing waste, fallen bamboo sheath and leaves are to be dried to the required moisture level and size reduced. Since the calorific value of these residues is less than 3500 kcal/kg, saw dust can be blended with the bamboo residues to

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enhance the calorific value of end product and also to support binding. Mixing bamboo residues and saw dust in 1:1 ratio will yield briquettes of higher calorific value and less ash content and thereby meets the mandate for usage in furnaces. After proper blending the mixture should be subjected to piston press briquetting machine to get briquette of desired size. In general, briquettes of 50 mm, 60 mm and 90 mm diameter are preferred for local industries to generate steam or for process heat.

Conclusion

Bamboo is significantly more productive than many other candidate bioenergy crops. Heating value of bamboo residues is lower than woody biomass. Bamboo residues when briquetted with saw dust yield higher heating value. Briquettes produced from bamboo residues blended with saw dust has the combustion rate comparable that of coal and hence can be used in residential, commercial, and industrial heating systems. These briquettes may be gasified to producer gas which could find application in thermal and electric power generation.

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