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Normal Temperature Briquetting Technology for Biomass with Original Moisture Content

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Abstract

Untreated biomass has low bulk density and high transportation cost. The existing biomass processing systems are normally complicated, expensive and space demanding. The new normal temperature briquetting technique developed for biomass with original moisture contents can simplify treatment process, reduce space required and lower transportation cost.

1 Introduction

A series of biomass briquetting systems have already been widely developed based on lignin plasticitation mechanism. These systems are normally complicated, space demanding and energy consuming. They are also very sensitive to biomass moisture content. The availability of these systems are limited by the radius of biomass transportation and the life of key abrasion-resistant components. Hence, the general cost of biomass utilization is high and the biomass application heavily rely on government subsidies. Biomass can only be market competitive after its running cost is comparable or even lower than that of coal.

2 Existing Biomass Briquetting Technique

2.1 Mechanism

Lignin and cellulose are the two major compounds of biomass. Lignin distributed among cellulose determines the structure strength of biomass. Lignin is a non-crystallized aromatic polymer with no fixed melting point. If heated to 200–300°C, lignin starts to be soft, melted and liquefied. If pressure is applied in this case, lignin will glue cellulose together, which is solidified and briquetted after cooling down.

2.2 Briquetting Process

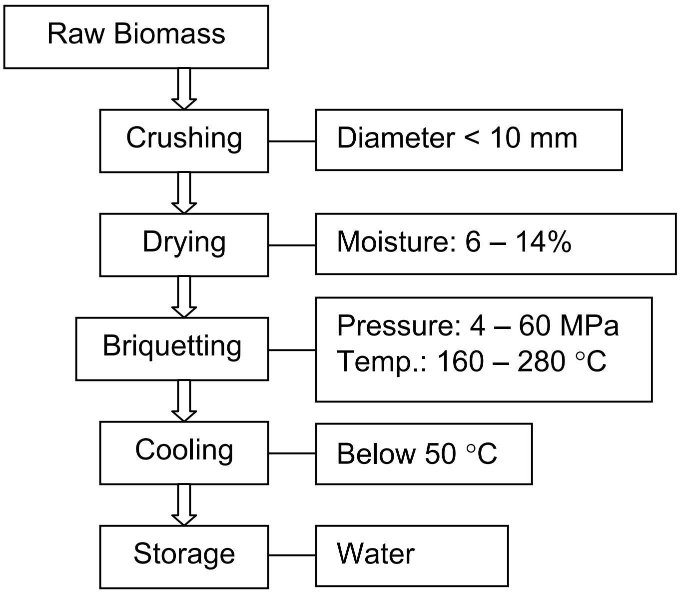


Figure 1. The Existing Biomass Briquetting Technique

2.3 Major Problems

The biomass briquetting systems based on lignin plasticitation mechanism requires high temperature of 160 – 280 °C. They generally have the following problems:

2.3.1 The moisture content of the raw material must be controlled within the range of 6 – 14% for a successful briquetting process. However, the moisture contents of original biomass is normally much higher than required. Energy must be applied for the drying and cooling procedures before and after the briquetting process respectively. The low moisture requirement not only increases the cost of biomass processing, but also limits the whole system to specific workshops.

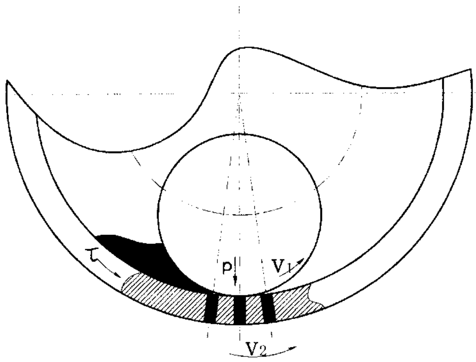
2.3.2 The compressing part must work under 160 – 280 °C. The abrasion of the device will be increased and the working lifetime will be reduced.

2.3.3 The whole system lost its mobility and is limited within the reasonable biomass transportation radius. It is difficult to scale-up to gain more economic benefits.

3 New Biomass Briquetting Technique

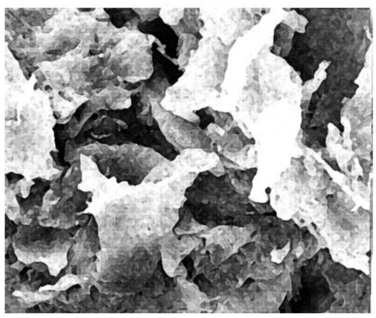
3.1 Mechanism

The characteristics of original biomass depends on the overall performance of its compounds. It has been verified that, although pure lignin does dissolve in water, it has the ability to absorb water. Lignin and water co-exist in original biomass. Biomass has low physical resistance. If a shear force is applied, the cellulose molecules in biomass will be disturbed, shifted and expressed as layers. With relatively small pressure, these layers will be embedded, folded and reformed into a new shape.



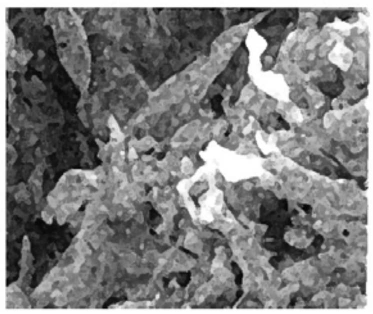
V_1 —— inner wheel speed P —— pressure
V_2 —— outer wheel speed τ —— shear force

Figure 2. Schematic Diagram of Briquetting Mechanism



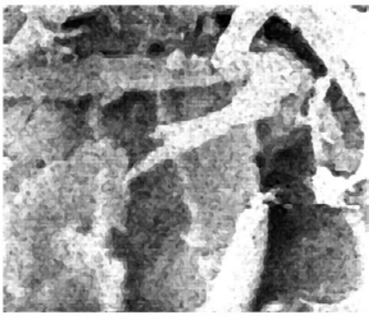
2000×Cross Section

1: Irregular layers formed after the process, layers embedded;
2: Spaces among layers are small as layer well folded;
3: Spaces among layers are well distributed.



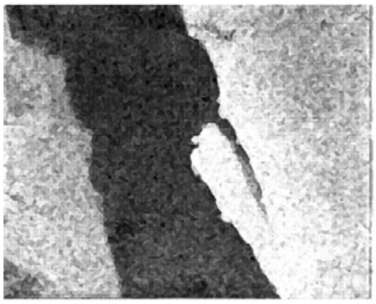
2000×Cross Section
Pingya, Nanjing

1: fibres from raw materials are obvious;
2: big gap can be found among fibres;
3: gaps have irregular orientation.



6000×Cross Section

1: Fibre-like material disappeared, layers cross linked;
2: layers' contacts and connections are irregular;
3: intervals among layers are unified



6000×Cross Section
Pingya, Nanjing

1: Parallel fibre remains without cross link;
2: Big gap among fibres;
3: The glue-effect of lignin may be suggested.

Figure 3. Comparison of Processed and Original Biomass

3.2 Briquetting Process

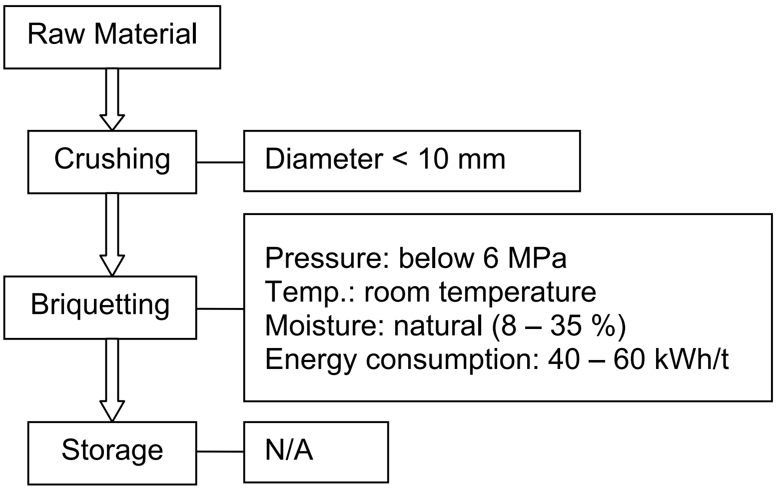


Figure 4. The New Biomass Briquetting Technique

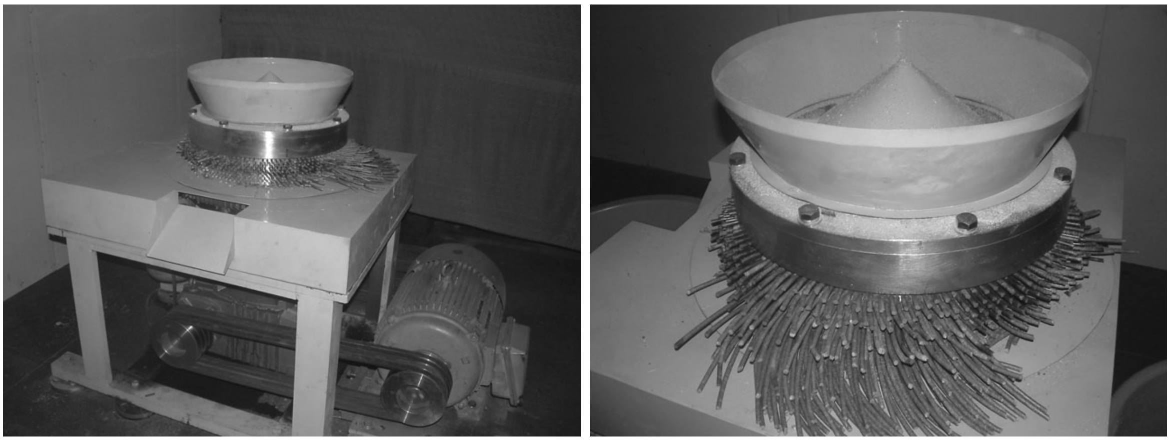


Figure 5 The Briquetting Device and Discharge Status

Figure 6 Raw Biomass Material and Briquettes

3.3 Major Parameters in Trial Test

Energy Consumption: 40 – 60 kWh/t
Density: $\geq$ 1.26
Moisture Contents: 8 – 35%
Particle Diameter: < 10 mm
Briquetting Pressure: < 6 MPa

3.4 Major Advantages of the New Briquetting Technique:

3.4.1 The electrical heating and temperature control are not required in the new briquetting system. The system complexity, the area requirement and energy consumption are greatly reduced.

3.4.2 The existing *Normal Pressure Briquetting* has been replaced by *Sheared Layer Embedding Briquetting*. The pressure required for the process is also reduced.

3.4.3 When briquetting under room temperature, there is no trouble caused by steam generated in the heat-up procedure. The technique is not sensitive to moisture content. The cost on drying and cooling systems can be saved.

3.4.4 Biomass is briquetted into pellet or stick shape under room temperature. There is no specific requirement on storage and transportation.

3.4.5 The whole system works under room temperature. The operation conditions, safety, reliability and maintenance are improved.

3.5 Current Status of Normal Temperature Briquetting Technique for Biomass with Original Moisture Content

3.5.1 The trial tests of normal temperature briquetting technique for biomass with original moisture content have been completed. The new briquetting mechanism has been verified.

3.5.2 The new briquetting process has been established via the trial tests:

Raw Material → Crushing → Natural Dry and Room Temperature Briquetting
→ Storage and Transportation

3.5.3 The prototype system revealing the new briquetting mechanism and technique has been developed.

3.5.4 18 patents have been declared nationally

3.5.5 2 patents have been declared internationally (PCT)

4 Conclusions

With the successful development of the new briquetting technique for raw biomass under room temperature, the space requirement, energy consumption, and running cost of biomass briquetting have been reduced significantly. With optimized system operation, small volume and low energy cost, this technique will make practical mobile biomass collecting and processing units. This will turn biomass into a promising alternative energy source for coal in the near future.