An Analysis of the Use of Local Bamboo as an Alternative Energy Source

Sallolo Suluh¹, Petrus Sampelawang², Normalia Sirande³

¹Departemen of Mechanical Engineering, Faculty of Engineering, Christian University of Indonesia Toraja, Tana Toraja, South Sulawesi, Indonesia
²Departemen of Mechanical Engineering, Faculty of Engineering, Christian University of Indonesia Toraja, Tana Toraja, South Sulawesi, Indonesia

E-mail: sallolonel@gmail.com, petrussampelawang145@gmail.com, lhiyar1@yahoo.com

Abstract. The use of local bamboo biomass bricket is very effective and efficient to be used as an alternative fuel. This research aimed to (1) evaluate the proximation and calor value of three types of local bamboo based on variasi jenis bambu, (2) to determine thermal efficiency of the bamboo charcoal bricket. This research applied experimental method by using three types of material through efficiency evaluation on the bricket stove. The result of experiment on the comparison of calor value was found that bricket type B1 (Petung Bamboo) has the highest calor value as 5176.33 cal/gram, B2 (Wulung Bamboo) has the value calor as 4873 cal/gram, and B3 (Apus Bamboo) has value of calor as 5025 cal/gram. Meanwhile, the result of burning experiment on the stove showed that B1 (Petung Bamboo) is the best in terms of the ability to boil water for five (5) times by thermal efficiency l in the amount of 56.91%.

Key words: charcoal bricket, petung bamboo, wulung bamboo, apus bamboo, calor value, thermal efficiency

1. Introduction

By the development of this increasingly advanced era, fuel energy consumption is increasing and focused only on the use of petroleum fuel which is limited and the price is increased. Therefore, it needs to do a variety of breakthroughs to get alternative energy sources, in addition to the use of oil and gas fuel.

Beside petroleum, there are three kinds of hydrocarbon sources namely coal, natural gas and biomass. Of the three sources of energy, only biomass that has the character can be renewed. Biomass is generally known as the dry matter of organic material or the material remaining after the water contain in a plant or organic material is being removed.

Biomass is very easy to be found in agricultural activities, plantations, livestock, fisheries and other wastes. Biomass waste becomes one of alternative energy sources. An example of the utilization of biomass energy derived from the forestry activities of bamboo. Bamboo is a plant of grass that grows a lot in our country. These plants can grow in both hot and cold climates. Most of the rural areas of bamboo plants are allowed to grow wild, but although not getting treatment, bamboo can grow well. Bamboo grows clustered to form clumps, shoots easily out of the rhizomes and form new plants. This new plant
will grow together with its predecessor plant and will eventually form a clump with many bamboo reeds. Single-leaved bamboo arranged alternately at the tip of the reed or twigs. The root of bamboo is very strong because the rhizome branches and have a strong bond that is difficult to separate. Therefore, bamboo is widely planted in sloping areas or riverbanks to prevent erosion or landslides.

Today, many people make handicrafts from bamboo. There are also musical instruments made from bamboo such as flute and angklung. The bamboo stems are round, hollow, fully segmented, can be split from vertical and flexible. The presence of the segment will increase the strength of the bamboo rod. Specific gravity of bamboo is about 0.6 to 0.9 (dry air) lighter than water. Although bamboo grows fast but remains at its maximum properties, i.e for the tropics 6 months after the buds arise. The use of bamboo itself, especially in South Sulawesi, especially North Toraja, provides more value not only used for handicraft, but also used in the making of temporary houses if there is an event of ‘Rambu Solo’ (Funeral Ceremony) and ‘Rambu Tuka’ (Thanksgiving) as the place to sit for the guests. After the event, the bamboo is wasted away. Therefore, I will utilize it in another form so it can be worth again for renewable energy.

The description above encourages authors to examine the calorific value of bamboo under the title: “Local Bamboo Experimental Studies As Alternative Energy Sources”. This study aims to determine the calorific value of bamboo in terms of variations of its type, and to determine the burning efficiency value of bamboo in the review of the variation of its type.

2. Basic Theory

Bamboo is a plant of grass that grows a lot in our country. These plants can grow in both hot and cold climates. Most of the rural areas of bamboo plants are allowed to grow wild, but although not getting treatment, bamboo can grow well.

Bamboo grows clustered to form clumps, shoots easily out of the rhizomes and form new plants. This new plant will grow together with its predecessor plant and will eventually form a clump with many bamboo reeds. Single-leaved bamboo arranged alternately at the tip of the reed or twigs. Root bamboo is very strong, because the rhizome branches and have a strong bond that is difficult to be separated. Therefore, bamboo is widely planted in sloping areas or riverbanks to prevent erosion or landslides.

Today many people make handicrafts from bamboo. There are also musical instruments made from bamboo such as flute and angklung. The bamboo stems are round, hollow, fully segmented, can be split from vertical and flexible. The presence of the segment will increase the strength of the bamboo rod. Specific gravity of bamboo is about 0.6 to 0.9 (dry air) which is lighter than water. Although bamboo grows fast but remains at its maximum properties, i.e for the tropics 6 months after the buds arise. This is the characteristic that distinguishes bamboo from ordinary trees. Bamboo felled after 4 years, the number of bamboo per hectare between 100 to 500 clumps or about 2000 to 14000 stems, depending on the type and fertility of the soil, while the diameter between 2 to 10cm. The types of bamboo that are found in Indonesia are: rope bamboo (apus), petung bamboo, ater bamboo, spotted bamboo, wulung bamboo and others.

2.1. Binder/Adhesive material

To bind the particles of substances in the raw materials in the process of making briquettes, there are some necessary binding materials to produce a compact briquettes, they are:

2.1.1 Clay

Clay is a silicate base fractional element of silicates less than 4 micrometers in diameter. Clay contains a fine silica and/or aluminum fused. These elements, silicon, oxygen, and aluminum are the elements that make up most of the Earth’s crust. Clays are formed from the process of weathering silica rocks by carbonic acid and partly generated from geothermal activity.

2.2 Adhesives/Sago Flour

Sago flour is flour obtained from sago stalk. Sago has adhesive properties, so it is very good to be made as an adhesive briquette in this study.
The testing consisted of two parts: briquette burning/water boiling and calculations efficiency ($\eta_{th}$):

$$\eta_{th} = \frac{Q_w + Q_p}{LHV \times M_{bb}}$$

$$\eta_{th} = \frac{(M_a \times C_p \times (T_a - T_p)) + (M_p \times C_{pal} \times (T_c - T_p)) + (M_u \times H_L)}{LHV + M_{bb}}$$

where:

- $\eta_{th}$: thermal efficiency of briquette burning (%).
- $M_a$: initial water mass (kg).
- $M_{bb}$: remaining briquette mass in the stove (kg).
- $M_u$: mass of water vapor (kg).
- $H_L$: vapor latent heat (kJ/kg).
- $C_{pal}$: aluminum/pot material specific heat (kJ/kg {°C}).
- $LHV$: briquette lower heating value (kJ/kg).
- $T_a$: water’s ambient temperature
- $T_p$: water vapor temperature (100 °C)
- $T_c$: Pot temperature (°C)

Figure 1. Petung bamboo (*Dendrocalamus asper*) Grows up in the Toraja area

Figure 2. Wulung bamboo (*Gigantochloa atroviolacea*) Grows up in the Toraja area

Figure 3. Apuss bamboo (*Gigantochloa apus Kurz*) Grows up in the Toraja area

3. Research Materials and Methods

The research method used was experimental method by utilizing local bamboo as rope bamboo (*apus*), briquettes as alternative fuel on the stove tested. The form of charcoal briquettes used is the form of the wasp nest because based on some previous researches that the form of the wasp nest has a larger surface of the flame field. The variation of bamboo charcoal species with a combination of raw materials can be that B1 briquettes (850 gram fuel petung bamboo+75 gram clay+75 gram sago flour); B2 Briquettes
(850 gram fuel wulung bamboo+75 gram clay+75 gram sago flour); B3 briquettes (850 gram fuel apus bamboo+75 gram clay+75 gram sago flour). The next is testing proksimate test, physical test, the calorific value and burning efficiency of the stove.

4. Results and Discussion
The content of heating value obtained in briquettes was B1 5176 cal/gram, B2 4873 cal/gram and B3 5025 cal/gram. The average of all three types of briquettes based on the type of bamboo obtained was 5033.777 cal/gram. The result of calculation of burning efficiency for the three types of bamboo charcoal briquette, can be seen in Figure 2. In the graph above, it can be seen that the results of the calculation of thermal efficiency shows that B1 has the highest efficiency of 57.93%, followed by B2 of 49.96% and the lowest efficiency is in B3 that is equal to 35.48%. B1 type briquettes have a very high thermal efficiency because they have a very high calorific value of 5176 cal/gram, with the ability to boil water 5 times with a mass of boiling water of 4000 ml which consumes 0.28 kg of briquettes.

![Figure 4. Graph of Brick Material Composition Against Thermal Efficiency](image)

5. Conclusions
By the results of this study, it can be concluded that: The highest calorific value was petung bamboo briquettes (B1) of 5176 cal/gram, followed by apus bamboo briquettes (B3) of 5025 cal/gram, and the lowest is wulung bamboo briquettes (B2) of 4873 cal/gram. The efficiency value of burning in briquette stove shows that bamboo bamboo briquettes have the highest efficiency of 57.93%, followed by bulu bulu bulu bulus (B2) of 49.96% and the lowest efficiency value is bamboo briquette briquette (B3) of 35.48%.

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