The 5th International Symposium on Material, Mechatronics and Energy The 5th ISMME 2018

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The 5th International Symposium on Material, Mechatronics and Energy The 5th ISMME 2018

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Foreword

First, we would like to thank all researcher who are already send the results of scientific research papers and participated in the 5th International Symposium on Material, Mechatronics and Energy 2018. All papers in this volume has presented at ISMME 2018 by oral presentation. The papers have been peer reviewed through processes administered by the proceedings Editors. Reviews were conducted by expert referees to the professional and scientific standards expected of a proceedings journal published by IOP Publishing.

Our theme is Challenges and Opportunities of Materials Engineering, Mechatronics and Energy towards independence of independent and sustainable technology products. Themes have been given an important role of Indonesian Development of Industrial Manufacture strategic plan, where the Indonesian people are still in desperate need of technology in these areas, material, mechatronics and energy.

Today Issues is still on Industry 4.0, they are five items should be considered:
1. Scalability; The automation principle of Industry 4.0 could help to facilitate improved scalability among companies in the manufacturing sector.
2. Security; One of the foremost concerns about Industry 4.0 among manufacturers is the possibility of mishaps due to glitches in cognitive computing.
3. Control and Visibility; As manufacturing networks globalize, it is crucial to make digital processes visible to all points of a system. When fully implemented, the principles of Industry 4.0 support responsiveness by making information available worldwide within a fraction of a second.
4. Customer Satisfaction; The process will be fully transparent along all stops on the manufacturing chain, from the moment someone places an order or submits a design until the moment when shipments arrive. Industry 4.0 will facilitate co-creation capabilities between manufacturers and related entities on a global scale.
5. Customization; Industry 4.0 could take customization to new levels with the use of commercial 3-D printers, which there are 23,000 of in use worldwide.

We hope many researchers play on such conditions. Finally, thanks to all of my college in Faculty of Engineering Hasanuddin University, Okayama University, Graduate School of Unhas, Research and Community Services Institute of Unhas and Polytechnik State of Ujung Pandang.

Makassar-Gowa, November , 2018
Yours

Dr. Ir. Muhammad Arsyad Thaha, MT
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Peer Review Statement

All papers published in this volume of Journal of Physics: Conference Series have been peer reviewed through processes administered by the proceedings Editors. Reviews were conducted by expert referees to the professional and scientific standards expected of a proceedings journal published by IOP Publishing.

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

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

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Abstract. The use of local bamboo biomass bricket is very effective and eficient to be used as an alternative fuel. This reasearch aimed to (1) evaluate the proximation and calor value of three types of local bamboo based on the variasi jenis bambu, (2) to determine therma 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 5176,333 cal/gram, B2 (*Wulung Bamboo*) has the value calor as 4873 cal/gram, and B3 (*Apus Bamboo*) has value of the calor as 5025 cal/gram. Meamwhile, 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 characterictic 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, the 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 (η_{th}) :

$$\eta_{th} = \frac{Q_w + Q_p}{LHV \times M_{bb}} \quad (1)$$

$$\eta_{th} = \frac{\left(Ma \times Cp \times (T_a - T_b)\right) + \left(M_p \times Cp_{al} \times (T_c - T_b)\right) + (M_u \times H_L)}{LHV + M_{bb}} \quad (2)$$

where :

η_{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).
Cp_{air} : water specific heat 4.1769(kJ/kg ^{0}C).
Cp_{al} : aluminum/pot material specific heat (kJ/kg ^{0}C).
LHV : briquette lower heating value (kJ/kg).
T_b : water's ambient temperature
T_a : water vapor temperature (100 ^{0}C)
T_C : Pot temperature (^{0}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

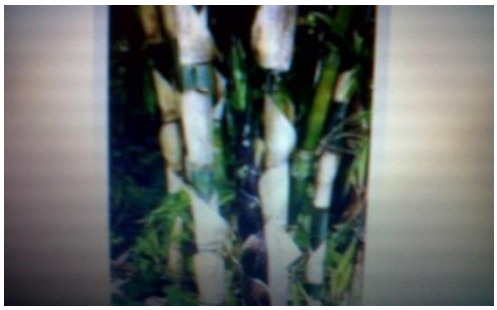

Figure 3. Apuss bamboo (*Gigantochloa apus* Kurz*)* Grows up in the Toraja area

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 briqutesss (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, pysical 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.

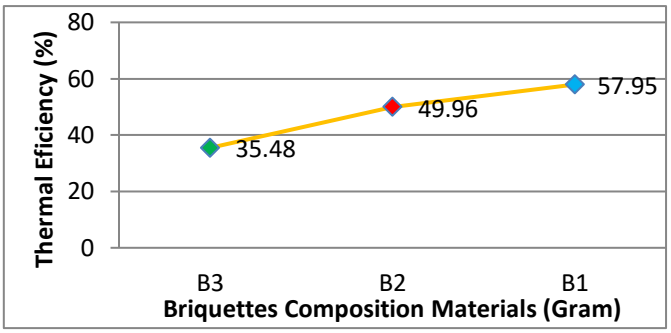

Figure 4. Graph of Brick Material Composition Against Thermal Efficiency

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 bambo 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 bulul bulse (B2) of 49.96% and the lowest efficiency value is bamboo briquette briquette (B3)) of 35.48%.

6. Reference

[1] Arif, E dan sallolo suluh., 2014 Study of Performance Improvement Possibility of Various Stoves with Waste BiomassFuel Briquettes. The 1st International Symposium On Smart Material And Mechatronics, Graduate School Of Mechanical Engineering University of Hasanuddin, . 2014.

[2] Pilimon Unukly dkk. 2016. The quality of charcoal briquettes as an alternative fuel made from corn cobs and bamboo waste.(Original in Bahasa: Kualitas briket arang sebagai bahan bakar alternative berbahan baku limbah tongkol jagung dan bambu) http://jurnalee.files.wordpress.com., Acessed April 20 2017.

[3] Taufik Iskandar, Hesti Poerwanto. 2015. Identification of calorific value and time of flame resulting from a combination of particle size and strength in the bamboo bio-briquettes (Original in Bahasa : identifikasi nilai kalor dan waktu nyala hasil kombinasi ukuran partikel dan kuat takan pada bio-briket bambu), http://Jurtek.akprind.ac.id/sites/default/files/116_123_putra.pdf.com, Acessed 10 Juli 2017.

[4] Hijra Purnama Putra., Melrdania Mokodompit. 2013. The study of the characteristics of briquettes made from bamboo waste using rice adhesive (Orginil in Bahasa : Study karakteristik briket berbahan dasar limbah bambu dengan menggunakan perekat nasi., http://Jurtek.akprind.ac.id/sites/default/files/116_123_putra.pdf.com., Acessed 10 Juli 2017