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Characterization of Briquettes from Rubber Seed Shell And Stem of Senggani

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***Abstract*— Briquettes are one of the renewable energies included in the solid fuel category. The raw material of briquettes used in this research was made from the mixture of rubber seed shell and stem of senggani. The composition of the mixture of rubber seed shell and senggani are 100%:0%, 75%:25%, 50%:50%, 25%:75%, 0%:100%. An adhesive used was 10% starch glue. The briquettes were formed with die pressure 100Psi and 110Psi. The objective of this study was to identify the property of briquettes base on the variation of briquette presses, as well as the calorific value of briquette and also determining the best mix variation according to SNI 01-6235-2000 quality standard. The results show that the variation of composition and die pressure gives effect to water content, ash and calorific value of briquette. For moisture content, only 110 psi pressure values meet the SNI standard (under 8%), while for ash and calorific values, all pressure variations meet the SNI standard (ash under 8% and calorific values above 5000Kal/g). The lowest water content was found in the 25% mixture of the rubber seed shell and 75% stem of senggani with a pressure of 110Psi. The lowest ash was found in 100% of rubber shell with value 3.7% and the highest calorific value was found in 100% rubber shell with value 6608.63 Cal/g.**

Keywords*— Briquettes, rubber seed shells, senggani, calorific value

I. Introduction

Biomass is a renewable fuel and clean energy[1]. Forest biomass, such as using wood, although not a new idea, but this type of biomass can be stored and used on demand [2]. It can be utilized for generating electricity, heat, fuels or development of them [3]. The energy system used to improve the national economy can be accessed by developing and utilizing biomass energy by changing the production system and energy consumption more efficient[4]. Unfortunately, the use of biomass waste is less efficient, this is because the biomass has a high content of moisture, high ash, low specific gravity, and non-optimal heating value. Therefore, to obtain better fuel characteristics, an advanced process should be applied, such as making briquettes.

One method used to optimize the use of wood fuel is by making briquettes. This method provides better efficiency because in addition to utilizing wood it is possible to use wood residues.Besides that, the briquette technique is also one method to overcome environmental challenges because it is one of the cleanest coal technologies[5]. Heat energy from briquettes that have been formed by the press method can be used for many things, for example for cooking or other industrial activities [6].

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In this study, the selected briquette material was derived from garden waste, namely rubber seed shells and stem of senggani. In Indonesia, especially in Bangka Belitung province, these materials are plentiful. In 2017, rubber plantation area in Bangka Belitung is 3,672,123 hectares area[7]. However, the farmers only focused on the rubber latex and they left the rubber seed shell waste useless. Rubber fruit can be seen in fig.1b.

While tree of senggani (Melastoma candidum D.Don), is an upright shrub as high as 0.5m - 4m which has many branches and can grow in places that get enough sunlight such as on the slopes of a mountain, bushes, fields that are not too arid, or planted in tourist areas as ornamental plants at elevations up to 1,650 above sea level. In this study, the part of the senggani tree that was used as briquette material was the stem with the assumption that the material with wood species had good potential to be used as briquettes. Senggani tree shown in fig.1a.

Both of these ingredients have not been used optimally and they have the potential to be developed as the raw material for briquettes. In other condition, the community Bangka Belitung province, not all of them use gas or electricity for cooking, this is due to unfavorable economic factors, so they use wood to fuel a lot. Therefore, briquettes are a good solution to help the community as alternative energy. To maximize the utilization of rubber seed shell and stem of senggani as a briquette, these two ingredients were mixed into various compositions.

Briquettes were formed with different die pressures because it gives the influence for the characteristics of briquettes[8]. The goal of the project was to obtain the characteristics of briquettes including moisture content, ash and calorific value of briquettes. Then the results of the study were compared to Indonesian National Standard for briquette (SNI 01-6235-2000) and the results of the previous study[9], with the same briquettes material composition at dying pressure 90Psi shows in Table 1.

II. EXPERIMENTAL

A. *Material*

Rubber seed shell and stem of senggani were collected from Bangka island, Indonesia. The main composition of rubber seed shell consists of 14.3% water content, 0.1% ash

a. b.

Fig. 1. (a) The Stem of senggani (b) rubber seed shell

TABLE I. THE COMPOSITION TREATMENT BETWEEN RUBBER SEED SHELL(RSS) AND STEM OF SENGGANI (S) 90PSI DIE PRESURE[9]

Parameters	**Treatment**				
	100RSS : 0S	***75%RSS : 25%S***	***50%RSS : 50%S***	***25%RSS : 75%S***	***0%RSS : 100%S***
Moisture Content (%)	8.42	10.65	12.11	17.12	16.32
Ash Content (%)	3.77	4.19	4.78	4.85	5.35
Calorific Value (Cal/gr)	6512.13	6123.23	6055.06	5531.43	5465.95

and 23.9 MJ/kg of calorific value. While for the stem of senggani has not been researched about its chemical composition yet. The composition of briquettes material is consists of 900 gram of mixed composition and 10% starch of total weight briquettes [10].

B. *Experimental Design*

The variation of composition briquettes from rubber seed shell and stem of senggani refers to Table 2. The research variable is a mixture of briquette material composition as independent variables, while moisture content, ash and, calorific value as dependent variables. Briquettes from rubber seed shells and stem of senggani were pressed with die pressure 100Psi and 110Psi. A simple mold was designed to create the briquettes, the diameter of cylinder is 40mm and height 60mm.

Before being used as a test material, rubber seed shells and stem of senggani were cleaned from dirt and then cut into small sizes. To reduce water content, the ingredients were dried under the sun for approximately 8-10 hours. Then the carbonization process was carried out by burning the materials into charcoal. Fig. 2 shows how to prepare the briquettes.

The burning of rubber seed shells and stem of senggani was done separately. After the two ingredients become charcoal, the ingredients were mashed with an 18 mesh sieve. Then, make adhesive using 100 grams of starch and 750ml of water. After all the ingredients were ready, mix the powdered rubber shell and the stem with the composition as in Table 2 of 900gram, then mix the adhesive. The mixed material was pressed using different die pressures, 100 Psi and 110 Psi. Then the briquette dried using an electric oven at the temperature of 80°C until 16 hours.

TABLE II. VARIATION TREATMENT BETWEEN RUBBER SEED SHELL AND STEM OF SENGGANI

Die Pressure (Psi)		**Specimen**	**Composition**	
			Rubber seed Shell (%)	***Stem of senggani (%)***
100	P1	A1	100	0
		A2	75	25
		A3	50	50
		A4	25	75
		A5	0	100
110	P2	B1	100	0
		B2	75	25
		B3	50	50
		B4	25	75
		B5	0	100

C. *Proximate Analysis*

Moisture content testing was carried out with the procedure of the American Society for Testing and Material (ASTM) D-3173 as follows: Samples of 2 grams (W_i) were dried in an oven at a temperature of ± 103ºC for approximately 4 hours until the weight was constant (W_f). The sample is then cooled in a desiccator and weighed. Moisture content is calculated with the formula:

$$A\,(\%) = \frac{W_i - W_f}{W_i}\,x\,100\% \quad (1)$$

Fig. 2. Preparation of Material

Ash or referred to as mineral materials contained in solid fuels which are materials that cannot be burned in the combustion process. Ash is the material that remains when solid fuel (wood) is heated to a constant weight. Ash content testing was carried out by the American Society for Testing and Material (ASTM) D-3174 as follows: Samples as much as ± 1 gram were inserted into the ignition cup (crucible) and weighed, crucible without a lid heated in the ovens with a temperature of 600ºC - 750ºC for 3-4 hours, then the oven is opened for 1 minute to perfect the heating process. After the heating process is complete, the sample is crushed and then cooled in an exicator. After going through the cooling process, weigh the sample to find out the mass. This heating and cooling treatment were repeated until a constant value is obtained. [11].

Calorific value is obtained through testing using a device, namely a calorimeter bomb. This tool is equipped with a water bath and oxygen controller. Tests are carried out using procedures that refer to the ASTM No. D-5865.

D. *Standardization of Briquettes*

After the briquette has been formed, the briquette was tested to determine the moisture content, ash, and calorific value. The results of these tests were compared with the standard charcoal briquette by the Indonesian National Standardization Agency (BSN), namely the Indonesian National Standard (SNI 01-6235-2000); a maximum 8% for moisture content, maximum 8% for ash and minimum 5000 Cal/gr [12].

III. RESULTS AND DISCUSSION

A. *Moisture Content*

The results of moisture content for die pressure 100Psi and 110Psi were varied, from 7.74% to 14.22% (see Table 3). The moisture content of briquettes at 100Psi is above 8%, this indicates that the briquette moisture content does not meet the SNI standards (≤ 8%). This condition is the same as the result using die pressure 90Psi [9], the value is 8,42% to 17,12% (see Table 1). While the moisture content at a pressure of 110Psi, all briquette compositions meet SNI standards, the value is between 7,13% – 7,74% (see Table 3).

In die pressure 90Psi (Table 1) and 100Psi (Table 3), the results indicate that the more amount of the stem of sengani, the higher moisture content. In Fig 3a, dies pressure significantly affected briquettes moisture content. Besides that, based on interpretation of ANOVA, it shows that die pressure influenced moisture content (α = 5%). The higher the briquettes die pressure, the lower the moisture content produced. Conversely, the lower the briquette pressure, the higher the moisture produced. The best moisture content is briquette composition D with 25% rubber seed shell and 75% stem of senggani.

B. *Ash Content*

The ash content for die pressure 100Psi and 110 Psi in all briquette compositions meets SNI standards (≤ 8%). The lowest ash was found in sample A (100% rubber seed shell) which was 3.69% and the highest is in sample E (100% stem of senggani) which was 5,45% (Table 3). Based on the results of the study, it was found that the ash of the stem of senggani material was higher than the ash of rubber seed shell.

In Fig.3b, as die pressure increased, the ash content of briquettes also increased. The results showed the opposite condition with moisture content. Moreover, the ANOVA analysis results also indicated that die pressure influenced the ash (α = 5%). At this level, with a pressure 100Psi, the value of ash decreased and with a pressure 110Psi, the value of ash increased. While [9] showed that for 90Psi, ash value is between 100Psi and 110Psi.

C. *Calorific Value*

The most important thing for characteristics of briquettes is the calorific value. For calorific value, all briquette compositions meet SNI standards (≥5000Cal/gr). The compaction pressure of briquette has a significant effect on the heating value. The higher pressure applied the higher heat value of the briquette produced.

The calorific values of briquette for 100Psi and 110Psi were between 5629.88Cal/gr to 6608.63Cal/gr (23,57MJ/kg to 27.67MJ/kg) see Table 3. On the other side, the composition of rubber seed shell and stem of senggani also give the effect on the calorific value. Briquettes which mixed with more of the stem of senggani composition will decrease of calorific value. This condition allows the heating value of the stem of senggani is below the heat value of rubber seed shell. If we compare the results with die pressure 90Psi, the calorific value for 100 Psi and 110Psi are higher, respectively (Fig. 3c).

In addition, referred on ANOVA analysis, it was shown that die pressure significantly influenced the heating values of briquettes (α = 5%). The compositions of rubber seed shell and stem of senggani had a higher calorific value respectively compared to other fuels used in energy production such as the biosludge and cotton textile industry residues 21.8MJ/kg [13], the palm shell and fiber 16,4 MJ kg^{-1} [10], Spent Bleaching Earth (SBE) briquettes was between 9.18 MJ/kg and 10.96 MJ/kg [14], and cashew waste 25.7 MJ/kg [2].

D. The Selection of The Best Composition and Die Pressure

Base on the result of the research, briquettes from rubber seed shells and senggani stems can be used as alternative energy sources for solid fuels In Bangka Belitung Province, Indonesia. It is clear that the characteristic of briquettes meets of Indonesian National Standard (SNI). The selected briquette is a composition of 100% rubber seed shells. In addition to briquettes composition, die pressure also has an effect on the characteristics of briquettes. The best die pressure is 110 Psi where the rubber seed briquette has a calorific value of 6608.63 Cal/gr, ash and moisture content are 3.71% and 7.74%. Furthermore, the best mix composition of rubber seed shell and stem of senggani is sample B (75% rubber seed shell and 25% stem of sengani) with die pressure 10Psi. This briquette has characteristics: 7,56% moisture content, 4,76% ash and 6398,88 Cal/gr calorific value.

TABLE III. CHARACTERISTICS OF BRIQUETTE FROM SEED RUBBER SHELL AND STEM OF SENGGANI

Parameters	**Treatment**										***SNI standard***
	A1P1	***A2P1***	***A3P1***	***A4P1***	***A5P1***	***B1P2***	***B2P2***	***B3P2***	***B4P2***	***B5P2***	
Moisture Content (%)	8.36	8.21	8.90	14.2	13.03	7.74	7.56	7.54	7.13	7.52	≤ 8%
Ash (%)	3.69	3.69	3.91	4.69	5.17	3.71	4.19	4.76	5.41	5.45	≤ 8%
Calorific Value (Cal/gr)	6562.53	6322.41	6080.10	5753.76	5629.88	6608.63	6529.13	6398.88	6130.98	6086.03	Min. 5000

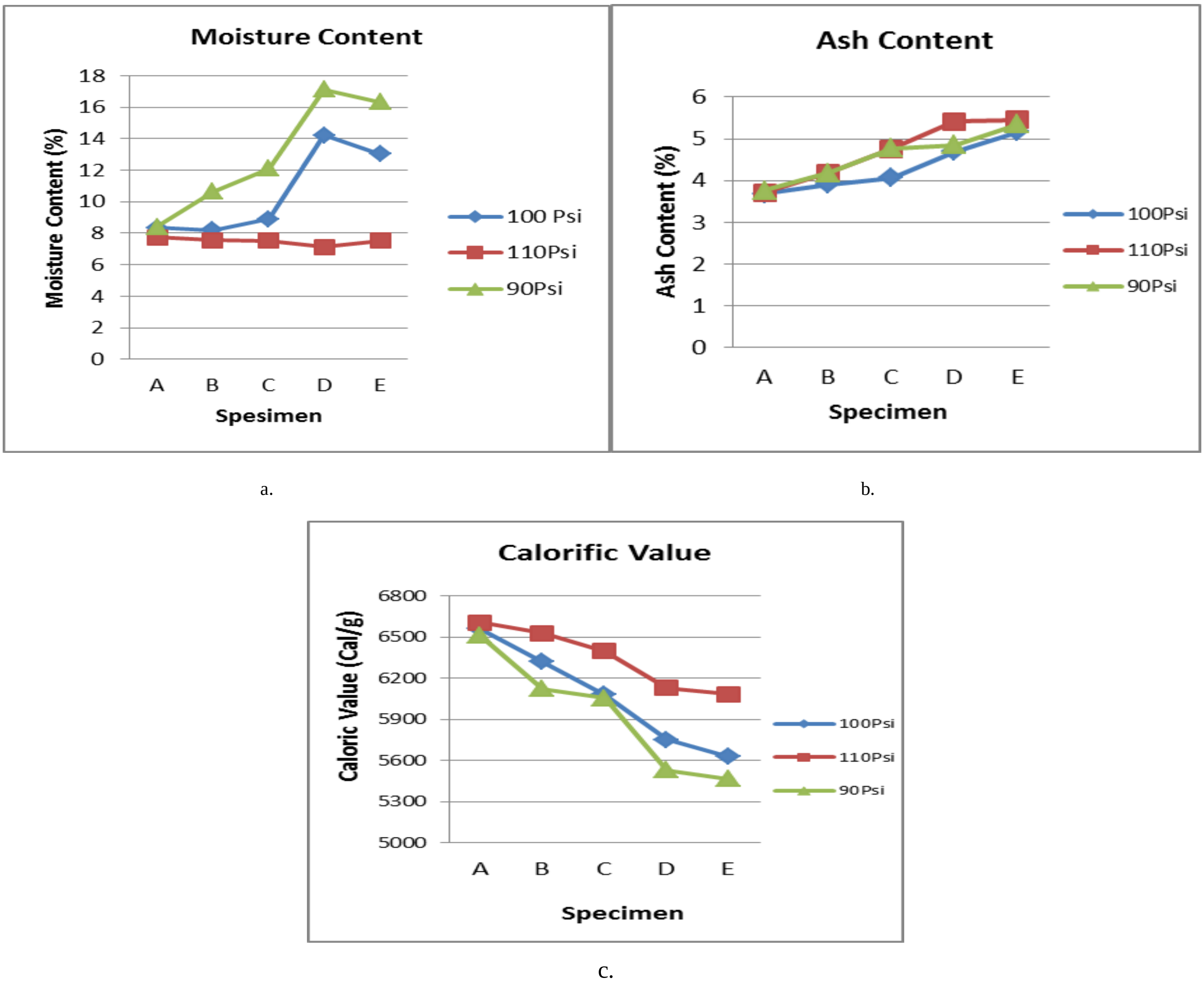

Fig. 3. (a) Moisture, (b) Ash, (c) Calorific value.

IV. CONCLUSION

The research is about making briquettes with a mixture of rubber seed shell and stem of senggani with different die pressure and variation in composition. It was found that all variables significantly influenced the characteristics of briquettes such as moisture, ash and calorific value. Briquettes with more stem of senggani composition will increase ash content and decrease the calorific values. Base on this research, the briquette with die pressure 110Psi had the best characteristics corresponds with Indonesian National Standard (SNI No. 1-6235-2000).

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