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CHARACTERIZATION OF BRIQUETTE FROM HALABAN CHARCOAL AND COAL COMBUSTION ASHES

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Abstract. The basis of this project was to make briquettes using waste materials. Halaban charcoal that is one of export commodities from South Kalimantan, produce a waste of charcoal. In our previous work, the halaban's waste still has high carbon energy. The halaban's waste mixed with combustion ashes from power plant, which were fly and bottom ashes. All of ingredients were crushed to 250 meshes in size and mixed in different compositions. The mixtures were molded and pressed at 150 Kg/cm² then were dried using sunlight. Each type of briquettes was characterized and analyzed the physical-chemical properties, such as water content, ash content and calorific value. The results showed that the water content, ash content and calorific value of briquettes, in average, are range from 2.9-4.1%; 0.3-25% and 4749-6621 cal/gr, respectively. Only the composition of 90:10 of halaban charcoal and ashes is suitable with Standar Nasional Indonesia (SNI).

Keywords: Halaban, fly ash, bottom ash, briquette.

1. Introduction

Halaban charcoal has been used for many years in South Kalimantan mostly for cooking, grilling and even ironing. The demand for halaban charcoal is increasing for local used and also exporting to other countries such as Japan, Korea and middle east countries. The producer or exporter would sorted the quality of charcoal for export and local used. This activity would cause a lot of wasted in form of powder or small pieces of charcoal. Mahdie [1] wrote that PT. Citra Prima Utama Banjarbaru, South Kalimantan, as exporter, produced about 6 tons per day. In our previous work [2], calorific value for halaban charcoal was 6,833.1 cal/gr. It is very potential to use the charcoal waste as briquette material. The previous work was done by Mahdie [1] show the halaban briquette has calorific value of 5,109.97 cal/gr.

Asam asam power plant at Jorong South Kalimantan use coal as their fuel. From coal combustion, ashes was produced about 5 % from its total weight. In 2014, the total ashes waste produced from the power plant were about 120 tons per day [3]. The ashes are divided in two which are fly and bottom ash. In our previous work [2], the carbon contents of fly and bottom ash were yield about 16.17 % and 41.87 %, respectively. Pels [4] wrote that utilization ashes as a fuel is possible when the carbon



content is larger than 35 wt%. It is confirmed by Gunawan [5] and Anetiesia [6] through their research in briquetting bottom ash mixed with coconut shell. Beside carbon, fly and bottom ashes also contain Al₂O₃ (5.7%), CaO (2.4%), MgO (2.03%), MnO₂, SiO₂ (74.2%) and Fe₂O₃ (14.4%) [7][8][9]. So even, fly and bottom ashes do not contain much carbon but they could be used as briquette material because of no sulphur contained. While silica could be donated to increase the briquette physical properties. Halaban charcoal would donate for calorific value. Then the composition of fly and bottom ashes would be varied to the mixing. The characteristics of briquette such as water content, ash content, volatile and calorific value would be observed to know the best composition. Therefore the objective of this research is to investigate the potential of briquette made from the waste of power plant and halaban charcoal and also determine some physical characteristics of the briquettes. The characteristics of briquette such as water content, ash content, and calorific value would be observed to know the best composition.

2. Experimental Methods

In this research, the halaban charcoal was wasted from PT. Citra Prima Utama Banjarbaru while coal ashes were from Asam-Asam power plant at Kabupaten Tanah Laut South Kalimantan. Halaban charcoal and coal ashes were crushed and then filtered to sizes of 250 meshes. For briquetting, the halaban charcoal was mixed with coal ashes, fly and bottom ashes, in different composition: 100:0, 90:10, 80:20 and 70:30. As binder, starch was used as much as 5 % of total weight. The mixed ingredients were pressed at 150 kg/cm². The results were dried in oven at 100 – 120°C for about 4 hours, then were leaved at open space for 24 hours. Some physical characteristics of briquettes, such as water content, ashes content and calorific value, would be examined.

Percentage of water content of briquette was investigated according to ASTM D 5142-02 [10]. The briquette was put into oven at temperature 104 – 110°C for 1 hour. Relative change in weight of the briquette was measured. Percentage water content was calculated using the following relationship:

$$\% \text{water content} = \frac{M_1 - M_2}{M_1} \times 100\% \quad \dots\dots\dots [1]$$

where M₁ is the Initial weight of briquette before drying and M₂ is the Final weight of briquette. Percentage of ash content of briquette was investigated also according to ASTM D 5142-02 [10]. The briquette was put into oven at temperature 450 – 500°C for 1 hour then the temperature increased to 700 – 750°C for 2 hours and another 2 hours at temperature 900 – 950°C. Relative change in weight of the briquette was measured. Percentage ash content was calculated using the following relationship:

$$\% \text{ash content} = \frac{M_2}{M_1} \times 100\% \quad \dots\dots\dots [2]$$

where M₁ is the Initial weight of briquette and M₂ is the Final weight of briquette. The calorific value of briquette was measured by bomb calorimeter and the SEM would be used to characterize the briquettes morphologies.

3. Results and discussion

3.1. Water content, ash content and calorific value of halaban charcoal-fly ash briquette
 The obtained value of water content, ash content and calorific value of halaban charcoal-fly ash briquette are presented in table 1.

Table 1 Water content, ash content and calorific value of halaban charcoal-fly ash briquette

Sample	Water content (%)			Ash content (%)			Calorific value (cal/gr)		
	100:0	90:10	80:20	100:0	90:10	80:20	100:0	90:10	80:20
S.1	3.8	4.6	3.9	0.3	8.9	17.4	6,620.8	5,846	5,283.8

S.2	4.0	4.3	3.0	0.4	7.5	17.4	6,619.4	5,871	5,273.5
S.3	3.9	4.1	4.9	0.4	8.0	17.3	6,623	5,859.2	5,294.5
Average	3.9	4.3	3.9	0.37	8.1	17.3	6,621.1	5,858.7	5,283.9

As can be seen in table 1, the average of water content of the briquette at composition 100:0 was about 3.9%. It is relatively the same with the water content of halaban charcoal in the previous work which was about 4.2 % [2]. At other composition, while the fly ash compositions were increase, the water content of briquettes was relatively the same. It could be caused by the majority of briquette are halaban charcoal. This value is still below the value of Indonesia National Standard (SNI), which is 8% (SNI No. 01 – 6235 – 2000) [10].

For ash content, as fly ash composition increased, the ash content was also increased. The consistency of ash content to the increase of fly ash composition could be understood because the calorific value of fly ash is almost zero [2]. So the calorific value was contributed by halaban charcoal which has calorific value of 6,833.1 cal/gr [2] while the fly ash only produced ashes. In Table 1, it can also be seen that the calorific value of briquette were decreased as fly ash composition increased but the values are larger than 5000 cal/gr. According to SNI No. 01 – 6235 – 2000 [10], the briquettes are good enough to be used in Indonesia.

3.2. Water content, ash content and calorific value of halaban charcoal-bottom ash briquette

The obtained value of water content, ash content and calorific value of halaban charcoal-bottom ash briquette are presented in table 2.

Table 2. Water content, ash content and calorific value of halaban charcoal-bottom ash briquette

Sample	Water content (%)				Ash content (%)				Calorific value (cal/gr)			
	a	b	c	d	a	b	c	d	a	b	c	d
S.1	3.8	3.9	2.7	3.7	0.3	12.7	15.7	23.8	6,620.8	5,872.1	5,393.8	4,765.6
S.2	4.0	3.6	2.7	3.9	0.4	7.6	15.6	28.6	6,619.4	5,869.3	5,391.1	4,734.1
S.3	3.9	4.6	3.3	3.8	0.4	3.3	9.8	23.7	6,623	5,873.2	5,397.2	4,749.1
Avg	3.9	4.0	2.9	3.8	0.38	7.8	13.7	25.3	6,621.1	5,871.5	5,394	4,749.6

Where: a=100:0 b=90:10 c=80:20 d=70:30

From Table 2, the average of water contents of briquettes were relatively the same at about 4% accept for composition 80:20 which has value of 2.9%. The ash contents and calorific values of the briquettes were consistently changed as the composition of bottom ash increases. The ash content were increased while the calorific value of briquettes were decreased

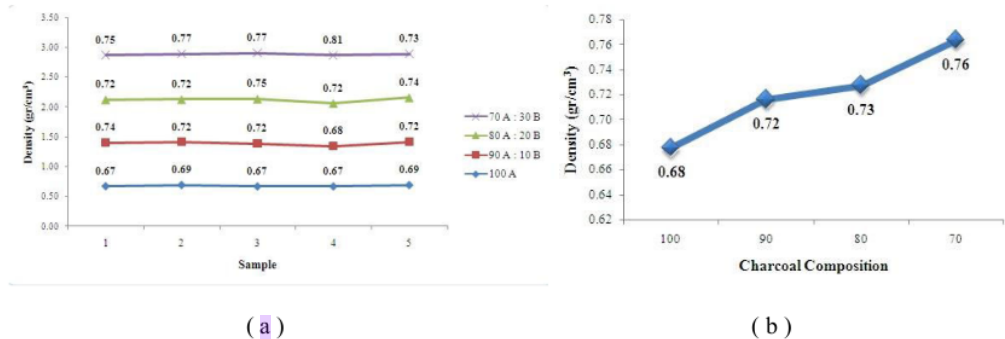


Figure 1. Density of briquette halaban charcoal-bottom ash: the experiment data of density to charcoal compositions (a) and the average of density to charcoal compositions (b)

From figure 1, there is an interesting result. The density of briquette was changed comparable to ash composition. When the ash compositions were increased, the density of briquettes were also increased. It seem that the small particles of ashes were gone in to the halaban charcoal structure. It is confirmed by SEM measurements, as presented in Figure 2.

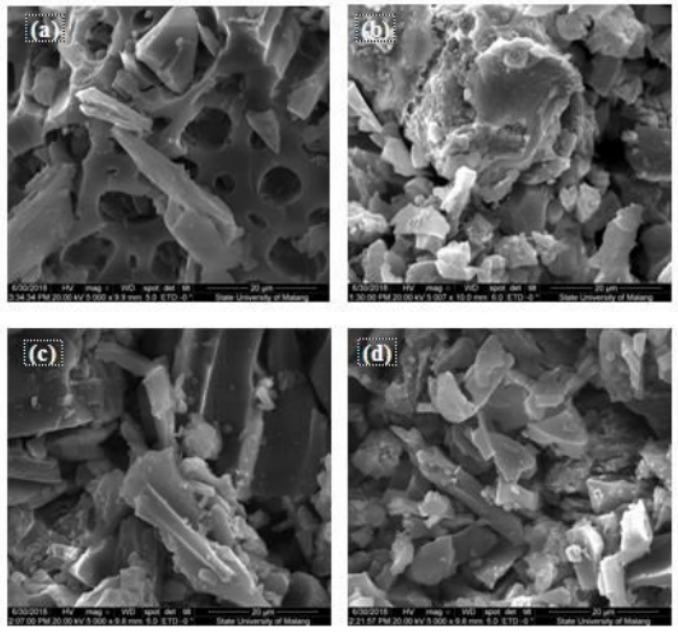


Figure 2. SEM image of briquette-bottom ash with composition: 100:0 (a); 90:10 (b); 80:20(c); and 70:30(d)

As can be seen at Figure 2 (a), the briquette was made without ash, the composition was 100 % halaban charcoal. The structure showed form of tree shell like with quite big lumps. At Figure 2 (b), as ash composition was added 10%, the structure looked more compact with big lumps and many small things that was believed come from the bottom ash. As the compositions of ash were increase, the SEM images of the briquettes were become more compact. It seems that the small particles of ashes were filled the gap between the charcoal structures and increase the density of briquettes. Even the fly and bottom ashes were not contributed to calorific values of briquettes, since the densities were increased, the briquettes would be burned longer.

4. Conclusions

Two type of briquette were made, halaban-fly ash and halaban-bottom ash briquettes. Physical characteristics of briquette were investigated. Water contents of the briquettes were about 4 % for both. Ash contents and calorific values of the briquettes were varied depend on the composition of ashes. According to SNI, based on those physical characteristics, the best composition of halaban charcoal and ashes is 90:10.

Acknowledgement

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