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Ash content of candlenut shell charcoal produced by candlenut shell carbonization tool using a vertical multi chambers

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Ash content of candlenut shell charcoal produced by candlenut shell carbonization tool using a vertical multi chambers

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Abstract. Candlenut shell, as one of biomass that has not optimally utilized, can be converted into charcoal which potentially increase its value. Candlenut shell carbonization tool using a vertical multi chambers is a tool that designed to convert candlenut shell into charcoal. The quality of the resulted charcoal remains unknown. This research aims to identify one of the quality variable of the charcoal which is ash content. The method used in the research was Gravimetric Analysis. Three samples from each carbonization chamber were taken to be analysed. As the tool has three carbonization chambers, the samples are 9 in total. The result showed that every chambers has different amount of ash content which are 2.167 % in CCI, 1.020 % in CC II and 4.687 % in CC III. In average, the ash content in candlenut charcoal resulted from Candlenut shell carbonization tool using a vertical multi chambers is 2.624 %. Hence, the tool managed to meet the SNI charcoal quality requirement in term of ash content which may not exceed 6 %.

1. Introduction

Recently, industrial and technological developments have increased fuel consumption which has led to a global fuel crisis. Therefore, alternative renewable fuels as supplement for higher demand of fuel are needed [1]. Regarding the situation and environmental issue, biomass has become a promising source for renewable energy development. Biomass is an abundant that commonly comes from agricultural processing waste [2]. In addition to that, biomass is renewable energy source that can be processed into bio-charcoal [3]. Charcoal is manufactured by deliberate carbonization in sealed ovens, chambers, or in furnaces provided with rigorous amounts of air [4]. Several studies concerning biomass for alternative energy have been carried out by some researchers. Some types of waste such as wood [5], mangrove wood [6], municipal waste [7], hibiscus leaf [8] and candlenuts shell [9] have considered potential for biomass.

Candlenut shell is solid waste resulted from candlenut plantations. It contains of hemicelluloses, cellulose, and lignin [10]. Up to the present time, candlenut shell, as one of potential biomass has not been optimally utilized and become waste. Whereas, it can be converted into charcoal which potentially increase its value. Considerable studies on utilization of candlenut shells for charcoal production have been carried out recently [11-18]. A high quality of charcoal can be produced using a high tool also. In this study, candlenut shell charcoals were produced through carbonization processed by candlenut shell carbonization tool using vertical multilevel chamber (CCT-VMC).

The aim of the research was to identify the quality of the charcoal candlenut shell, in term of ash content. The quality of charcoal produced was tested in accordance with Indonesian national standards (SNI), SNI 01–6235–2000.

2. Methods

2.1. Raw Material Preparation
This research method is done by means of the experiment. The raw material used in this research is candlenut shell waste (Figure 1). Candlenut shell waste was gathered from candlenut collectors in the South Aceh Regency. The initial process of preparation charcoal sample test was drying process. Candlenut shells were naturally dried using sunlight then proceed into candlenut shelling.

Figure 1. Candlenut shell [13].

2.2. Sample Preparation
The sample used in this research was charcoal resulted from candlenut shell. Charcoal was produced through carbonization process using a candlenut shell carbonization tool equipped with vertical multilevel chamber. The tool used can be seen in Figure 2. The tool furnished with three vertical carbonization chambers (CC), namely CC I, CC II, and CC III. The size of each chamber is 60cm x 30cm [13].
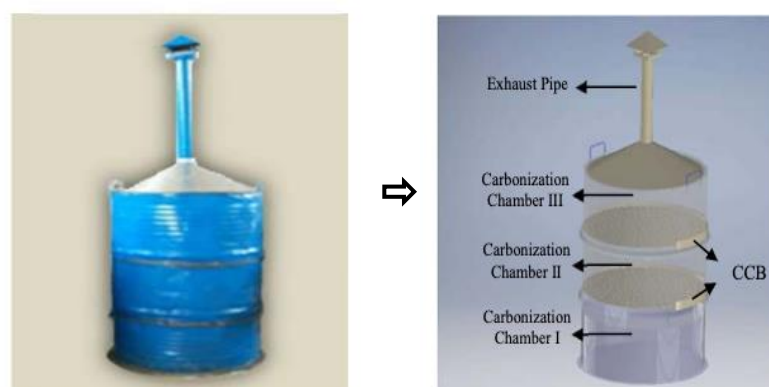
Figure 2. Candlenut shell carbonization tool using a vertical multi chambers (CCT-VMC) [13].

The carbonization process consists of two stages including combustion and cooling process. The carbonization process was estimated from the time the combustion process starts until the cooling process is complete. Each carbonization process was distinguished by the number of candlenut shells processed in each carbonization chamber, CC I, CC II, and CC III. The combustion process initiates

when the early combustion is carried out in the carbonization chamber I and is completed when the candlenut shell has all burned. The cooling process starts when the combustion process is stopped by closing all the air supply holes into the tool and is completed when the temperature of the outer wall of the carbonization tool is equal to the ambient temperature. The carbonization stages processes 8 kg in each carbonization chamber. Figure 3 shows the charcoal produced from candlenut shell carbonization processed by candlenut shell carbonization tool using vertical multi chamber (CCT-VMC).

Figure 3. Candlenut shell Charcoal.

For ash content testing purpose, the sample used was prepared in the form of powder. Candlenut shell charcoal was weighed, crushed and milled into small particle sizes using compression method until to form a powder. In order to get a homogeneous (uniform) particle size, the candlenut shell charcoal was then sieved until the sample is ready to be tested (Figure 4).

Figure 4. Candlenut shell Charcoal Powder

2.3. Testing

The purpose of this study is to determine the ash content of the charcoal produced from the candlenuts shell processed by a candlenuts shell carbonization tool using vertical multilevel chamber (CCT-VMC). The ash content testing of the sample was carried out at the Kinematics and Catalysis Laboratory of Chemical Engineering Department, Syiah Kuala University, Indonesia. Gravimetric method was employed to analyze the ash content of charcoal resulted from candlenuts shell carbonization. Gravimetric method is one of the quantitative analysis methods of a substance or component that has been known by measuring the weight of the component in a pure state after going through the muffle furnace process. The samples were weighted then heated in a muffle furnace at 600 °C. After a certain time, the samples were removed from furnace then cooled and weighed. The ash content is expressed by the percentage of residual dry oxidation results of the sample test at a temperature range of $\pm$ 580-600°C. The percentage of ash content in the charcoal was calculated by using the following formula[2].

$$\% \, Ash \, content = \frac{b}{a} \, x \, 100\% \qquad (1)$$

Where:
a = weight of sample before heating process (gram)
b = weight of sample after heating (gram)

3. Results and discussion

3.1. Time needed for Carbonization Process
The combustion process time need is shown in Table 1.

<div align="center">

Table 1. Time needed for carbonization process.

Sample	Time (hours)	
	Combustion	Cooling
I	1.25	6.5
II	1.20	7.0
III	1.15	7.5

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The Table I illustrates that the time used for candlenut shell carbonization process was about 7 hours in average. The time needed for combustion process range from 1.15 to 1.25 hours while time needed for cooling process range from 6.5-7.5 hours. It can be said that burning stage consumed less time than cooling stage.

3.2. Weight lost
The weight losses of samples measured after heated muffle furnace are shown in Table 2. It can be seen that each sample shows different number of the weight loss. The highest weight loss was shown by candlenut shell charcoal carbonized in CC II, 2,969 grams, followed by sample carbonized in CC I, 2,935 grams. The lowest weight loss was shown by candlenut shell charcoal carbonized in CC III, 2,859 grams. The average weight loss of sample from different carbonization chamber are 2,921 grams. A number of weights loses have effect on percentage of ash content of sample.

<div align="center">

Table 2. Weight loses of sample after heated process.

Sample	weight (gram)		Weight lost (gram)	Average (gram)
	Initial sample	Dried-oven sample		
I	3	0.066	2.934	2.935
		0.062	2.938	
		0.067	2.933	
II	3	0.030	2.970	2.969
		0.030	2.970	
		0.031	2.969	
III	3	0.140	2.860	2.859
		0.135	2.865	
		0.147	2.853	

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3.3. Ash content

Ash, which is the residue of combustion process, is an inorganic substance in the form of metal or mineral. The ash contents of sample measured are shown in Table 3.

Table 3. Ash content of candlenut shell charcoal.

Sample	Ash Content (%)	Average (%)
I	2.200	
	2.067	2.167
	2.233	
II	1.000	
	1.000	1,011
	1.033	
III	4.667	
	4.500	4,689
	4.900	
SNI 01-6235-2000	< 6.000	< 6.000

Table 3 shows that the ash content of charcoal for each carbonization process. The highest ash content contained in candlenut shell charcoal was shown by sample in CC III, 4,687 %. Whereas, the lowest ash content of candlenut shell charcoal was shown by sample in CC II, 1,020 %. In average, ash content contained in candlenut shell charcoal is 2,62%. According to SNI 01-6235-2000, quality requirements for charcoal ash content may not exceed 6%. Accordingly, ash content of the candlenut shell is still below the maximum ash level required by SNI. It can be concluded that the ash content of charcoal samples resulted from candlenut shell meet the SNI requirements. The lower the ash content, the better the quality of the charcoal produced. In addition, data in the Table 3 indicates that the carbonization chamber associated with ash content percentage. In general, carbonization using the multilevel carbonization chamber method is qualified to produce high quality candlenut shell charcoal, in terms of ash content, which is an average of 2.62%.

4. Conclusions

The ash content of charcoal produced from candlenut shell carbonization tool using a vertical multi chamber has been investigated in this study. The results show that ash content of the charcoal is 2,624% in average. The highest ash content contained in candlenut shell charcoal was shown by sample in CC III, 4,687 %. Whereas, the lowest ash content of candlenut shell charcoal was shown by sample in CC II, 1,020 %. The ash content measured in this study, meet the Indonesian national standards (SNI) requirements for charcoal quality, which may not exceed 6 %. The lower the ash content, the better the quality of the charcoal produced. In terms of ash content, candlenut shell carbonization tool using a vertical multilevel chamber (CCT-VMC) method is adequate to produce high quality candlenut shell charcoal.

5. Acknowledgments

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