Effect of Compaction Pressure on Quality of Activated Charcoal Briquette Made from Sago Stem Midrib Material

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Abstract. Fabrication and characterization of activated charcoal briquette made from sago stem midrib have been performed. The sago stem midrib firstly dried before carbonized using kiln drum method. Subsequently, the sago stem midrib charcoal was activated using electric furnace with 650°C of temperature for 5 minutes. Then, the activated briquette mashed and sieved by 80-mesh strainer before moulded into a compaction pressure. The pressure that applied were 34.66 kg/cm², 69.32 kg/cm² and 103.98 kg/cm². Ignition time, burning rate, and burning test were performed to characterize the briquette quality. The result shown that the higher the pressure applied, the lower ignition time, burning rate and the longer of burning time of sago stem midrib briquette, compared to the unactivated sago stem midrib briquette.

1. Introduction

By the increasing of human population in the world, necessity of energy also increase. The main energy source for nowadays is taken from the fossil energy, such as oil. Because of its non-renewable characteristic and highly utilization, the oil reserves are getting runs out. If there are no new oil reserve that could be found, especially in Indonesia, it is estimated that the oil will completely disappear in 15 years latter [1]. An alternative energy source that could be developed to substitute the oil energy is biomass [2-4]. Biomass popularly used as alternative fuel [5-6]. Another form of biomass energy is briquette that is produced from organic materials. There are some advantages of biomass briquetting such as no sulfur and fly ash in its burning process, easy to ignite and could solve the residual disposal problem [7]. There were many briquettes that have been produced from organic materials, such as cocoa shell [8-10], palm shell [11], durian peel [12], banana waste [13], rice husk and corn cob [14].

Sulawesi Tenggara province is one of the biggest sago producing regions in Indonesia, besides Papua as the biggest producing regions in Indonesia [15]. Sago flour is produced from sago stem, while the sago stem midrib will become unuseful materials. By the abundant availability of sago trees, the existence of sago stem midrib waste is also huge and could affect the environment. By the reason, in this research, sago stem midrib is used as main material to produce the activated charcoal briquette and the characteristic of the briquette, such as ignition time, burning rate and burning test, will be studied by varying the compaction pressure on its fabricating process.
2. Material and methods
Material used to fabricated the briquette is sago stem midrib that is taken from Konda region, Konawe Selatan regency, Sulawesi Tenggara province. Before carbonated, the sago stem midrib wastes were dried firstly. Then, the sago stem midrib was carbonized using kiln drum method [8]. The sago stem midrib charcoal from carbonization process was sieved using 80-mesh strainer to yield charcoal powder. The charcoal powder is then activated using electric furnace with 650°C of temperature for 5 minutes [8]. Before adding the adhesive agent, the charcoal was cooled using desiculator. Sago powder is used as the adhesive agent with mass ratio 9:1 [8]. After mixing with the adhesive agent, the charcoal powder was compressed with different compaction pressure: 34.66 kg/cm², 69.32 kg/cm² and 103.98 kg/cm² [8]. The characterization of the briquettes include the ignition time, burning rate and burning test. Temperature is measured using infrared thermometer. Briquette fabrication and characterization are shown in Figure 1.

Figure 1. Flow chart of sago stem midrib briquette fabrication and characterization process
3 Result and discussion

3.1 Ignition time
Ignition time represents the time that is needed to burns the briquette. Ignition time was observed when the briquette starts to burn. Figure 2 shown the the ignition time of sago stem midrib briquette with different compaction pressure. The blue line shows the briquette that was not activated, while the red one represents the activated briquette. It can be shown that the higher pressure that applied, the shorter of ignition time, both for the unactivated and activated briquette. Applied high pressure causes the decreasement of porosity so the ignition time become faster [8]. The shortest ignition time is reached on the activated briquette condition, which is 0.093 minutes of time or 5.58 seconds on 103,98 kg/cm² of pressure.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure2.png}
\caption{Ignition time of sago stem midrib briquette with different compaction pressure}
\end{figure}

3.2 Burning rate
Burning rate represents the time that is needed to consumes 1 gram of briquette when it starts to blame until become ash. Figure 3 shown the burning rate of sago stem midrib briquette with different compaction pressure. The blue line shown the unactivated condition, while the red one shown the activated briquette with 650°C of temperature for 5 minutes. It can be shown that the increase of compacting pressure causes the burning rate decrease. It can be caused by the decrease of porosity inside the briquette at higher compaction pressure [16]. Decrease of porosity caused the reduce of air cavities inside the briquette. Mallika et al [16] reports that the reduce of air cavities inside the briquette will curb the mass and heat transfer in combustion process and consequently the lower compaction pressure will produce briquette with higher burning rate.
3.3 Burning test
Burning test was held to determine the maximum temperature in briquette burning process. The temperature measurement was done in every 1 minute using infrared thermometer. Figure 4 shown the burning test for the sago stem midrib briquette without activation, while the Figure 5 shown the burning test result for the activated sago stem midrib briquette. It can be seen that the graph in Figure 4 is narrower than the the activated briquette graph. This means that the activated briquette spends more times to burning than the unactivated briquette. The unactivated briquette stops to burn in 17-22 of minutes, while the activated briquette stops to burn in 35-38 of minutes.

![Figure 3. Burning rate of sago stem midrib briquette with different compaction pressure](image)

![Figure 4. Burning test of unactivated sago stem midrib briquette with different compaction pressure](image)
4. Conclusion

Fabrication of activated charcoal briquette made from sago stem midrib has been successfully done. After carbonizing the sago stem midrib, the charcoal is then mashed and sieved using 80-mesh strainer. Then the charcoal grain is activated using the electric furnace with 650°C of temperature for 5 minutes. Sago powder is mixed to the activated charcoal to adhere the material. Subsequently, the mixed material was compacted with different compaction pressure: 34.66 kg/cm², 69.32 kg/cm² and 103.98 kg/cm². The result shown that, the higher compaction pressure, the shorter the igniton time, the lower burning rate, and the longer the burning test, compared with the unactivated sago stem midrib briquette.

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