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Performance Evaluation of Rotary Carbonization Pyrolysis as Durian Shell Biobriquettes Raw Materials

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Abstract-
The main process of making biobriquettes is carbonization, namely the formation of biomass into charcoal. Carbonization as charcoal producing tool are being developed today. This is conducted to produce maximum and qualified charcoal. In this research, we have made a prototype of multipurpose tool for carbonization. Besides producing charcoal, we can also utilize its smoke as liquid smoke.This tool is called the Pyrolysis Rotary Carbonisator. This carbonization tool is very effective and easy to use in terms of removing charcoal from the carbonization tool. This design can provide optimal results, that give maximum quantity of charcoal and more evenly heat transfer so carbonization process can be perfect and produce high quality of charcoal as material for bio-briquette. Performance evaluations on the tool proof that it has average efficiency of 90%. Another way of evaluating the work is viewed from the temperature of durian shell, palm shell and coconut shell processing with temperature variation of 200, 250, 300 and 400 ^{o}C, we also obtained various maximum heat. From this research, maximum calorie of durian shell charcoal at 400 ^{o}C is 5628 kcal/kg, while the palm shell at 300 oC is 7578 kcal / kg and the coconut shell at 400 is 7354 kcal / kg

***Keywords* —** Rotary Carbonisator Pyrolisis; Durian Shell Biobriquettes.

I. INTRODUCTION

Carbonization is a major process in the manufacture of biobriquette which is defined as a process for converting organic substance into charcoal [9]. Carbonization is a method or technology to obtain charcoal as the main product by using solid biomass such as durian shell, wood, rice husk etc. At 400 °- 600 °C, it can produce tar, pyroligneus acid and combustible gas as by-product. The objective of carbonization process is to increase solid carbon content and remove the volatile matter contained in the coal as low as possible to produce semi cokes or coke with ideal flying content of 8-15% and high calorie value above 6,000 kcal / kg [2].

Pyrolysis is a chemical decomposition of organic matter throughheating process, in which raw material will break down the chemical structure so that the solid phase turns into gas phase. This process is a decomposition process through heating with very limited amount of oxygen. Pyrolysis products generally consist of three types, namely solid (Char), liquid (Bio oil), and gas (H_2, CO, CO_2, and CH_4) [1]. Biomass is a number of natural elements (organic matter) produced through photosynthesis, both in the form of products and waste. Biomass is composed of cellulose, hemicellulose and lignin commonly found in plants such as: durian skin, bagasse and coconut shell.

Biobriquette is a charcoal that is altered in shape and size by means of pressing and mixed with adhesive, and can be used as an alternative energy source. According to [4], the use of biomass that produces alternative solid fuels can reduce greenhouse gas emissions Biobriquette has several advantages, such as uniform shape and size because it is made with a special printing device, has higher combustion heat value than regular charcoal, not smoky in use, durable and cheap. Besides carbonization, this process also involves pyrolysis process to obtain by-products of liquid smoke and tar. The process can be done in various ways, for example by burning it in open space, by using ordinary carbonization tool, but it still have problems with the smoke of combustion that pollute the environment. This has also been studied by [3] coal waste as briquettes. Therefore, it is necessary to design a tool that has function as charcoal media, but also produce liquid smoke as a byproduct that can be used for food preservatives. To obtain this, we need Rotary Carbonisation Pyrolysis tool which can produce charcoal and liquid smoke [10]. And the tool performance needs to be evaluated.

II. THE MATERIAL AND METHOD

Tools

Equipment used for rotary carbonization device consist of a furnace, rotary combustion reactor, tar refrigerant, tar container, liquid smoke coil cooling.

Materials

Materials used are durian shellsobtained from durian traders around the city of Padang, Palm shells and coconut shell.

Research Stage

The methodology used in this research is the experimental method and is conducted in Chemical Engineering Laboratory of Bung Hatta University. The tool used is a biomass size reducer, a pyrolysis Rotary Carbonisator consisting of a furnace, a rotating reactor, a coolant and a liquid smoke container. Materials used: durian shell biomass, palm shell and coconut shell as raw material of durian shell biobriquette.

Working Stages :

The predetermined biomass is reduced in size by inserting into the chopper and become small pieces of about 1.5 cm. This is to make faster drying process. Further, it is dried by sunlight to reduce its water content. Then we put it in pyrolysis rotary carbonisator with certain mass, each with a capacity of 3 kg. Variable parameter is carbonization temperature of 200, 250, 300, and 400°C. This variable is the same as the one tried by [12], with upright carbonization process small scale. Carbonization times are 1 hour and 2 hours. The output parameters are charcoal mass, calorific value, fixed carbon and ash content.

III. RESULT AND DISCUSSION

The process of carbonization in durian shell, palm shell and coconut shell biomassis carried out on the pyrolysis rotary carbonization device shown in Fig. 1

Fig. 1. Rotary carbonization pyrolysis tool

The tool in Fig. 1 is designed by [11]. This pyrolysis rotary carbonization device is used for charcoal producing from biomass and it can also produce liquid smoke and tar. The carbonated biomass for charcoal is used as raw material and mixer on the manufacture of durian shell briquettes, while the smoke is used as liquid smoke as a food curing agent.

Evaluation of Rotary Carbonization Pirolisis Performance

Evaluation of the performance of pyrolysis rotary carbonization tool is reviewed from several variables, ie charcoal obtained, carbonization temperature and carbonization time. As the test analysis is the value of fixed carbon, ash content and calorific value.

The Form of Raw Materials and Charcoal and the resulting product

Biomass raw materials in this study can be seen in Fig. 2. Biomass is carbonized by means of a pyrolysis rotary Carbonisator which can be seen in Fig. 1. By varying operating temperature according to specified variable and the form of charcoal from various carbonization temperatures and biomass types, it can be seen in Table 1.

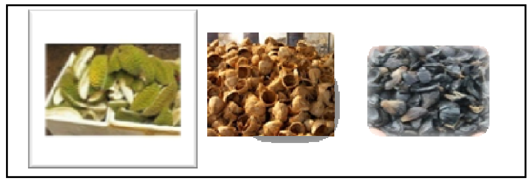
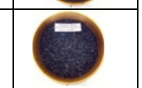
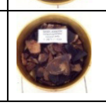
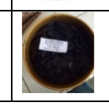


Fig. 2. Durian shell biomass, coconut shell and palm shell

TABLE 1
CHARACTERS OF SOME BIOMASS WITH VARIOUS OPERATING TEMPERATURES

Biomass	**CARBONIZATION TEMPERATURE**			
	200 °C	**250 °C**	**300 °C**	**400 °C**
Durian Shell				
Palm Shell				
Coconut Shell				

From Table 1, we can see that at 200°C, almost all the charcoal formed is still low, because biomass component to form carbon is not achieved yet. And when temperatures reach 250, 300 and 400, all biomass gradually begins to become charcoal. The yield of charcoal resulting from the pyrolysis rotary carbonization device can be seen in Fig.3.

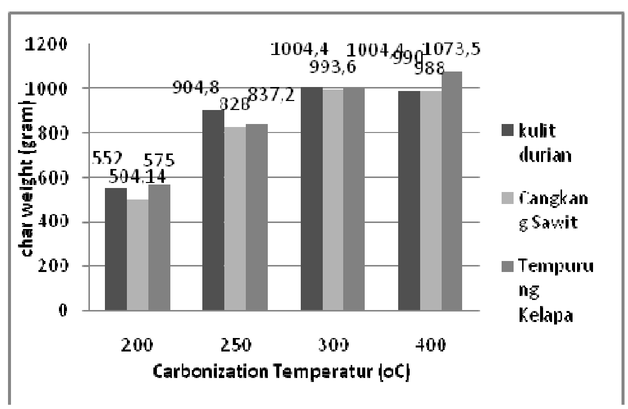


Fig. 3. Acquisition of Charcoal from biomass for various carbonization temperatures.

From Fig. 3, can be seen that most charcoal gain at carbonization temperatures of 300 ^{o}C and 400 ^{o}C, where as at 200 ^{o}C and 250 ^{o}C, charcoal are formed very little and biomass is not much fabricated. This is because the higher carbonization temperature, the less volatile substances in the charcoal, so that the carbon content is greater. The same results are shown by [14] in his research on the bagasse which results in an increase in carbonization temperature from 320 °C and above. In this study, for durian shell and palm shell, the perfect charcoal obtained is starts at 300 ^{o}C, while for coconut shell at 400 ^{o}C. From the results obtained in Fig. 3, the performance of the pyrolysis rotary carbonisator can be evaluated and the efficiency value of the tool is shown in Fig. 4.

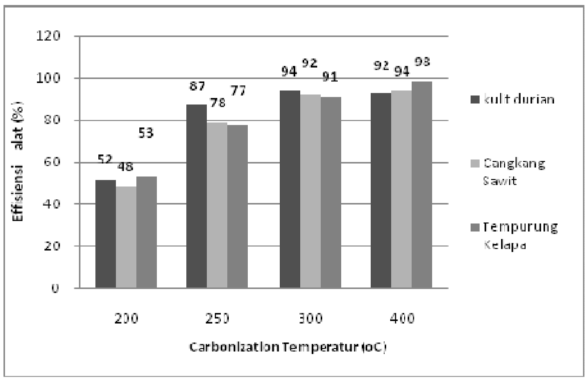


Fig. 4. Effect of carbonization temperature on the efficiency of the pyrolysis rotary carbonization device.

The results of biomass charcoal obtained from carbonization process at various temperatures are tested against the calorific value, fixed carbon content and ash content. The effect of carbonization temperature on heating value can be seen in Fig. 5.

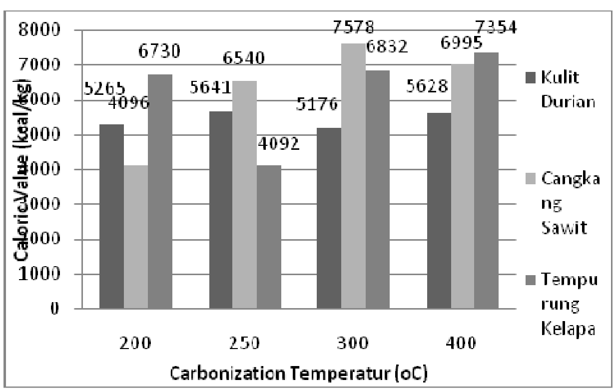


Fig. 5.Effect of biomass carbonization temperature on caloric value.

From Fig. 5 can be seen that at a temperature of 200^{o}C to 250 ^{o}C, the average value of charcoal calorie is still low and when at temperatures of 300 ^{o}C and 400 ^{o}C, the calorific value of charcoal is increasing. This is because Carbon has been perfectly formed from the burning result of the pyrolysis rotary carbonization prototype tool. The highest calorific value was obtained on each of the durian shell, palm shell and coconut shell biomass charcoal of 5628 kcal / kg at 400 ^{o}C, 7578 kcal / kg at 300 ^{o}C and 7354 kcal / kg at 400 ^{o}C. This higher yield was obtained from the pyrolysis rotary carbonization tool compared to the upright pyrolysis carbonisator has been studied [9]. And the caloric value of coconut shells is 7283,5 kcal/kg [5]

Subsequent research was conducted by varying the length of carbonization for 1 hour and 2 hours. The calorific value of old variations can be seen in Fig. 6.

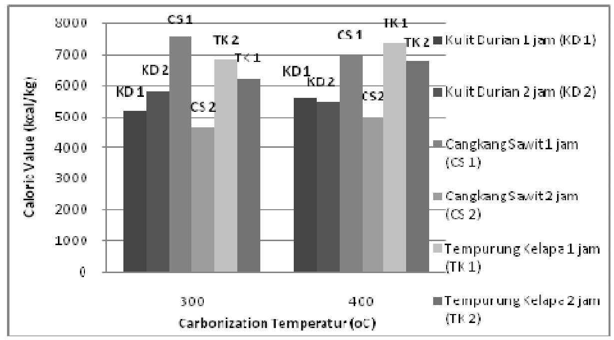


Fig. 6. Effect of temperature and duration of biomass carbonization on caloric value

From Fig. 6, we can see that the longer carbonization time in average Temperatures of 300 and 400^{o}C,the lower the heating value obtained. But this does not occur in durian shell charcoal which is at a temperature of 300,we got the highest heating value for 2 hours carbonization. The calorific value obtained can reach 5815 kcal / kg. Meanwhile, when the temperature of 400 ^{o}C with 1 hour carbonization, we obtained 5628 kcal / kg.

The effect of temperature on fixed carbon value on pyrolysis carbon monoxide biomass can be seen in Fig. 7.

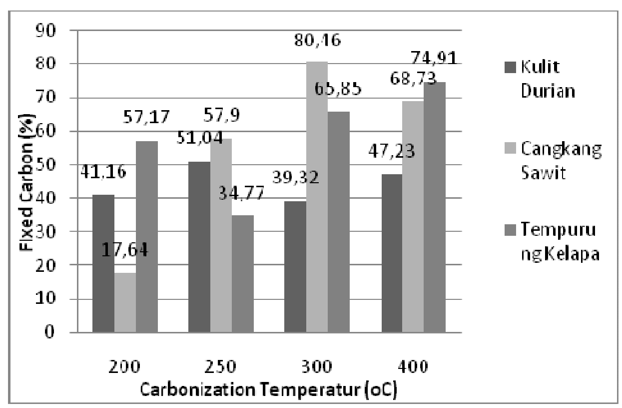


Fig. 7. Effect of biomass carbonization temperature on fixed carbon value

From Fig. 8 can be seen that the higher the carbonization temperature, the higher fixed carbon of each biomass, but the increase occurs at certain temperature. For durian shell charcoal at 250 ^{o}C, temperature has maximum fixed carbon value of 51.04%, while palm shells at 300 ^{o}C, we obtained 80.46% fixed carbon and for coconut shell at 400^{o}C we get 74.91%. The influence of carbonization time on fixed carbon value can be seen in Fig. 8.

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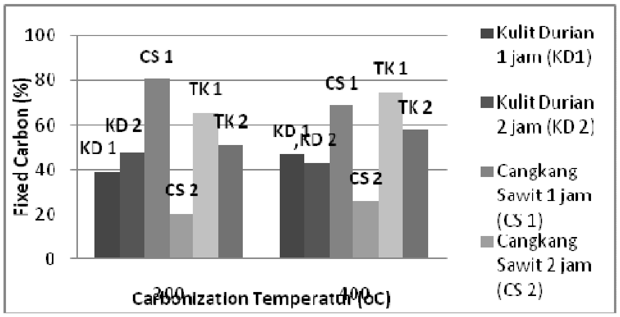

Fig. 8. Effect of temperature and duration of carbonization of biomass on fixed carbon value.

From Fig. 8 can be seen that the longer carbonization time, the lower fixed carbon value that we obtain.The influence of carbonization temperature of biomass to ash content can be seen in Fig. 9.

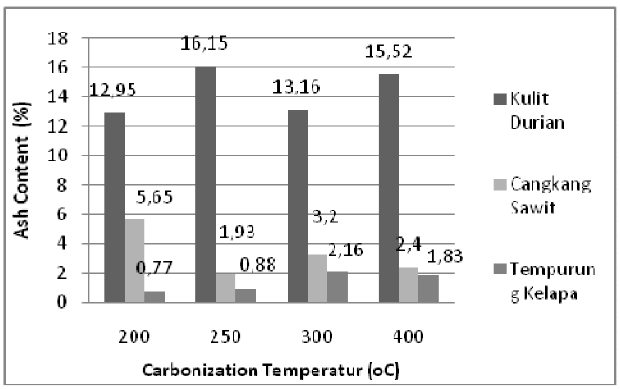

Fig. 9. Effect of carbonization temperature of biomass on ash content

From Fig. 9 can be seen that the ash content of each biomass is different and the higher the carbonization temperature, the less the ash content. This is inconsistent with research from [7], where increasing carbonization temperature and carbonization time hence increasing ash content for palm shell. This is due to the interaction between carbon and air so that the volatile substance levels will increase [6]. The ash content of palm shells and coconut shells is very small on average compared to ash content on durian shell. While the influence of carbonization time at temperature 300 and 400 ^{o}C to ash content can be seen in Fig. 10.

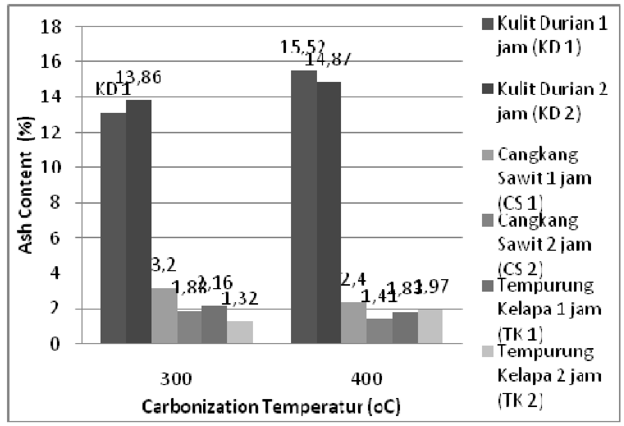

Fig. 10. Effect of temperature and duration of carbonization of biomass on ash content

IV. CONCLUSION

From the research result of carbonization process of durian shell, palm shell and coconut shell biomassby using rotary carbonization pyrolysis prototype, we got conclusion:

1. The higher the carbonization temperature the higher the charcoalobtained.
2. The longer the carbonization time, the less charcoal obtained.
3. From the results of calorific value analysis test, the higher the fixed carbon value,the temperature and the length of carbonization, the lower ash content.
4. From this research, maximum calorific value of durian shell charcoal at400 ^{o}C is 5628 kcal / kg, while the palm shell at Temperature of 300 ^{o}C is 7578 kcal / kg and coconut shell at the temperature of 400 ^{o}C that is 7354 kcal / kg.
5. Efficiency of performance evaluation of rotary carbonization pyrolysis prototype obtained is 98%.

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