Effect of variations in the composition of additives on the performance of petung bamboo charcoal briquettes

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Abstract. The use of petung bamboo as a raw material for making charcoal briquettes will reduce dependence on fossil fuel energy which is already depleting. The abundant condition of petung bamboo waste in Toraja comes from the rest of the party activities of tuka signs and solo signs that are useful for making houses / loud places for relatives and guests to sit. This research was conducted by making charcoal briquettes from petung bamboo waste by varying the composition of the sago adhesive and clay as an alternative energy source. The purpose of this research is to determine the optimal thermal efficiency. The method to be used is an experimental method using petung bamboo waste as an alternative fuel on the stove with a water boiling process. The results showed that B2 briquettes (a mixture of 175 grams of petung bamboo charcoal and 25 grams of clay reinforcement) were the most superior in terms of boiling 21 liters of water and produced a thermal efficiency of 70.39%.

1. Introduction

Petroleum is an energy that cannot be renewed, but in everyday life, fuel oil is still the main choice, resulting in depletion of oil reserves in the earth. While natural gas and other alternative energies have not been maximized for domestic consumption, this has led to a fuel crisis, especially fossil fuels. Therefore, to reduce dependence on fuel oil, especially kerosene, other alternative energy sources are maximized, namely biomass, which is very easy to find from agricultural activities, plantations, livestock, fisheries and other wastes. Biomass waste is an alternative energy source, one example of utilizing biomass energy from forestry and plantation activity waste products, namely bamboo waste. This material will be used as raw material in this study, because there have been many previous studies that discuss wood-based briquettes.

Seeing the abundance of petung bamboo available in North Toraja Regency, it is very potential to be used as a substitute for fuel or as an alternative energy in the form of charcoal briquettes[1] . In several previous studies, the quality and potency test of this material was used as a briquette material and other materials, namely [2]testing 3 types of local bamboo resulting in a calorific value of 5176.33 cal / gram and 56.91% thermal efficiency in petung bamboo briquettes. [3] conducted a study on bamboo statues as a composite material in the form of woven material, which produced a tensile strength of 39.139 N/mm^2 at a strip volume of 60% with sulfur water immersion for 4 weeks. [4]conducted a research on a mixture of able petung briquettes to produce a heating value of 7152.6 cal / gram. [5] conducted a research on petung bamboo in the form of biopelets resulting in a calorific value of 4216 cal/gram. [6]conducted a study on petung bamboo with organic cow dung adhesive produced a calorific value of 6635 cal / gram and the flame lasted 64.30 minutes.

Constraints that are sometimes encountered in the use of biomass as fuel, not in the briquette material, but in a mixture of additives that function as an adhesive and briquette reinforcement, which generally have the same composition, lead to low briquette performance. In this research, the authors tried to replace the tapioca starch adhesive with sago and its reinforcing agent from clay. There are previous studies using sago adhesive, namely [7] the calorific value of briquettes is 5637 cal / gram and [8] the heating value is 4567 cal / gram. [9] conducted research using coconut shell briquettes with clay as a strengthening agent to produce a calorific value of 5365 cal / gram and [10] also using coconut shell briquettes with reinforcing clay yields a heating value of 4979 cal / gram and a thermal efficiency of 4979 cal / gram. 71.03%. [11]conducted research on 3 types of stoves using coconut shell briquette fuel with a clay reinforcing agent with a calorific value of 4948.76 cal/gram. [12]conducted research on the briquette composition of a mixture of pine fruit with clay as a fixed variable as reinforcement to produce a calorific value of 6023 cal/gram. Since there has been no research that varies the composition of additives (adhesives and reinforcement) with briquettes, I try to combine the ingredients with the variations above. So that later the optimal thermal efficiency will be obtained from the content of this petung bamboo briquette

2. Methodology

In this study, the stove used as a burning tool for 5 types of bamboo petung charcoal briquettes based on its composition is a briquette stove made of steel. As for the dimensions of the stove; height 280 mm, outside diameter 220 mm, inner diameter 200 mm, distance from the base of the stove 10 mm, as shown in Figure 1

Figure 1. Stove

The research method used is an experimental method by utilizing bamboo petung charcoal briquettes waste which will be mixed with a variety of additives (sago adhesive and clay reinforcing agents with various compositions) as fuel for the tested stoves. Honeycomb briquettes are used because they have a larger flame surface area [10]. Testing the estimation, heating value and burning process of briquettes in the combustion chamber of a steel stove The table of briquette material composition can be seen in table 1 below:

Table 1. Variation in The Composition of Petung Bamboo Charcoal Briquettes

Sample	Material Composition		
	Petung Bamboo (Gram)	Sago flour (Gram)	Clay (Gram)
B1	800	150	50
B2	800	175	25
B3	800	100	100

B4	800	50	150
B5	800	25	175

In table 1, we can see the variation in the composition of the petung bamboo charcoal briquettes, there are 5 types of briquettes, where the petung bamboo charcoal is still 800 grams. The 200 grams of additives were varied, namely sago adhesive and reinforcing agents. So that later we can see the performance of the 5 types of briquettes.

3. Result and Discussion

This research begins with the manufacture of briquettes, estimation testing, heating value and combustion test (performance) on the stove / stove. The data retrieval process that becomes the parameters is the heating value, boiling time, burning time, fire temperature, the ability to boil water and thermal efficiency.

Table 2. Recapitulation of the results of the thermal efficiency values of 5 types of briquettes

Sampel	B1	B2	B3	B4	B5
ma (kg)	0,8	0,8	0,8	0,8	0,8
mp (kg)	0,25	0,25	0,25	0,25	0,25
Cp water (kj/kg°C)	4,1769	4,1769	4,1769	4,1769	4,1769
Cp api (kj/kg°C)	0,9	0,9	0,9	0,9	0,9
Tw (°c)	100	100	100	100	100
Ta (°C)	28	28	28	28	28
Tapi (°c)	565	765	782	685	560
HHV (Calori/Gram)	5624	5850	5438,32	4832,44	4506
Ability To Boil (Liter)	15	21	18	12	3
First Boiling Time (mnt)	20	15	25	30	35
ηth (%)	40,73	70,39	65,54	23.65	15,89

In table 2 it can be seen that B2 briquettes, namely a mixture of 800 grams of petung bamboo charcoal with 175 grams of sago starch adhesive with 25 grams of clay as a reinforcing agent, is superior to the four other briquettes in terms of calorific value, ability to boil water, the first time to boil water and lastly the thermal efficiency,

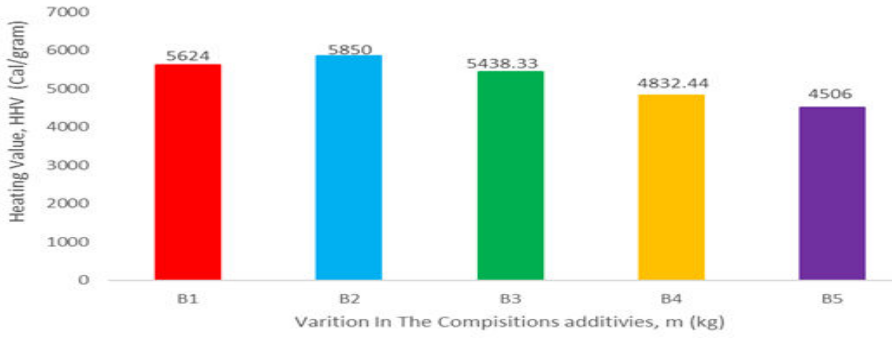

Figure 2. Heating Value on Variations in The Compositions Additives

Figure 3 above shows that the highest calorific value is found in briquettes B2 with blue color of 5850 cal / gram. And the lowest calorific value is found in B5 briquettes of 4506 cal / gram. This happens because of the maximum briquette processing process. The higher the fixed carbon, contained in this briquette, the higher the calorific value.

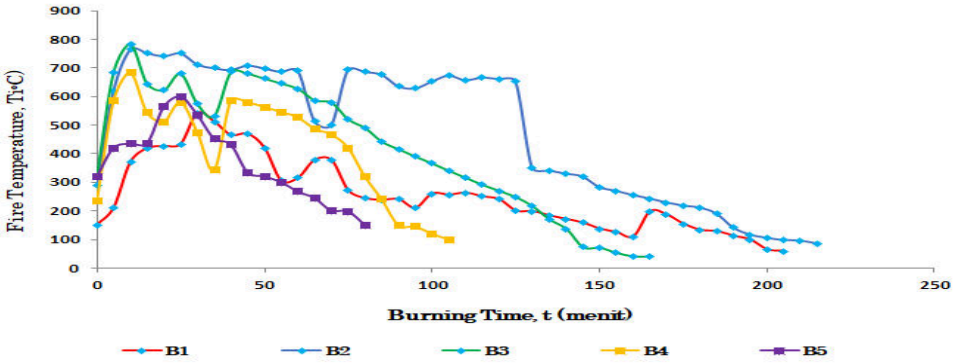

Figure 3. The Fire Temperature to the Burning Time

In Figure 4 above shows that the maximum flame temperature produced in green B3 briquettes is 784°C with a flame duration of 165 minutes. Compared to blue briquettes B2 has a flame process that lasts for about 220 minutes the longest, but has a slightly lower maximum flame temperature than B3, which is 765°C. The greater the composition of the sago adhesive in the briquette, the more the flame retains in the process of burning and boiling water.

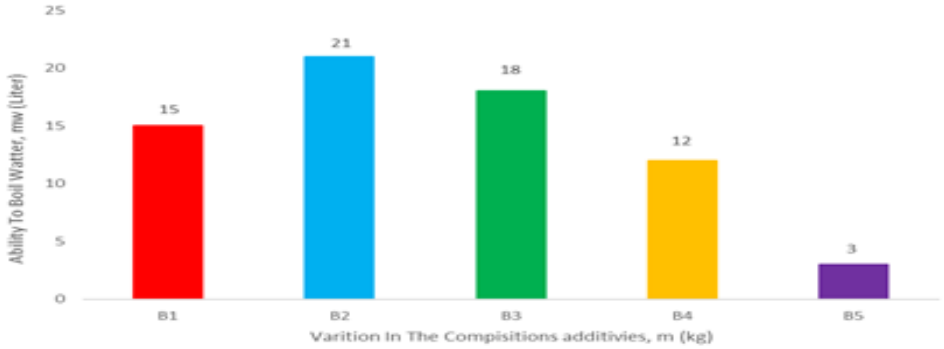

Figure 4. The Ability to Boil Water to Variation in The Composition Additives

In Figure 5 we can see the relationship between the ability to boil water and the variation in the composition of the additive. The results showed that briquette B2 was the most superior in terms of boiling water as much as 21 liters (7 (seven) times the water boiling process). This is influenced by the calorific value contained in briquette B2 so that the flame process of the briquette in the stove combustion chamber lasts a long time.

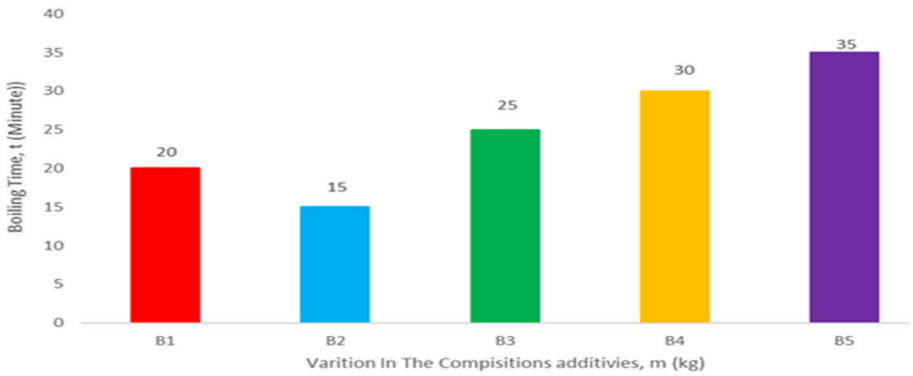

Figure 5. Boiling Time to Variation Compositions Additives

Figure 6 shows the relationship between the time of boiling water for the first time to the variation in the composition of additives (adhesive and reinforcing compositions). The results showed that briquette B2 had the fastest boiling time at 15 minutes. The more sago adhesive composition in the briquette, the faster the heat transfer process to the cooking utensil. Because the adhesive substance in the bamboo charcoal briquette material is very integrated, causing the burning rate to be faster too.

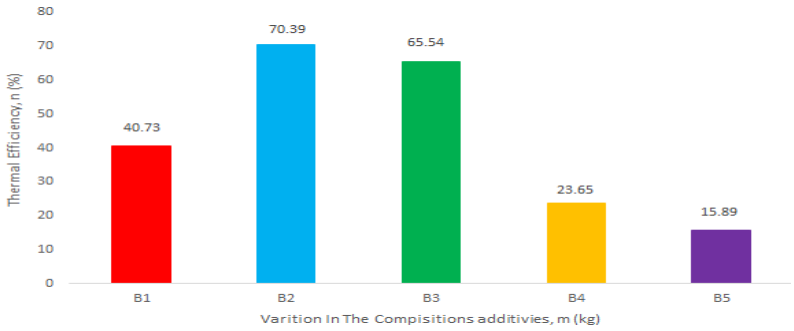

Figure 6. Thermal Efficiency for Variation in The Compositions Additives

In Figure 7 above shows the Thermal efficiency relationship to the variation in the composition of the additive. The combustion results showed that the highest thermal efficiency was found in B2 briquettes (a mixture of 800 grams of petung bamboo charcoal, 175 grams of sago adhesive, 25 grams of reinforcing clay) of 70.39%. This is influenced by the high calorific value contained in briquette B2 so that it can maintain the briquette flame for 220 minutes.

4. Conclusion

Based on the results of this study concluded that the: more sago adhesive composition contained in biomass charcoal briquettes, especially bamboo petung, the higher the thermal efficiency produced. So that it can be obtained that it is suggested for further biomass briquette research to use sago adhesive which is a local product that can be developed again.

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