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Combustion Analysis Process of Old Coconut, Young Coconut and Cocoa Waste Briquettes

Wahidin Nuriana[1], Agus Suryanto[2]& Mustafa Kamal[3]

[1]*Faculty of Engineering, University of Merdeka Madiun*
[2]*Faculty of Agriculture, University of Merdeka Ponorogo*
[3]*Faculty of Engineering, University of Merdeka Madiun*

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Abstract

The potential of biomass energy in Indonesia was quite large. Biomass energy can be explored from agricultural waste, biomass that was easily available and abundant for example: old coconut waste, young coconut waste and cocoa waste. The purpose of this study was to obtain charcoal briquette heating value from the biomass of old coconut waste, young coconut waste and cocoa waste. The study was conducted in a laboratory, and using a randomized design complete with 3 repetitions. The research was carried out by sorting raw materials, chopping, drying, carbonizing, grinding, sieving, by adding tapioca glue, printing, and pressing at 115 kg / cm2. Carbonization at 400oC, for 30, 60, 90 and 120 minutes. In briquettes, density analysis, calorific value, the highest calorific value of old coconut waste briquettes, young coconut waste and cocoa waste were analyzed for mass reduction and combustion reaction rates. The results of the old coconut briquette density test were 0.937g / l, the highest heating value was 6.927 cal / g with a carbonization time of 90 minutes. The old coconut briquettes have the slowest or lowest rate of combustion reaction compared to the rate of burning of young coconut briquettes and cocoa. The effect of the higher density value, the higher the briquette calorific value and the slower or lower combustion rate. In the Thermogravimetry test using Thermal Gravimetry Analyzer (TGA), the highest reduction in mass weight in old coconut waste briquettes compared to young coconut waste briquettes and cocoa waste briquettes was 55.34% from a temperature of 590.5 ^{o}C to 599.2 ^{o}C. On Thermal Gravimetry Differential. (DTG) shown the rate of combustion reaction in old coconut waste briquettes was 0.10% / minute with an air rate of 5 ml / minute.

Keywords: Briquette, Heating Value, Reaction Rate, Activation Energy.

Introduction

Energy was a basic need for human life, the need for fuel was increasing. As an example of increasing energy consumption in all sectors, among others in the fields of transportation, electricity, industry and domestic. Total energy consumption in 2013 amounted to 1.1 billion BOE (Barel of Equivalent), the use of conventional fuel was quite dominating such as petroleum and coal (ESDM , 2014) The potential of biomass in Indonesia, especially agricultural waste biomass (old coconut skin waste, young coconut and cocoa) was available in large quantities and cheaply, the utilization was not maximized. Aside from being a fuel, these wastes can be used as raw materials for activated charcoal, carbon paper, battery stones and others. In general, agricultural waste was only used as fuel that was directly burned, so that it can cause environmental pollution (Jati, et al., 2005; Nuriana, 2013). Conversion of young coconut skin waste, old coconut and cocoa into briquettes will increase the density, thus increasing economic value. Fuel in the form of briquettes in addition to having high heat values can ignite for a long time (Lusia, 2008).

This research was to obtain the characteristics of the combustion reaction and its application, it was necessary to reduce the mass weight, reaction rate and its relationship with density, heating value in young coconut skin waste briquettes, old coconut and cocoa.

Correspondence
Wahidin Nuriana
E-mail: nuriana@unmer-madian.ac.id

Materials and Method

The research was carried out and analyzed in a laboratory manner, the treatment was repeated three times. The design of the experiment using a completely randomized design with the variable effect of carbonization time and response variable was density, heating value. Weight reduction period and rate when the combustion reaction process.

Materials and Tools

The materials used in this study were: old coconut waste (skin, coir, shell), young coconut (skin, coir, shell), cocoa, starch, water, aluminum foil as a wrap when oven. The equipment used in this study were ovens, knives, trays, mortars, desiccators, printing devices, briquette presses, measuring cups, picnometers, erlenmeyers, volume flasks, electric scales, 80mesh sieves, bomb calorimetry, Thermo Gravimetry Analayzer (TGA) units , Differential Themo Analayzer (DTA).

Making Briquettes

Old coconut waste, young coconut waste and cocoa waste were sorted, dried in the sun for 3 days to reduce water content. Continued carbonization at 400oC for 30, 60. 90, 120 minutes using an oven. Then pounded, sieved with 80 mesh sieve, followed by mixing with starch glue / stirred until homogeneous, printed and pressed with a pressure of 115 kg / cm2. The printed briquettes were then dried to reduce the water content contained in the glue, dried in the sun for 2 days. Briquettes were analyzed for water content, density, heating value, combustion reaction rate, reduction in mass weight in the combustion process. From carbonization with a variation of time 30, 60, 90, 120 minutes the highest heating value of each briquette was selected and then analyzed the reaction rate and reduction in mass weight in the combustion reaction process.

Result and Discussion

The research was carried out and analyzed in a laboratory manner, the treatment was repeated three times. The design of the experiment using a completely randomized design with the variable effect of carbonization time and response variable was density, heating value. Weight reduction period and rate when the combustion reaction process.

Old Coconut Waste Briquette Density Test, Young Coconut waste and Cocoa waste

In figure I shows the graph of the effect of carbonization time at 400oC on the density of old coconut waste, young coconut and cocoa. The manufacture of carbonized briquettes was basically to increase the density of a raw material and obtain a greater heat value than the material before making a charcoal. Increased carbonization time increases density.

In the graph below the price of density increases significantly with the length of carbonization time (Tirono, 2011; Nuriana, 2013).

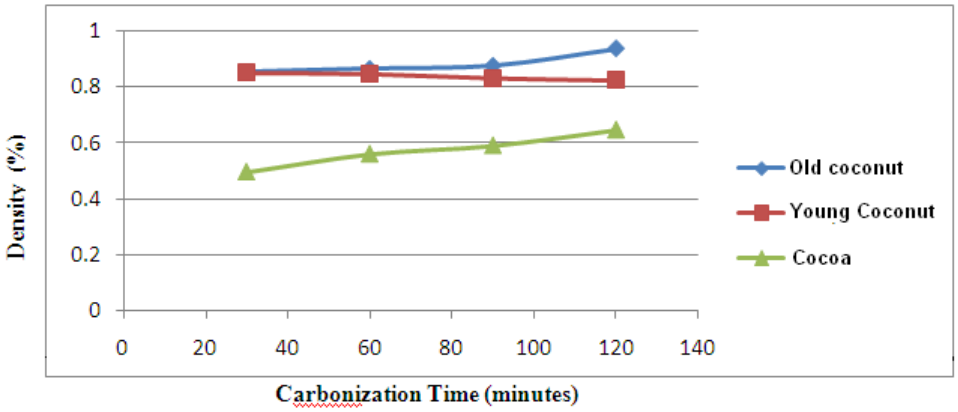

Figure I

Effect of carbonization times 30, 60, 90, 120 minutes at 400oC on the density of old coconut waste, young coconut waste and cocoa waste

Calorific Value Test for Old Coconut Waste Briquettes, Young Coconut Waste and Cocoa Waste

After the carbonization process was carried out at a temperature of 400oC with a time variation of 30, 60, 90, 120 minutes and briquette was made and then pounded and sifted to a size of 100 mesh, to facilitate the heat value test in combustion with oxygen in bomb calorimetry (Syamsiro, 2007). The smaller the particle size will increase the surface so that the material burns faster (Subroto, 2006; Nuriana, 2013). Calorific value was the main parameter in the assessment of a fuel or energy (Scroder E., 2006; Tirono, 2011;

Table 1

The calorific value of old coconut, young coconut and cocoa waste briquettes at a carbonization temperature of 400°C with variations of carbonization time of 30, 60, 90, 120 minutes

No.	Waste	Time (minutes)	Heating value (cal / g)
1.	Old coconut	30	6.635
		60	6.882
		90	6.927
		120	6.879
2.	Young coconut	30	5.457
		60	5.846
		90	5.328

		120	5.740
3.	Cocoa	30	4.925
		60	5.059
		90	4.967
		120	4.787

Source: Nuriana, 2018

The results were tested by TG, DTG in reducing the weight and rate of combustion reaction at the highest calorific value, also in testing the activation energy with Differential Scan Calorimetry (DSC). The three of old coconut, young coconut and cocoa waste briquettes, each had a value of 6,927 cal/g with 90 minutes carbonization time, 5,846 cal/g with 60 minutes long, 5,059 cal/g 60 minutes long.

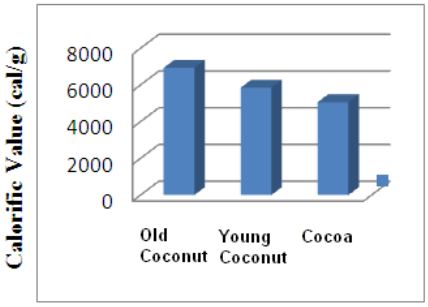

Figure II

Calorific value of old coconut waste briquettes 6,927 cal / g with carbonization time 90 minutes, young coconut calorific value, 5,846 cal / g with 60 minutes carbonization time, cocoa 5,059 cal/g with 60 minutes long.

The results of the reduction in briquette weight and the reaction rate of burning old coconut waste briquettes were tested by TG and DTG

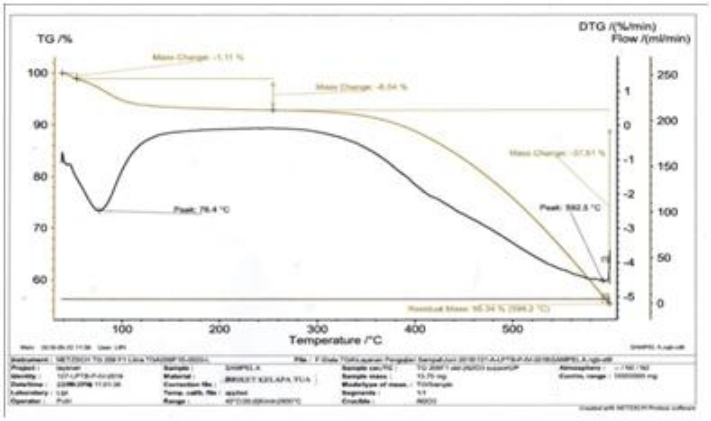

Figure III

TG and DTG curves for old coconut waste briquettes with heating value of 6,927 cal/g, weight of 13.75 mg briquette sample, temperature of 40-600 oC, air rate of 5ml/minute and heating rate of 10^{o}C

- Changes in the weight of briquettes when starting burning 40 oC to 100 oC reduced weight was 1.1%, at a temperature of 100 oC to 262oC reduced weight 6.04 and at a temperature of 262 oC to 590.5 oC reduced weight 37.51% and temperature 590, 5 oC to 599.2 oC 55.34%. The DTG was shown as an endothermic process, and at the end of the combustion there was a faster reduction of the charcoal period.
- The rate of combustion reaction in Figure I was 0.10% / minute. with an air rate of 5 ml / minute.

The results of reduction of briquette weight and reaction rate of burning young coconut waste briquettes with testing with TG and DTG.

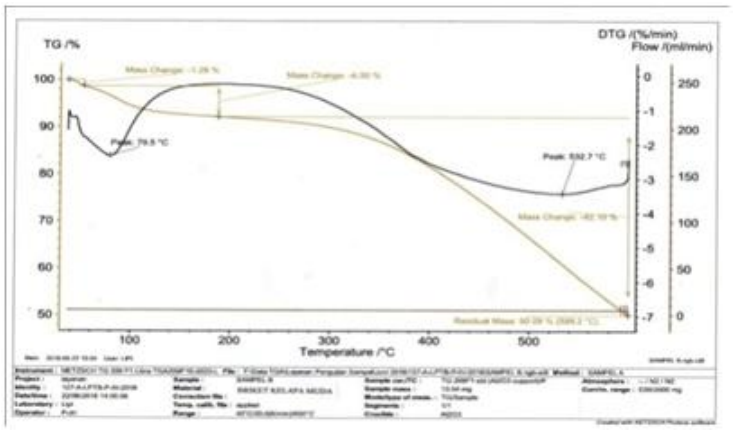

Figure IV
TGA curve and DTA for young coconut waste briquettes with heating value of 5.846 cal/g, weight of briquette samples of 13.54 mg, temperature of 40-600 oC, air rate of 5ml/minute and heating rate of 10^{o}C.

- Changes in the weight of briquettes at the start of combustion temperature of 40 oC to 79.5oC reduction in weight of 6.04%, at a temperature of 79.5oC to 188 oC weight reduction of 6.50%, at a temperature of 258 oC to 590 oC and a reduction in weight of 42.10% . at a temperature of 590 oC to 599.2 oC weight reduction drastically 50.09%.
- The rate of combustion reaction in young coconut waste briquettes was 0.22% / minute.

The results of the reduction of briquette weight and reaction rate of combustion of cocoa waste briquettes testing with TGA.

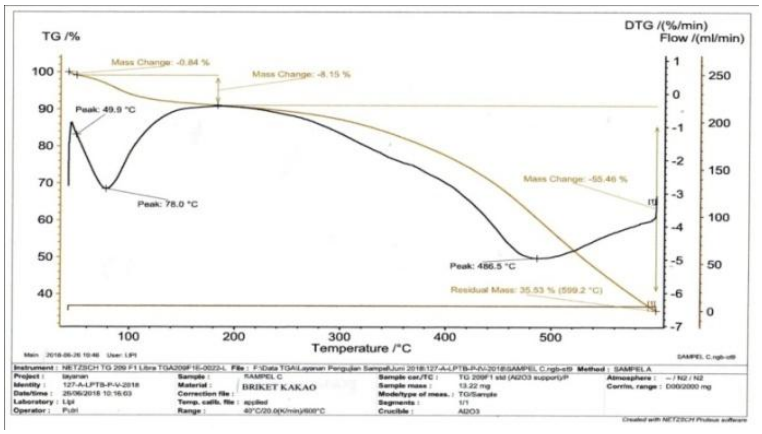

Figure V
TGA curve and DTA for cocoa waste briquette with heating value of 5,059 cal/g, weight of briquette sample 13,22 mg, temperature 40-600 ^{o}C, air rate of 5ml / minute and heating rate of 10^{o}C

- Changes in the weight of briquette when starting burning temperature of 40 oC to 50.5oC reduction in mass weight 0.84%, at a temperature of 50.5oC to 188 oC weight reduction of 8.15%, at a temperature of 188 oC to 590 oC there was a reduction in weight 55.46% . At a temperature of 590 oC to 599.2 oC there was a reduction in weight of 35.53%.
- The rate of combustion reaction in young coconut waste briquettes was 0.24% / minute.

The results of this study, the calorific value of old coconut briquettes has a slow or low combustion reaction rate compared to the rate of burning of young coconut briquettes and cocoa. The effect of the higher density value, the higher the briquette heating value and the slower or lower combustion rate according to the study of Afif, et al., 2014; Kurniawan, et al., 2012).

The highest mass weight reduction in old coconut waste briquettes compared to young coconut waste and cocoa briquettes was 55.34% from 590.5 ^{o}C to 599.2 ^{o}C in the analysis by Thermogravimetry (Himawanto, DA, et al., 2011; Aries D. Himawanto, 2013).

Activation Energy Results

Activation energy results by testing using DSC (Differential Scaning Calorimetry) tools on old coconut briquettes, young coconut and cocoa each of different weights performed with a variation of air flow rate of 20.30.40 ml / min was stated in table 4.1 below.

Table 2
Results of activation energy in old coconut briquettes, young coconut and cocoa with variations in air flow rates of 20,30,40 ml / minute

Air flow (ml/minutes)	Activation of briquettes (j/ g)		
	Old Coconut	Young Coconut	Kakao
20	163,80	195,40	216,60
30	150,50	182,4	207,10
40	133,20	138,4	185,60

The results of comparison of the activation energy of old coconut briquettes, young coconut and cocoa with variations in airflow rate of 20.30.40 ml / min and the weight of each sample in the DSC test were different, can be seen in the graph below.

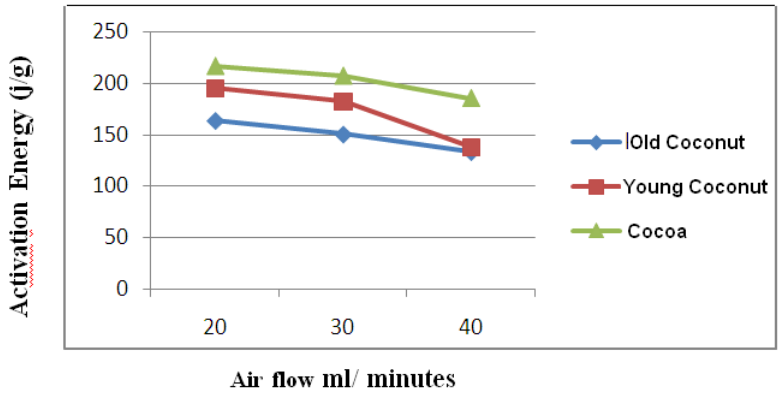

Figure VI
Energy Chart of activation of old coconut briquettes, young coconut and cocoa on variations in air flow rates of 20,30,40 ml / minute

The higher the air flow rate was 20,30,40 ml / minute, the activation energy in old coconut briquettes, young coconut and cocoa decreases significantly. This was because the higher the air flow rate, the activation energy required for the combustion reaction was smaller. Activation energy depends on the calorific value of the briquette, the activation energy will be low if the fuel has a high fuel value, this occurs in young coconut waste briquettes. Higher air flow speeds have more oxygen content that can help make changes more perfect. Because it has burned more completely, it will require low activation energy (Aries, et al., 2013).

Conclusion

- The highest calorific value obtained in the old coconut waste briquette was 6,927 cal/g at 400^{o}C carbonization temperature for 90 minutes compared to young coconut waste and cocoa;
- The price of briquette density was high, the heating value has a high price;
- The reaction rate of old coconut waste briquette burning was lower (0.10% / minute) compared to young coconut waste briquettes and cocoa

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2. Chair of the Polymer Test Laboratory, P2F-LIPI Bandung.
3. Chair of the Engineering Physics Department, ITS Surabaya Physics Engineering.
4. Head of School and Head of the Analytical Chemistry Laboratory at Madiun University.

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