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Manufacture of organic briquettes made from mixtures of rice husk charcoal and coconut shell charcoal

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Abstract : The calorificvalue of rice husk briquette was low and have not met the permitted quality standard of fuel industry.The goal aimed in this research was to increase the calorific value of rice husk briquette by making organic briquettes frommixtures of rice husk charcoal and coconut shell charcoal. Method used in making briquettes wasthe blending method. Results of proximate analysis showed that the moisture content of organic briquettes revolved around 1.39 – 3.89%; ash content 1.14 – 4.49%; volatile matter content 42.83 – 81.86% and the calorific value of organic briquetteswere3,673-5,876 calories/gram which met the quality standard of briquette fuel according to Indonesian National Standard (SNI).
Keywords : Briquette, rice husk, coconut shell, heat, fuel.

Introduction

In general, one of many problems experienced by Indonesian society nowadays is the costly fossil fuels, which happened to be their primary needs. Besides, fossil fuelsare natural resources that is not renewable, therefore needs more effort to find new energy source as the alternativerenewable energy.Indonesian society has become familiar with wood charcoal or coconut shell charcoal as the alternative energy sources.On the other hand, utilization of wood charcoal has quite significant obstacle due to the decreasing forest area which is the main wood supplier.Consequently, it is necessary to find new alternative energy as a solution to overcome the fossil fuel problems by utilising less useful materials which also safe and will not induce environmental issues [1].

North Sulawesi as an agricultural region leave behind so much rice husk as their agricultural waste.Rice husk is massively procuded by time which makes it easy to obtain with enormous amount for a year. The decay of rice husk is significantly slow, making its waste not onlycapable to disrupt the environment but could also affect human health [2].

Rice husk waste is one of energy source biomass and was an alternative energy which needs to be paid attentionto its development. The utilization of rice husk was merely limited to being the fuel of brick or roof tiles making, while the charcoal was used as growing media. The potential rice husk which has enormous amount have not been utilized at its best, a lot of rice husk was only wielded as direct fuel [3, 4]. Besides using it as fuel, rice husk was also used as ice cubes reservatives and as growing media [5].

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The biomass of rice husk can be processed and developed to briquette fuel which is one of renewable alternative fuel. Additionally, the advantage of briquettes made from agricultural waste such as rice husk, corn knob, coconut husk, sawdust, and coconut shell, is environmentally friendly and renewable. But these biomasses cannot be utilized directly because each has quite high moisture content and considerably low calorific value. Rice husk has a calorific value as much as 3300 kcal/kilogram[6].

The coconut shell biomass was initially considered as waste from its fruit production, but nowadays has been wielded as raw material in the process of activated charcoalmaking. Thecalorific value of coconut shell is 20890 kJ/kg, and this calorific value is still revolves in basically low biomass calorific value range [7].

The calorificvalue of rice husk and coconut shell were still low, and because of it, the solution to increase the calorific value of both rice husk and coconut shell is needed. The calorific value of both rice husk and coconut shell could be increased by manufacturing briquettesby mixing those two as the main ingredients. Process of manufacturing the briquettes preceded by pyrolysis of rice husk and coconut shell at temperature 400 – 450^{0}C.It is expected that the pyrolysis can produce high quality charcoal, so that the briquettes become a high quality briquette with notably high calorific value, thus meet the quality standard of briquette established by Indonesian National Standard (SNI).

Experimental

Materials and Methods:

Materials

The materials used in this research were rice husk and coconut shell as much as 50 kg each, which were taken from JawaTondano village, Minahasa. The adhesive material was 10 kg of cornstarch bought from store with GunungAgung brand.

Instruments

The instruments used in this research was briquette pressing machine, briquette print (height 4 cm and diameter 4 cm), 40-mesh sieve, oven, balance, a set of pyrolysis apparatus and bomb calorimeter to determine the briquette’s calorific value.

General Methods:

Briquettes making

1. Raw materials drying

In this process, the rice husk and coconut shell was washed thoroughly and cleaned from physical contaminant such as soil and the other contaminants. The rice husk and the coconut shell was dried under the sun for two days in order to decrease the sample’s moisture content.

2. Charcoal making

The dried rice husk was then weighed as much as 50 kg. It was then put in pyrolysis apparatus. The pyrolysis apparatus was closed tightly so that no leak will be found. Below the pyrolysis apparatus, wood was put as fuel. Pyrolysis was conducted for 4 hours. The making of coconut shell charcoal followed the same process with rice husk.

3. Charcoal grinding and sifting

Rice husk charcoal and coconut shell charcoal were ground with grinding machine. The rice husk and coconut shell powder were then sift with 40-mesh sieve according to Indonesian National Standard (SNI)No.1/6235/2000.

4. Charcoaland adhesive material blending

Cornstarch adhesive was made by boiling 250 g of cornstarch with 750 mL water at temperature of 70^0C until gel was formed. The formed cornstarch adhesive then was mixed with charcoal powder evenly. The charcoal and adhesive mixing can be seen in Table 1.

Table 1 Mixture of Rice Husk Charcoal, Coconut Shell Charcoal and Adhesive Made from Cornstarch

Briquette	**Composition**			
	Rice husk charcoal (g)	**Coconut shell charcoal (g)**	**Cornstarch (g)**	**Water (mL)**
Control (RH)	1000	0	250	750
Control (CS)	0	1000	250	750
A = RH : CS (1 : 1)	500	500	250	750
B = RH : CS (2 : 1)	600	300	250	750
C = RH : CS (3 : 1)	900	300	250	750

5. Printing, pressing and drying

Charcoal mixture with cornstarch adhesive (batter) was put in the cube-shaped print with 4 cm high and 4 cm wide then solidified with hydraulic-powered printing machine. The charcoal briquette produced was then dried under the sun for seven days. Dried briquette was packed in a plastic bag and tightly closed to keep the briquettes dry.

6. Proximateanalysis

The proximate analysis of organic briquette includes moisture content, volatile matter content, ash content, and calorific value determination using Bomb Calorimeter.

Results And Discussion

The pyrolysis process of rice husk and coconut shell took 4 hours. Gases produced from pyrolysis was condensed with condenser and the condensate was collected in a vessel. Pyrolisis was stopped when there were no more condensate dripped and the white smoke diminish. The highest temperature read in the pyrolisis was 400^0C.

The pyrolisis apparatus model used, rice husk charcoal and coconut shell charcoal is shown in Fig. 1.

(a) (b) (c)

Figure 1. (a) A set of pyrolysis apparatus, (b) rice huskcharcoal, (c) coconut shell charcoal.

The rice husk and coconut shell charcoal was each ground to powder and sift used 40-mesh sieve. Cornstarch for adhesivewas boiled at 70^0C until gel was formed, then the adhesive was mixed with the charcoal and was blended evenly.

The mixture was placed in the cube-shaped (4 cm high and 4 cm wide) print and was pressed with hydraulic-powered machine. The printed briquette was dried under the sun for seven days. Rice husk (RH) briquette, coconut shell (CS) briquette and the mixture of RH and CS briquette is shown in Figure 2.

RH **CS** **A = RH : CS (1 : 1)** **B = RH : CS (2 : 1)** **C = RH : CS (3 : 1)**

Figure 2.Dry briquette after seven days of sunbathe

Based on the results, the moisture content of RH briquette = 1.63%; CS briquette 1.72%; the "A" briquette = 3.89%; the "B" briquette = 1.84% and the "C" briquette = 1.44%. The moisture content of each briquette is shown in Fig. 3.

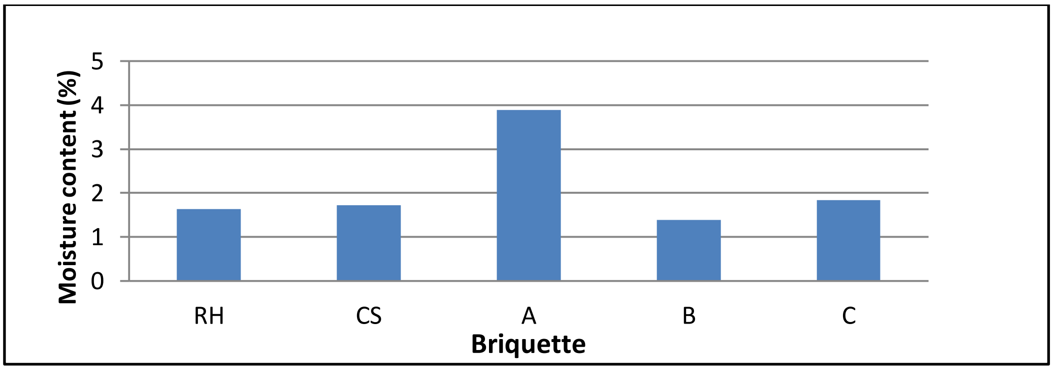

Figure 3.Graphic of moisture content in RH, CS, A, B and C briquettes

From Fig. 3, the graphic shows that the moisture content of RH briquette is 1.63%, while the CS briquette is 1.72%. Moisture content of A, B and C, which are the mixture of rice husk and coconut shell is in range of 1.44 – 3.89%.

The difference of moisture content in A, B and C briquettes could be caused by unequal composition of RH and CS charcoal mixture. Data showed that the moisture content of RH, CS, A, B and C went lower as the rice husk charcoal composition increase. The moisture content of RH, CS, A, B and C is lower than the briquette quality set by Indonesian National Standard (SNI) No. 1/6235/2000 which is ≤ 8%, then is brought to conclusion that the briquettes made from mixing rice husk and coconut shell charcoal are a good material to utilize as alternative energy source due to its low moisture content. The low moisture content in briquettes will facilitate the ignition of briquetteseasily and will not induce excessive smoke when burned [8]. The moisture content of briquettes affect the calorific value produced. High moisture content will cause declining calorific value [9, 10]. The other factor that will cause low moisture content in briquettes is how long the briquettes is dried. The longer the briquettes was dried the more water will vaporize, which then decrease the briquette's moisture content [11].

Based on the results, the ash content of RH briquette = 3.70%; CS briquette = 4.49%; the "A" briquette = 1.14%; the "B" briquette = 3.82% and the "C" briquette = 3.91%. The ash content of each briquette is shown in Fig. 4.

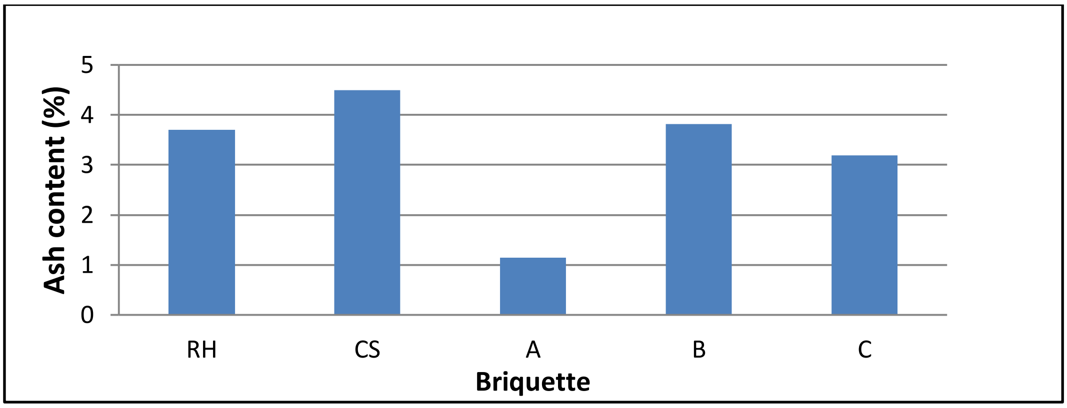

Figure 4.Graphic of ash content inRH, CS, A, B and C briquettes

From Fig. 4, the graphic of ash content, it is shown that briquette with the lowest ash content value is the A briquette, which is 1.14%, while briquette with the highest ash content is the C briquette which is 3.19%. The increasing of ash content is due to the unequal composition of rice husk and coconut shell charcoal mixture. The raise of A, B and C ash content is connected to the increasing composition of rice husk charcoal in the mixture, the higher the rice husk composition, the higher the ash content. The ash which consist in solid fuel is minerals that cannot be burned further after the burning process as well as after the reaction accompanying the burning process [12].Ash content data from the organic briquette is lesser than the standar quality of briquette ash content based on SNINo.1/6235/2000, which is ≤ 8%. Briquettes with high ash content has the disadvantage of forming crust [10]. The higher the ash content the more difficult to ignite and high ash content could decrease the calorific value.

Based on the results, the volatile matter content of RH briquette = 59.19%; CS briquette = 58.88%; the "A" briquette = 81.86%; the "B" briquette = 59.00% and the "C" briquette = 42.83%. The volatile matter content of each briquette is shown in Fig. 5.

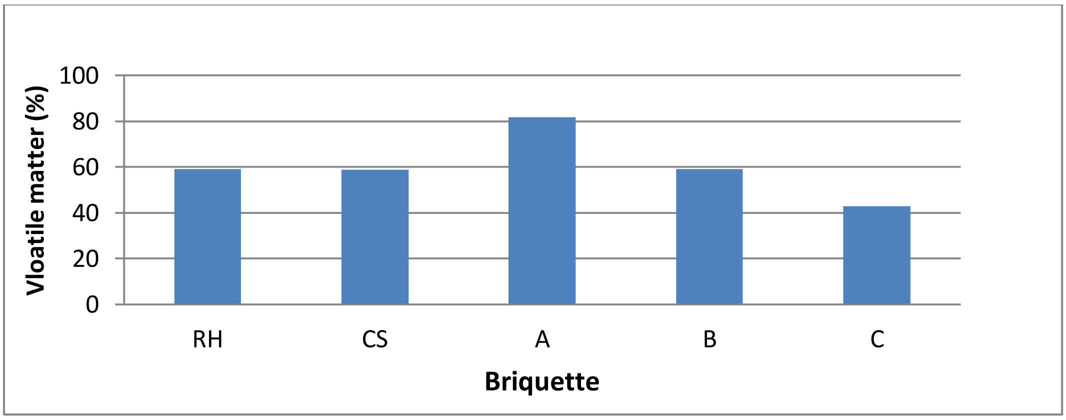

Figure5. Graphic of volatile matter content in RH, CS, A, B and C briquettes

From Fig. 5, it isshown that the volatile matter in RH, CS, A, B and C briquettes is between 42.83 – 81.86%. Briquette with the highest volatile matter content is the A briquette with 81.86%, while the lowest volatile matter content is the C briquette with 42.83%. Thevolatile matter content will decline when the pyrolisis is conducted in high temperature [11]. High content of volatile matter will decrease the briquettes quality, because when the volatile matter is quite high, the carbon content will be low which then is brought to low calorific value and will cause excessive smoke when burned [13]. The higher the volatile matter inside briquette, the easier the briquettesto beburned and the burning process will be faster [10].Data ofvolatile matter content in RH, CS, A, B and C briquettes are qualified for the quality standard of briquettes based on regulation set by Indonesian Ministry of Energy and Mineral Resources No.47/2006.

Based on the results, the calorific value of RH briquette = 3,673 cal/gr; CS briquette = 5,876 cal/gr, the A briquette = 4,675 cal/gr, B briquette = 4,509 cal/gr and C briquette = 4,233 cal/gr. From Fig. 6, the graphic of calorific value in RH, CS, A, B and C briquettesis between 3,673 cal/gr and 5,876 cal/gr. The difference of calorificvalue in A, B, and C briquette is caused by the unequal composition of rice husk and coconut shell charcoal mixture. The higher the calorific value of briquettes, the higher the fuel quality. The calorific value of A, B and C briquettes increased approximately by 1000 cal/gr higher than the rice husk briquette. The calorific value graphic shown in Fig. 6.

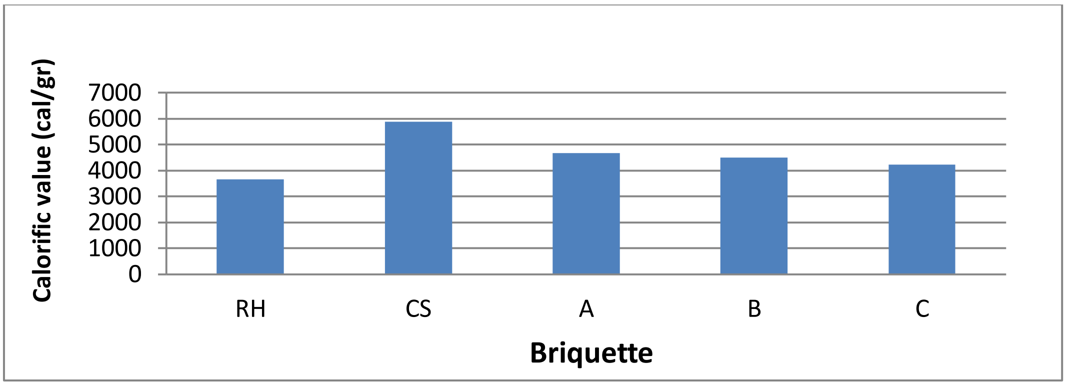

Figure6.Graphic of calorific value in RH, CS, A, B and C briquettes

Conclusions

1. Briquettes from mixtures of rice husk charcoal and coconut shell charcoalareenvironmentally friendly and could be considered asone of renewable energy source.
2. Based on the proximate analysis and calorific analysis, it was found that the A, B and C briquettes areconsideredas high-quality briquettesbecause it have already met the quality standard for briquette fuel established by Indonesian National Standard (SNI).

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