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Densification of Product Torrefaction from Coconut Coir to Bio-briquette as Renewable Energy that Environmentally

Hilmiyati,[a,*], Laisa Husraini [a,*] and Ahmad Zamhuri [b]

[a)] *Chemical Engineering Department, Universitas Riau, Indonesia.*
[b)] *Civil Engineering Department, Universitas Riau, Indonesia*

*Corresponding author: hilmiyati.hilmiyati@student.unri.ac.id

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ABSTRACT

Coconut coir waste which has a high calorific value can still be used as fuel by way of briquettes. bio briquette production is done by using torrefaction reactor and hydraulic press machine with different particle size and pressing pressure. Variations in particle size used were 60, 80 and 100 mesh and the pressure variations used were 100, 110 and 120 bar. The process used is torrefaction and densification. Characteristic analyzes of bio briquettes include compressive strength and heat value test. In this experiment, bio briquette produced with calorific value 21065.47 kJ/kg obtained at 60 mesh particle size with pressurization pressure of 120 bar and the highest compressive strength of 7,526 kg/cm^2 was obtained at 100 mesh particle size with pressure of 120 bar.

KEY WORDS: *bio briquette, densification, coconut coir, torrefaction*

1.0 INTRODUCTION

As oil fuel prices soar higher, as an alternative to search for fuel other than oil, then research on coconut coir biomass potential as an alternative energy source, to be processed into alternative fuel in the form of bio briquette (Subroto et al, 2016) coconut husk generally consists of cellulose, lignin, pyroligneous acid, gas, charcoal, and potassium are environmentally friendly.

Indonesia as an archipelagic country and located in the tropics and supporting agroclimate conditions, is a major coconut producing country in the world. However, only a small portion of coconut husk is utilized. Most of the coconut husk is removed and become waste (Setyawati et al., 2006). According to Coconut statistic year book (2008), Indonesia as the world's largest coconut producing country with 3,799 hectares (35.96%) and Riau (10.92%) is the second province after Sulawesi Utara (11.04%) with coconut plantation area widest at the moment (FAO, 2012).

Biomass-making bio-briquettes can be obtained from agricultural waste, industrial waste and household waste. In order to utilize it as fuel, the waste can be processed into solid fuel in the form of briquettes. Each material has certain properties to be utilized as a briquette but the most important thing is that the material must have high thermal properties and low CO2 emissions resulting in no impact on global warming (Maryono et al., 2013).

2.0 MATERIAL AND METHODS

2.1 Material

A very easy source of biomass today is the solid waste of coconut plantations that have not been well utilized. The coconut plant (Cocos Nucifera L.) is a multi-function palm plant because almost all parts of the plant can be used from trees to coconuts (Miskiyah et al., 2006).

The raw materials of biomass from coconut husk used in this study were collected from Pekanbaru and Kampar, Riau. The initial conditions of the raw materials may affect the quality of densification of the torrefaction products. Thus, the analysis of

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raw materials. The analysis of raw materials consists of cleaning, reducing the size and drying of coconut husk. It is intended that the process of torrefaction can take place perfectly and not interfere with the existing dirt.

2.2 Torrefaction and Densification

To achieve the target, this research is divided into several stages: raw material preparation, torrefaction process, densification, yield analysis, data processing. The preparation stage of the raw material aims to prepare the materials to be used in the experiment so as to have a form corresponding to the variables, namely: 60, 80 and 100 mesh and can be easily used in the next stage. This stage includes cleaning, reduction of size, and drying of coconut coir raw materials.

The torrefaction process was performed in a horizontal fix bed reactor (Figure 2) with a temperature range of 275 ^{o}C and a residence time of 15 minutes. Nitrogen flowed during the process of torrefaction takes place according to predetermined variations. After the torrefaction stage is completed, the densification process aims to minimize the space requirements, the use of more practical briquettes and better burning stability. The densification process is carried out using a Hydraulic Press (Figure 3) at 100, 110 and 120 bar pressures and the pressing time is carried out for 15 seconds. Densification process obtained by product of coconut husk briquette, further analysis result. Block the overall diagram of the process of coconut coir making until the results analysis is shown in Figure 1.

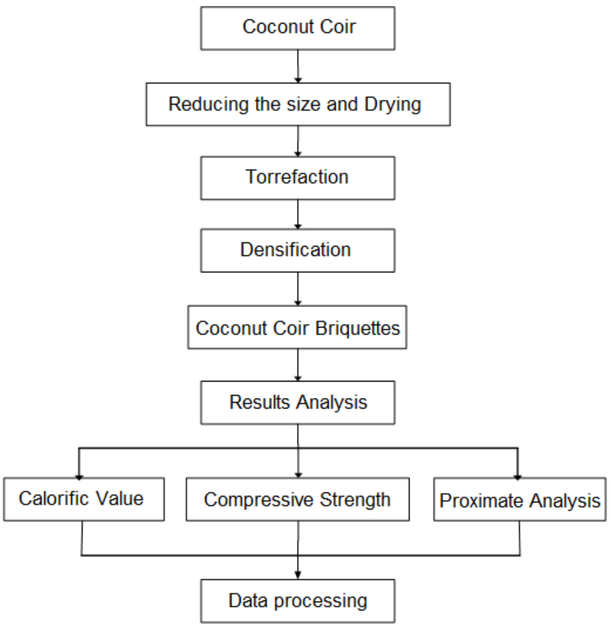

Figure 1: Block Diagram Process Torrefaction and Densification

Figure 2: Fix Bed Horizontal

Figure 3: Press Hidraulic

The resulting briquette product will be tested for calorific value, compressive strength and proximate analysis consisting of moisture content, ash content, volatile matter content, and fixed carbon. The calorific value is a fuel that expresses the energy content of the fuel by using the American Society for Testing and Materials (ASTM) D-2015-96 standard. The compressive strength is the capacity of a material or structure in the load-bearing that will reduce its size (Saktiawan, 2008).

2.3 Bio Briquettes

Biomass briquettes are a biofuel substitute to coal and charcoal. Briquettes are mostly used in the developing world where cooking fuels are not as easily available. Briquettes are used to heat industrial boilers in order to produce electricity from steam. The briquettes are con-fired with coal in order to create the heat supplied to the boiler. People have been using biomass briquettes since before recorded history. Biomass briquettes are made from agriculture waste and are a replacement for fossils fuels such as oil or coal, and can be used to heat boiler in manufacturing plants (Sharma et al, 2015)

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Biomass briquettes are a renewable source of energy and avoid adding fossils carbon to the atmosphere. The extrusion production technology of briquettes is the process of extrusion screw wastes (straw, sunflower husks, buckwheat, etc.) or finely shredded wood waste (sawdust) under high pressure. There is a tremendous scope to bring down the waste of convention energy sources to a considerable level through the development, propagation of non-convention briquettes technology i.e. briquettes machine , briquettes plant, biomass briquettes plant for production of agro residue briquettes to meet thermal energy requirement . Therefore this substitute energy medium is given national priority as appears to be the only permanent solution into restriction of the national laws and avoid pollutions (Sharma et al, 2015).

3.0 RESULTS

The result that has been achieved in this research is coconut coir briquettes. All variables of particle size and pressing press have been done, so that 9 different coconut briquettes are produced.

3.1 Coconut Shell Torrefaction

Before the process of torrefaction, coconut husk dried by drying under direct sunlight until the water content reaches below 8%. Subsequently, the raw materials were fermented using a torrefaction reactor at a temperature of 275°C for 15 minutes using nitrogen gas with a flow rate of 2.5 mL / sec as a gas carrier to create a non-reactive (limited oxygen) state. The result of coconut charcoal process.

3.2 Coconut Coal Charcoal Densification

Coconut coir charcoal produced from torrefaction was first done by reducing size using 60, 80, and 100 mesh sieve. Sifting is done at the Laboratory of Materials Technology Department of Civil Engineering, Faculty of Engineering, Universtitas Riau. Coconut coir charcoal is shown in Figure 4.

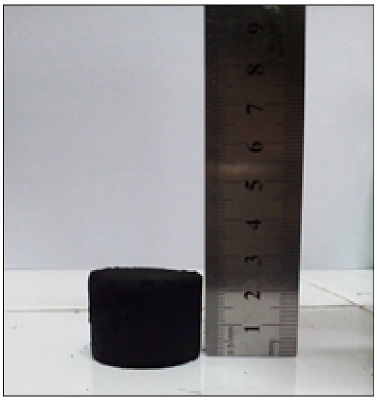

Figure 4: Bio-Briquettes of Coconut Coir

The saturated coconut charcoal is then pressed using a hydraulic press with densification technique, with the addition of crude glycerol as filler. Crude glycerol is a by-product of biodiesel manufacture obtained from PT. Wilmar Bioenergi Indonesia, Dumai City. The ratio of coconut coir mixing with crude glycerol is 60:40. The final product of coconut coir densification process that has been mixed with cylindrical glycerol with 3 cm diameter and briquette height in the range 2-3.2 cm. Briquettes are then dried under the sun.

Table 1: Data Analysis of Calorific Values and Compressive Strength Values of Bio Briquettes

Natural Variable		Respons	
X_1	X_2	Y_1	Y_2
60	100	20803,79	0,86
80		19286,45	1,302
100		18110,84	4,929
60	110	20192,10	1,202
80		19609.72	2,149
100		18467,98	5,346
60	120	21065,47	1,010
80		19607,62	1,530
100		20854,45	7,526

3.3 Heat Value Analysis

From result of calorific value analysis that pressure press variable have influence to calorific value. This is in accordance with the results of research conducted by Anderson, Helwani, and Komalasari (2017) who said pressing pressures affect the calorific value. While the particle size does not give a significant effect on the calorific value. Relationships of particle size and pressure to compressive strength value of coconut coir briquettes is shown in Figure 5.

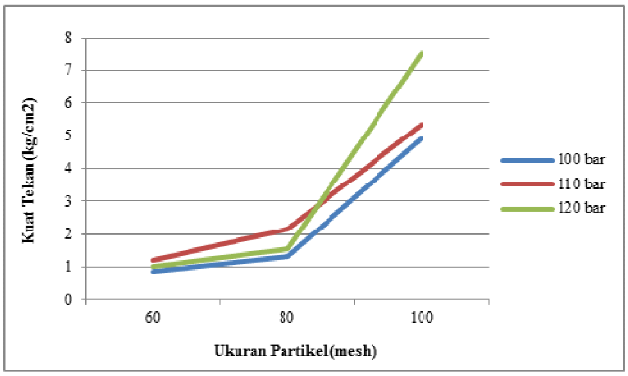

Figure 5: Relationships of Particle Size and Pressure to Compressive Strength Value of Coconut Coir Briquettes

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At 60 mesh particle size, the highest calorific value of 21065.47 kJ/kg was obtained at a pressure of 120 bar, while the lowest calorific value of 20192,10 kJ/kg was obtained at pressing pressures of 110 bar. At 80 mesh particle size, the highest calorific value obtained at 19609,72 kJ/kg was obtained at a pressure of 110 bar and the lowest heating value of 19286.45 kJ/kg was obtained at a pressure of 100 bar. So also d for the particle size of 100 mesh, the highest heat value of 20854.45 kJ/ kg obtained at pressing pressures of 120 bar and the lowest heating value of 18110.84 kJ/kg obtained at a pressure of 100 bar From the analysis obtained shows that the particle size change changes provides different calorific values with the same pressing press conditions.

3.4 Analysis of Compressive Strength

From the results of the compressive strength analysis that the particle size and pressing press have a very significant influence. According Martynis et al, (2013), the larger the mesh size the resulting briquettes are getting stronger. At pressing pressures also give a significant effect this is in accordance with the statement Subroto et al (2007), the increase in pressing pressure resulted in mechanical strength of briquettes.

At pressing pressures of 100 bar, the highest compressive strength is 4,929 kg/cm^2 with the particle size of 100 mesh and the lowest compressive strength of 0.86 kg/cm^2 with 60 mesh particle size. At press pressures of 110 bar, the highest compressive strength is 5,346 kg/cm^2 with a particle size of 100 mesh and the lowest compressive strength of 1,202 kg/cm^2 with a particle size of 60 mesh. Likewise with the pressure of 120 bar, the highest compressive strength of 7,526 kg/cm^2 with a particle size of 100 mesh and the lowest compressive strength of 1.010 kg/cm^2 with a particle size of 60 mesh. Thus for pressing pressing pressures provides different compressive strengths on the same particle size.

4.0 CONCLUSION

Particle size and pressure have a significant effect on calorific value response and compressive strength. The highest calorific value of our research was 21065.47 kJ / kg obtained at 60 mesh particle size with pressurization pressure of 120 bar and the highest compressive strength of 7,526 kg / cm2 was obtained at 100 mesh particle size with pressure of 120 bar.

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