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OPTIMISING BRIQUETTE CHARACTERISTICS BASED ON THE RATIO OF BAMBOO AND COCONUT FIBRE UNDER CONVENTIONAL METHOD

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ABSTRACT: This study aims to optimise the potential of bio briquettes produced from a mixture of bamboo and coconut fibre using starch adhesive. The research focuses on determining the composition ratio of bamboo and coconut fibre that gives the best results, as well as the physicochemical characteristics of the briquettes, including moisture content, volatile matter, ash content, and calorific value. The types of bamboo used are (Bambusoideae), and coconut fibre use is (Cocos Nucifera). In the research carried out in one experiment, 1 kg of bamboo carbon and 800 grams of coconut fibre were needed. The equipment uses conventional tools for the carbonisation process using a barrel and carbon refinement using a grinder. Bamboo is processed for 5 hours in the carbonisation process, while coconut fibre is processed for 2 hours, with an operating temperature of 140°C. This study considered variations in the bamboo and coconut fibre mixture ratio, such as 1:1, 5:1, and 9:1. Starch adhesive was used in a concentration of 25% of the total mixture as a determining factor in forming bio briquettes. The results showed that the bamboo: coconut fibre mixture ratio 5:1 gave the best bio briquette characteristics. This briquette has a low moisture content of about 0.49%, optimal volatile matter of about 51.31%, standard ash content of about 7.91%, and a high calorific value of 5,679.15 cal/gram. Carbonisation at 140°C positively influenced the physicochemical properties of the bio briquettes.

Keywords: Bio Briquette, Bamboo, Characteristic, Coconut Fibre

1. Introduction

The increasing consumption of fossil fuels has led to the depletion of fuel resources and the increasing impact of environmental pollution. One solution to this problem is to develop alternative fuels that are more environmentally friendly and renewable [1]. Energy demand continues to increase along with population and global economic growth. In Indonesia, the National Energy Management Blueprint 2006-2025 issued by the Ministry of Energy and Mineral Resources (MEMR) sets various energy policy targets. By 2025, Indonesia seeks to reduce the role of oil to 26.2%, increase the contribution of natural gas to 30.6%, increase coal utilisation to 32.7% (including coal briquettes), increase geothermal to 3.8%, and increase the contribution of renewable energy to 15%. Charcoal briquettes are one form of renewable energy that has the potential to be developed in Indonesia. Green Technology Development Plan Creating charcoal pellet fuel is one potential alternative [2]. The advantages of using charcoal briquettes include more affordable cost than oil or wood charcoal, longer burning period, relatively higher safety of use, ease of storage and transfer, and no need for repeated fanning or fuel addition. With these advantages, the role of charcoal briquettes as an alternative fuel has been recognised in various countries [3].

Briquettes are solid fuels that serve as an alternative energy source to fuel oil. The briquette production process involves carbonising raw materials, which are then moulded under a certain pressure. This process can be executed with or without adhesives or other additives. The main raw materials for briquetting are usually powders with small particle sizes such as light charcoal powder, sawdust, rice husks, agricultural waste, forest waste, residues or charcoal. Briquettes have a specific shape and are produced through certain pressing techniques. They often use adhesives as hardening agents. Briquettes can be considered a cost-effective and environmentally friendly solution as an alternative fuel to replace the use of fuel oil in a more sustainable way [4]. Based on Indonesian National Standard 01-6235, Wood Charcoal Briquettes, 2000, the following is the quality standard of briquettes. The following is a table 1 of briquette quality standard:

Table 1 Briquette Quality Standard

No.	Parameter	Kadar
1.	Moisture content	Max. 8%
2.	Ash Content	Max. 8%
3.	*Volatile Matter*	Max. 15%
4.	Calorific Value	Min. 5000 cal/g

Carbonisation is decomposing cellulose into carbon at a temperature of about 275°C. With carbonisation, the heating value produced can reach 25-30 MJ/kg, while the non-carbonization process only produces a heating value of around 15 MJ/kg [5]. In making briquettes, adhesives are needed to glue between charcoal particles. Adhesives are substances or materials that can glue two objects together through surface bonds. Some other terms for adhesives with specific properties include glue, slime, paste, and cement. Glue is an adhesive made from animal proteins, such as skin, nails, tendons, muscles and bones, used in the woodworking industry. Slime is a kind of glue made from rubber and water mainly used for glueing paper. The paste is a starch-based adhesive made by heating a mixture of starch and water and stored in paste form. Cement is the term used for rubber-based adhesives that harden through solvent release [4].

Bamboo is a non-timber forest product with a large production area because of its rapid growth cycle. Bamboo is included in the Gramineae (grass) family in bunches and consists of several stems (bamboo) which grow gradually from shoots and simple stems and mature at 4-5 years old. Bamboo culms are cylindrical and branched; internodes are sometimes hollow and hard-walled, and each internode has a bud or branch. Bamboo roots consist of rhizomes (Rhizon) with nodes and twigs, nodes invaded by fibres and shoots that can turn into stems [6]. Silica content of 0.10%-1.78%, and moisture content of 15-20% [7].

Coconut fibres account for a large portion of the coconut fruit, equivalent to 35% of the total fruit weight. Coir consists of fibres and corks that connect one fibre to another. Fibre is the most valuable component of coconut fibre. Each coconut fruit contains 525 grams of fibre (75% of the coir) and 175 grams of cork (25% of the coir) [8]. Coconut fibre contains the following components: -cellulose (26.6%), nitrogen (0.1%), water (8%), ash (0.5%), and lignin (29.4%) [9].

2. Research Method

The research was conducted by preparing raw materials, namely bamboo and coconut fibre. Then, the raw materials are reduced in size and put into the carbonisation barrel. The carbonisation process is carried out for 5 hours for bamboo and 2 hours for coir. When it becomes charcoal, it can be processed by a grinder and sieved using a 70-mesh sieve. Then, the charcoal is added with adhesive as much as 25% of the total mixture, and hot water is added. Next, pressing and drying is done for 3 days.

2.1 Research Variables

The variables used were a carbonisation temperature of 140 C, the carbonisation time of bamboo for 5 hours, and coconut fibre for 2 hours. The material mixture between bamboo and coir has several comparisons including 1:1, 5:1, and 9:1. For example, when making 200 grams of briquettes using a 1:1 ratio, 100 grams of fine bamboo material and 100 grams of fine coir material are required. Other ingredients besides bamboo and coconut fibre are starch and water as an adhesive. The concentration of adhesive used was 25% of the total mixture.

2.2 Diagram Chart

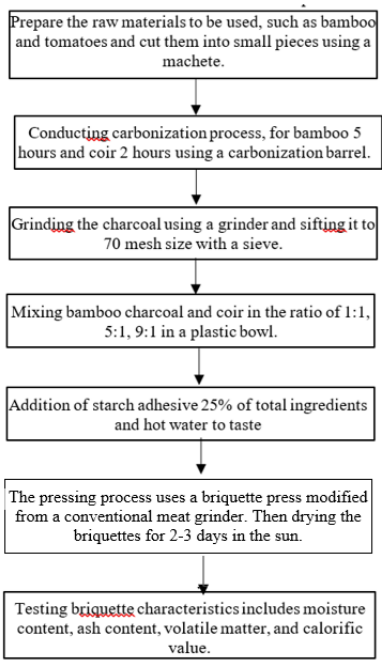

Figure 1 Diagram chart process

3. Result and Discussion

Table 2 Briquette characteristic test results

Bamboo: Coconut Fiber	Moisturize Content (%)	Ash Content (%)	Volatile Matter (%)	Calorific Value (cal/gram)
SNI Standard	< 8	< 8	< 15	> 5000
1 : 1	0.48	7.03	39.90	4211.03
5 : 1	0.49	7.91	51.31	5679.15
9 : 1	0.35	6.62	45.38	5236.18

3.1 Moisturize Content

Moisture content analysis determines how much water is in a biobriquette. Water content is very influential on the calorific value. The smaller the water content value in the biobriquette, the higher the heating value produced in the biobriquette. Factors affecting the water content value are the press process and drying temperature [10].

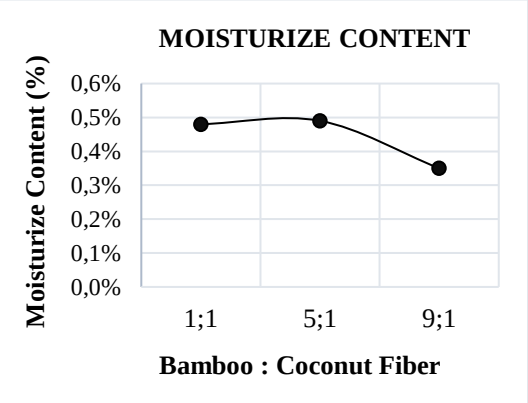

Figure 2 Comparison of Bamboo and Coconut Fiber on Moisture Content

According to Figure 2, the water content of bio-briquettes is determined by various parameters. Bio briquettes with the highest water content are shown by the 9:1 concentration ratio with a water content of 0.35%, and the lowest water content is shown by the 5:1 concentration ratio with a water content of 0.49%. The result shows that adding adhesive is an important factor in the quality of water content. The addition of a small amount of adhesive will make the bio briquette results comply with SNI [11].

3.2 Ash Content

The ash content is analysed to determine the amount that remains unburned after a complete combustion. The high ash content is influenced by the high inorganic materials found in biomass waste and the adhesive level used in making bio briquettes [12]. Another factor affecting bio briquettes' ash content is the type of raw material used. Raw materials have different chemical compositions and amounts of minerals, so the ash content produced in each biobriquette is different [13].

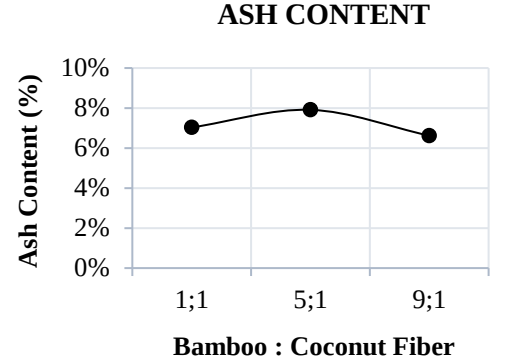

Figure 3 Comparison of Bamboo and Coconut Fiber on Ash Content

Based on the graph above, the highest ash content is shown by bio briquettes with a 9:1 composition at 6.62%, while the lowest ash content is obtained by bio briquettes with a 1:1 ratio at 7.03%. Therefore, all samples have met the quality requirements for the quality of bio briquettes (SNI 01-6235-2000), with a maximum ash content of 8%. The graph shows that the more bamboo added, the lower the ash content. This is because the amount of silicate, the ash component compound contained in bamboo, is smaller than that of coconut husk. Bamboo ash content is 1.89 - 4.63% [14], and coconut fibre ash content is 3.95% [15].

3.3 Volatile Matter

Volatile Matter is the combustible gases in bio briquettes such as hydrogen, carbon monoxide, and methane, and non-combustible gases such as CO_2 and H_2O. Volatile Matter levels can be seen in the graph in Figure 4.

The graph in Figure 4 shows that the highest Vollatile Matter content is obtained from the composition of bamboo and coconut fibre 5: 1 at 51.31%, while the lowest Vollatile Matter content is obtained from the composition of bamboo and coconut fibre 1: 1 at 39.90%. Therefore, all samples did not meet the quality requirements for the quality of bio briquettes (SNI 01-6235-2000), which is the percentage of Volatile Matter content of a maximum of 15%. Variations in the type of raw material significantly impact the volatile matter content of briquettes, as these variations determine briquettes with high and low levels of

volatile matter content [16]. Lower levels of volatile matter have better quality compared to briquettes that have higher levels of volatile matter [17].

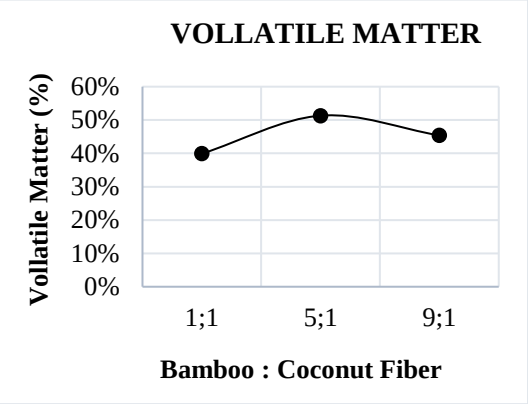

Figure 4 Comparison of bamboo and coconut fibre composition on volatile content

3.4 Calorific Value

Calorific value analysis is one of the analyses that determine the quality of a biobriquette. The higher the calorific value of the bio briquettes produced, the better the quality of the bio briquettes produced. The results of the calorific value analysis can be seen in the graph below:

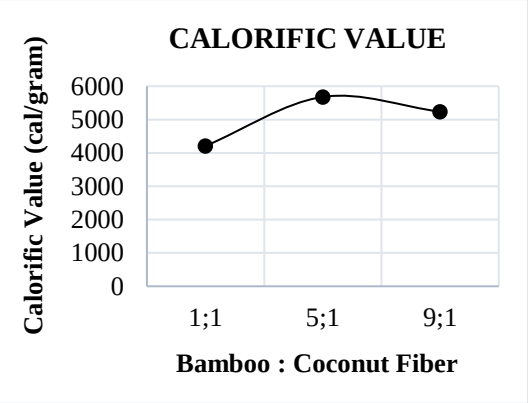

Figure 5 Comparison of bamboo and coconut fibre composition on calorific content

The graph above indicates that the highest calorific value is obtained from bamboo and coconut fibre 5: 1 at 5679.15 cal/gram, while the lowest calorific value is obtained from the composition of 1: 1 at 4211.03 cal/gram. From the results obtained, only samples with a ratio of 5:1 and 9:1 meet the quality requirements of briquette quality (SNI 01-6235-2000), namely the percentage of calorific value above 5000 cal/gram. Meanwhile, the results of the calorific value in other samples do not meet (SNI 01-6235-2000) because the calorific value is below 5000 cal/gram. The type of adhesive and material composition influences the heating value produced. Each raw material has a different bound carbon value, resulting in different calorific values for each type of biobriquette raw material.

4. Conclusions

One of the important factors determining the quality of bio briquettes is the addition of variations in the composition of bamboo charcoal and fibres. The best briquette mixing ratio is available in the 5:1 mixture with a calorific value of 5679.15 cal/g, moisture content of 0.49%, ash content of 7.91, and Volatile Matter of 51.31%. Apart from Volatile Matter, the other three parameters have met the SNI standard for bio briquettes (SNI 01-6235-2000).

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