Making briquette as fuel from rice husk waste and glutinous rice flour

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Abstract. Briquette is fuel energy produced from organic materials or agricultural waste (biomass) that is underutilized such as rice husk waste. In this research, briquettes will be made from a mixture of rice husk waste, sticky rice glue and PVAc glue. The purpose of this research is to see the temperature and length of burning of charcoal briquettes. This research uses conventional experimental methods. Based on the results of the study, sample 1 had a mixed composition of 100 gr rice husk waste, 15 gr glutinous rice flour, 5 gr PVAc glue, and 110 ml hot water, then a maximum temperature of 335.4˚c was obtained and with a burning time of 19.18 minutes, whereas at sample 2 has a composition of mixed ingredients namely 90 gr rice husk waste, 25 gr glutinous rice flour, 5 gr PVAc glue, 110 ml hot water, then a maximum temperature of 353.6˚c is obtained with a burning time of 17.54 minutes, whereas in sample 3 with a mixture of ingredients 110 gr rice husk waste, 5 gr glutinous rice flour, 5 gr PVAc glue, 110 ml hot water, then a maximum temperature of 427.1˚c is obtained with a burning time of 27.46 minutes. Of the 3 sample specimens that obtained good temperature values were sample 3 with a maximum temperature of 427.1˚c and a burning time of 27.48 minutes.

1. Introduction
Briquette is a lump of charcoal made from hardened soft materials. The factors that influence the nature of charcoal briquettes are the specific gravity of the material or the specific gravity of the charcoal powder, powder fineness, carbonization temperature, pressure pressing and mixing formula briquette raw material. Charcoal briquettes must have good quality as briquettes. The briquetting process is a treatment process that is subjected to mashing treatment, mixing raw materials, hydraulic system printing and drying under certain conditions, so we get a briquette that has a shape, physical size, and certain chemical properties to produce good briquettes [6].

Good quality briquettes require the right composition so that the heat generated is good and as needed. The main problem in making briquettes is to determine the right composition so that the briquette's heating value is higher and its use is increasing. In addition, the types of adhesives used in making briquettes must be considered in order to know the heat resistance when burning [3].

Rice husk waste is biomass waste produced from the agricultural sector. This waste is one type of agricultural industrial waste that has been a waste that has not been well handled. Therefore we need new innovations in the use of rice husks to make products or materials that are more useful, namely briquettes.
This research aims to increase the utilization of rice husk waste by making briquettes as fuel and testing the best composition of briquettes on the quality of the briquettes produced. This research is an experimental study by combining the types of briquette making material, namely rice husk and sticky rice glue and PVAc glue with a specific composition which aims to observe the effect of the combination of ingredients on the quality of the briquettes which includes the rate of combustion and flame quality of the briquettes.

2. Materials and methods

2.1. Biomass as an energy source
Biomass is a natural material that is usually regarded as waste and is often destroyed by burning to produce new energy. The biomass can be processed into bioarang briquettes, which is a fuel with a significant level of heat value and can be used in the needs of daily life. Biomass is very easy to find from community activities in terms of agriculture, animal husbandry, forestry, plantation, fishery, and other wastes [11].

Basically the material used to make briquettes is agricultural waste such as straw, rice husk, bagasse, dried leaves from bark and bark, etc. Fibrous waste material such as coconut fiber, jute, coconut fiber. Food processing wastes such as skin of nuts, seeds. Cellulose like, paper waste, cardboard [4].

2.2. Rice husk
Rice husk is a hard layer that covers karyopsis consisting of two interlocked halves called lemma and palea. Unlike bran or rice bran which still has economic value and is generally used as animal feed or fish, husk is considered as rice mill waste. Husk is produced from about 16% -26% of rice from the milling process depending on the model or type of rice mill used. According to data from The Potential of Biomass Residues as Energy Sources in Indonesia it is reported that the energy that can be generated from the utilization of rice husks is 27x109 J / year [2].

Chemical properties of rice husk are generally composed of organic and inorganic components. The organic component includes carbohydrates that are dominated by cellulose and hemicellulose. Crude protein in rice husk is around 3% and lipid is 0.039-2.98%. The amount of pure lignin in rice husk is around 19.20-24.47%. Vitamins contained in rice husks including thiamine, riboflavin, and niacin, then around 13.2-29.0% of the weight of rice husk are inorganic components such as Fe, Ca, Mg, P, etc. are compounds needed for rice growth [2].

2.3. Charcoal briquettes
Briquettes is a lump of charcoal made from hardened soft materials. The factors that influence the nature of charcoal briquettes are the specific gravity of the material or the specific gravity of the charcoal powder, the fineness of the powder, the carbonization temperature, the pressing pressure and the mixing formula of the briquette raw material. Charcoal briquettes must have good quality as briquettes. The briquette process is a processing process that is subjected to mashing treatment, mixing of raw materials, molding with a hydraulic system and drying under certain conditions, so that briquettes that have the shape, physical size, and chemical properties naturally produce good briquettes [6].

Biomass energy using the method of making briquettes by converting solid raw materials into a form of compacting or compression which is easier to use and used as renewable energy to overcome the problems of society. Briquettes that have good quality are those that have high carbon content and low ash content, because with high carbon content the energy produced is also high [10].

Heating value is a measure of heat or energy produced to convert into new energy, the energy produced in the form of heat and measured as a gross calorific value (groos calorific value) or net calorific value (nett calorific value). The principle of determining the heating value is to measure the energy caused by combustion in units of mass, usually expressed using units of grams. Measurement
of the value of the heat is calculated based on the amount of heat released by the amount of heat absorbed. Testing of the calorific value aims to determine the extent of the combustion heat value produced by the briquettes, the calorific value determines the quality of the briquettes [4].

2.4. Adhesive
With the use of adhesives, the bond between particles will be stronger, the grains of charcoal will bind to each other which causes water to bind in the pores of charcoal. The use of adhesive is intended to attract water and form a dense texture or bind the two substrates to be cracked. With the adhesive, the particle structure will be better, orderly and denser so that in the process of pressing press and charcoal briquettes will get better [13].

2.4.1. A combination of adhesives. In order to get carbon that has superior properties in terms of quality and is more economical in terms of production costs, it is not uncommon for charcoal briquette producers to combine 2 types of adhesives at once. On the other hand, the combination of these types of adhesives aims to increase the briquette's resistance from unfavorable factors, such as extreme temperatures, high humidity, and damage during transportation [7].

2.4.2. Glutinous rice flour. Glutinous rice flour is high in nutrients, 89% carbohydrate, 4% fat, 6% protein, and 10% water. From its chemical composition, it is known that the main constituent carbohydrate in sticky rice is starch. Starch is a glucose polymer carbohydrate that has 2 types namely amylose and amylopectin. Glutinous rice is almost entirely dominated by amylopectin so it is very sticky. Glutinous rice contains amylopectin which is very high at 99.7% and is not fluffy in cold water. Glutinous rice used must be new, clean white, musty smell, and free from dirt, fungi and insects [5].

2.4.3. PVAc glue (white glue). PVAc glue or adhesive is a sticky material that is used to glue two or more objects, white glue PVAc (Polyvinyl Acetate) is a glue that has very high adhesion properties, material that is glued with white PVAc glue is stronger and not easily separated so it is widely used as adhesives in the manufacture of crafts, wood glue, and paper glue, besides that white glue PVAc has odorless properties, and is more quickly solid or faster to stick to raw materials [8].

2.5. Method of implementation
In this study using the experimental method that is the method of experimenting with experience to prove them a statement being studied, this method is conducting an experiment about something, observing the process and writing the results. The materials in this study were rice husks, glutinous rice flour, PVAc glue, hot water. While the tools used to make charcoal briquettes are measuring cups, sieves / filters, scales, basins, dimples, molds, ovens, digital thermometers and stopwatches.

2.5.1. Work procedures. The working procedure in this study is the preparation of raw materials, the raw materials prepared are rice husks, then burning the rice husks to charcoal. Charcoal collision, after burning it is then carried out the process of collision of husks using mortar. The results of the hulling are then filtered. Then making adhesives, the adhesive material used in making charcoal briquettes is a mixture of glutinous rice flour, white glue (PVAc) and hot water. This mixture is then heated to maturity characterized by a change in the color of the mixture from white to turbid and clear. Making dough, raw material that has been filtered and weighed and then put into a basin, the material is then mixed with sticky rice glue and white glue (PVAc) and then evenly mixed until it forms a dough. Furthermore, briquette printing, raw materials that have been mixed put into a mold, then pressed. And the last thing is drying, briquettes that have finished printing then are left for a while. Then it is dried in an oven at 60°C for 24 hours [9]. The goal is to reduce the water content of the briquettes, so that the briquettes burn quickly and are not smoky. Too high a temperature can result in cracking of the printout.
3. Results and discussion

3.1. Results of making rice husk briquettes
The results of making briquettes that have been printed can be seen in the picture below:

![Briquettes Images](image1)

Figure 1. Rice Husk Briquettes. (a) Sample 1; (b) Sample 2; (c) Sample 3.

Every sample that has been prepared is then tested, that is testing the maximum temperature using a Digital Thermometer and testing the burning time using a Stopwatch.

3.2. Test results for maximum burning briquette temperature
Temperature testing is carried out in stages in each sample that is, every 2 minutes, more details can be seen in the picture below:

![Temperature Graph](image2)

Figure 2. Testing the Maximum Temperature in sample 1.

In figure 2, In figure 1, sample 1 can be concluded that the maximum temperature of burning briquettes is obtained in the 10\(^{th}\) minute with the maximum temperature produced 335.4°C.
Figure 3. Testing the Maximum Temperature in sample 2.

In figure 3, sample 2 can be concluded that the maximum temperature of burning briquettes is obtained in the 10th minute with the maximum temperature produced 353.6°C.

Figure 4. Testing the Maximum Temperature in sample 3.

Whereas in Figure 4, sample 3 can be concluded that the maximum temperature of burning briquettes is obtained in the 10th minute with the maximum temperature produced 427.1°C.

Based on the results of maximum temperature testing on rice husk briquettes with variations in the composition of materials and pressures with raw materials of rice husks obtained by 353.6°C to 427.1°C. The temperature value determines the quality of charcoal briquettes. The higher the temperature, the briquette, the better the burning time for briquettes [1]. This states that the best results are in sample 3 with the resulting temperature of 427.1°C. Whereas the lowest combustion temperature occurred in sample 1, 335.4°C. Based on [12] the calorific value is influenced by water content, the smaller the water content in biobriquette, the greater the calorific value obtained.

3.3. Test results of the burning time
This test is carried out when the briquette becomes fire until the briquette turns to ash. More details can be seen in the picture below:
From Figure 5 above shows that the burning time in sample 1 (S1) is 19.18 minutes, and sample 2 (S2) is 17.54 minutes, while sample 3 (S3) is 27.46 minutes. Combustion is also influenced by the air velocity and moisture content present in the material. The water content that is mixed will reduce the length of combustion.

Burning briquettes with variations in material composition and pressure with rice husk raw materials were obtained between 17.54 minutes to 27.46 minutes. The analysis result in Figure 5 states that the longest time for combustion is in sample 3 with a duration of 27.46 minutes. Whereas the lowest burning time occurred in sample 2, namely 17.54 minutes.

The more the adhesive composition, the lower the heating value, the addition of the adhesive also causes the heating value of rice husk briquettes to decrease. This is caused by the adhesive used in the manufacture of briquettes in this study namely glutinous rice flour, where glutinous rice contains high amylopectin, it is very easy to gelatinize if added with water and heated.

4. Conclusions
The conclusion of this study is, of all the samples tested, the third sample that has the highest combustion temperature, namely with a temperature of 427.1 °C. Time Good combustion time was obtained in sample 3 with variations of 110 gr rice husk composition 5 gr glutinous rice flour 5 gr PVAc glue 5 gr and 110 ml hot water that is the resulting duration of time was 27.46 minutes.

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