The Processing Of Coconut Shell Based On Pyrolysis Technology To Produce Reneweable Energy Sources

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Abstract : This study is an experimental study that aims to make coconut shell charcoal briquettes which have reliably characteristics or qualities. This study includes drying of raw materials, composing, grinding and sifting, mixing the adhesive, printing and compression, drying, and determination of characteristics include density, ash content, duration of combustion and calorific value. The result of the study showed that in general there is no significant difference between the characteristics of the briquettes using a starch adhesive with one that use sago starch adhesive. The characteristics of briquettes that were produced are in accordance with the standard in Indonesia, the United States and Japan, except Britain which give very strict standards. Activated charcoal from coconut shell charcoal that was activated with 1M HCl has metal adsopsi power Cr (VI) that is quite high (up to 22.15%).

Keywords*: briquettes, coconut shells, gluten, calorific value, tapioca, sago, ash, density.*

INTRODUCTION

Limitations of fossil fuels, forcing researchers to look for alternative fuels as a substitute. One of the alternatives that can be done is by using biomass energy. Biomass energy is a source of energy that comes from natural resources that can be renewed so it is likely to be used as an alternative fuel. The materials to make biomass can be obtained from agricultural waste, industry and households, including coconut shells that are abundant in places of coconut stripping/processing.

One of biomass fuel is briquettes which are usually made from coal, or from bio charcoal. Coconut shell charcoal burns longer than the charcoal from other plants, so it is good if pocessed into briquettes.

Table 2.2 Specifications of Coconut Charcoal According to Importers from England and Manufacturers from Philippines (Wahyuni, 1996)

Spesification	England Spec	Philippines Spec
Water content (%)	2 – 5	6
Volatiles (%)	7 – 14	15 or less
ash content (%)	2 – 5	3 or less
The amount of carbon (%)	80 – 85	75 or more

Carbonization is one stage in the production of charcoal. At carbonization stage, performed conditions arrangements for carbonization, such as temperature, pressure, time, and atmosphere. Through this carbonization conditions arrangement, it is expected to charcoal as a result of carbonation does not experience the burning that is more protracted, so it is obtained charcoal with maximum randemen and high quality (Amin, 2009).

Briquette of coconut shell charcoal is very potential as a subtitude for fossil fuels such as kerosene and LPG, as well as a substitute for coal briquettes, because technically, charcoal briquettes are easy to make, does not require high technology and the the most important is the price is much cheaper and the basic materials is coconut shell that are available in abundance in the midst of society, therefore, the development can be carried out by the public as consumers themselves (Nursuci, 2012, dan Basriyanta, 2007). Briquette of coconut shell charcoal and the charcoal itself have a chance to be exported especially to industrial countries, such as United States, Japan and European countries, not only briquettes can be used as fuel of industry, but also charcoal can be used as an additional materials in tires industry, cosmetics, inks and etc.

In making the briquettes, it is required adhesive in order for briquettes to withstand, not easily be destroyed if exposed to collision or other physical events. Starch and sago has physical properties that are not much different. Starch component from amylum generally consist of 17% of amylose and 83% of amylopectin, whereas starch component from sago consist of 28% of amylose and 72% of amylopectin. This content indicates that starch and sago can be used as an adhesive in the making of briquettes in addition to having an economical price.

The quality of charcoal briquettes is generally determined by the physical and chemical properties, namely ash content, water, levels of substance evaporates, the levels fixed carbon, density (g/cm3), compressive strength (kg/cm2), and combustion caloric value (cal/g) (Hendra in Hazra et al., 2011).

Table 2.3 Quality standard of charcoal briquettes (Research Agency Hut in Wijayanti, 2009)

Characteristics of Charcoal Briquette	**Japan**	**England**	**USA**	**Indo. (SNI 1-6235-2000)**
Water Content (%)	6-8	3,6	6,2	8
Easy Evaporate substances (%)	15-30	16,4	19-28	15
Ash Content (%)	3-6	5,9	8,3	0,62-4,42
Tied Carbon Levels (%)	60-80	75,3	60	77
Caloric Value (Kal/g)	$6\text{-}7.10^3$	7289	$6{,}23.10^3$	5.10^3
Density (g/cm^3)	1,0-1,2	0,46	1	0,44
constancy Press (kg/cm^2)	60-65	12,7	62	0,46

RESEARCH METHODOLOGY

Equipment and Materials and Procedures

Equipment: Tube kiln drum, milling machines, sieve, plastic containers, thermometer, oven, analytical balance, calipers, mortar and pestle, printers and felts charcoal, glassware, hot plate, buret, stand and clamps, and Oxygen Bomb Calorimeter.

Materials: Coconut shell, starch, sago starch, Na2CO3 0.07N, MO indicator and aquadest.

Procedures

a. Drying Raw Materials

Coconut shell was cleaned first from fibers then dried and then it was broken down into smaller parts so when carbonization it's easy to set up and generate more mass og charcoal..

b. Carbonization (Pyrolysis)

Coconut shells were charred using drum kiln. At the filling time of raw materials in the middle of the kiln drum were placed bamboo with a diameter of about 10 cm and 1 m long that is intended as an air hole at the time of carbonization process. After the drum kiln is full then combustion was performed by providing decoy for combustion in the form of twigs, paper or by dropping kerosene.

At the time of the combustion process took place and estimated the fire is not quenched kiln drum is closed, closed holes at the most bottom around the kiln drum was started to be opened. If the combustion on the bottom has been completed which can be seen from the embers in those holes, then the first hole was closed and continued opening hole at the top, and so forth until the combustion is complete by looking at the smoke coming out through the chimney was thinning. Then all the holes were closed again to prevent further combustion, the combustion was allowed to take place within 5-7 hours until the smoke thinned.

c. Milling and Filtering

The results of milled charcoal by using a milling machine then charcoal powder was sieved with a 60 Mesh escaped.

d. Mixing with Tapioca Adhesives

Tapioca adhesive is made by heating 24 grams of starch in 150 mL of water until it formed a gel. The same treatment also conducted on sago adhesive. Considering coconut shell charcoal powder and adhesive, where the mixture overall weight is 300 grams. Tapioca adhesive weight is 8%. While the weight of sago adhesive was varied that is, 1%, 2%, 3%, 4%, 5%, 6%, 7% and 8%. Having weighed the comparison between coconut shell charcoal powder and adhesive, then mixed in a plastic container so they became one and homogeneous.

e. Molding and Compression

The results of briquettes dough (a mixture of coconut shell charcoal powder with starch or sago) molded and compressed.

f. Drying

Charcoal briquettes produced were then dried in an oven at 60° C for 24 hours. After that it was packaged in a plastic bag and sealed to keep the briquettes remain in the dry state.

g. Coconut Shell Charcoal Briquette Density

The determination of density was conducted by weighing the briquttes and measuring the diameter as well as the height in a dry state. The density of the briquettes can be calculated using the formula:

$$K = \frac{W}{\frac{1}{4}\pi . D^2 . T}$$

Notes:

W = Briquette weight (g)
K = Density
D = Briquette diameter (cm)
T = Briquette height

h. Coconut Shell Charcoal Briquette Ash Content

The determination of ash content was done by drying rate of porcelain in 105° C oven for 30 minutes. Then, cup was cooled in eksikator for 30 minutes and weighed its empty weight. Then into the empty rate, a sample of 1 gram was inserted. Plates contained the next samples were put into the furnace at a temperature of 850° C for 4 hours until the sample turned into ashes. Furthermore, the rate was removed from the furnace and cooled in eksikator, then weighed. The determination of ash content is performed three times of repetitions (triplo).

The ash content can be calculated using the following formula:

$$\text{Ash content (\%)} = \frac{A}{B} \times 100\%$$

Where:

A = weight of ash (gram)
B = weight of sample (gram)

i. Duration of Combustion for Briquette Coconut Shell Charcoal

The determination of how long the combustion is done by, burning briquettes above bunsen. Once the briquettes begin to burn, charcoal briquette was added into porcelain cup. Turning on the stopwatch when the briquettes begin to burn and turning it off when the briquettes were burned to ashes. The determination of combustion time is performed three times of repetitions.

j. Calor of Coconut Shell Charcoal Briquette Combustion Result

The determination of fuel calorific value in this study was using a bomb calorimeter with the weight of the materials used about 1 gram.

The fuel calorific value is calculated based on the amount of calor that is released as much as the calor that is absorbed, with the following equation:

$$\text{Calor Value} = \frac{(T2-T1)\text{x } W}{m} \quad \text{(Sinurat, 2011)}$$

With:
W = coefficient of calorimeter bomb (kal/^{o}C)
T_2 = temperature after combustion (^{o}C)
T_1 = initial temperature (^{o}C)
m = burnt sample weight (g) .

FINDINGS AND DISCUSSION

Finding

The making of coconut shell charcoal briquette was done by using two types of adhesives that were starch adhesive and sago adhesive. Tapioca adhesives were used with a percentage of 8%. While on the sago adhesives were performed adhesive variations of 1%, 2%, 3%, 4%, 5%, 6%, 7%, 8%. Results of quality testing of coconut shell charcoal briquettes that were produced can be seen in Table 4.1. This data is the result of the average of three times of repetitions for each treatment.

Table 4.1 Quality Testing Results of Coconut Shell Charcoal Briquette

Adhesive	Cons. Of Tapioca (%)	Calorific value (kcal)	Adhesive	Cons. Of Sago	Calorific Value (kcal)
Tapioca	1	6744,259	Sago	1	6673,041
	2	6807,621		2	6802,766
	3	6789,764		3	6665,643
	4	6679,827		4	6458,846
	5	6652,912		5	6384,256
	6	6627,029		6	6507,179
	7	6483,525		7	6345,775
	8	6402,275		8	6349,685

Table 4.2 Adsorption Power of Activated Charcoal Coconut Shell toward ion Cr (VI)

No	% Adhesive	Cons. Ion Cr (VI) (ppm)	The rest of the Cr (VI) Average (ppm) (Ce)	Cr (VI) absorbed on average (ppm)	Adsorption capacity average (W) (mg / g)	Power adsorption average (%)
1	A (4%)	50 50	42,686	7,314	0,365	14,630
2	B (8%)	50 50	41,701	8,290	0,414	16,590
3	C (12%)	50 50	40,870	9,130	0,456	18,260
4	D(16%)	50 50	38,993	11,007	0,549	22,150

The measurement results of adsorption power of activated charcoal coconut shell that was activated with 1M HCl are shown in Table 4.2.

Discussion

1. Coconut Shell Briquette

Coconut shell has a high thermal diffusion characteristic because it is influenced by the high content of lignin and cellulose, so the coconut shell is good to be used as an alternative fuel. In its use as an alternative fuel, coconut shell is made in the form of briquettes, so it could increase the economic value and make easy on its use. Materials for making briquettes are come from old coconut shell marked from dark brown color if we see it from its slit side. Old shell has a higher carbon content and low water content. Coconut shell that will be used is cleaned first from its fiber and dirt attached to it, then dried under the sun so that during the process of charring or carbonization smoke produced is not too much and simplify the process of carbonization.

Carbonization process in this study was conducted using a kiln drum with a limited air supply, in order to the formed charcoal does not experience further combustion, so the yield charcoal that was obtained is high, while the ash that was formed is little. The total of coconut shell that was burnt are 125 kg, which is divided into 5 times burning. For each burning, the coconut shell that was burnet is 25 kg for 3-6 hours. Charcoal produced from carbonization of 125 kg coconut shell was 30 kg with 24% yield.

Charcoal from results of carbonization then was grinded to obtain a smaller size. To obtain the same size then sieving with the size of 60 mesh was performed. Furthermore, charcoal from sieving was mixed with sago flour and starch each with a variation of 1%, 2%, 3%, 4%, 5%, 6%, 7%, 8%, as the adhesive.

Amylum component of starch generally consist of 17% amylose and 83% amylopectin. Meanwhile, from tapioca component from sago consist of 28% amylose and 72% amylopectin. These components indicated that sago and starch can be used as an adhesive. The amylum granules in the starch and sago will swell in water with high temperatures. Rising temperatures during the heating will increase the swelling of the starch granules. Swelling of the starch granules is reversible (can return to the beginning form), but when a certain temperature has been exceeded, swelling of the starch granules is irreversible (can not be returned). The irreversible starch is called gelatinization and it occurs at a temperature of 85oC. Increasing of swelling of the starches granulan will cause the increased of viscosity or consistency of the solution.

Tapioca adhesive or sago is mixed with water while heated and stirred until thickened mixed with charcoal powder until homogeneous with a predetermined ratio. When the adhesive is mixed with the powder, then the powder particles will attract each other due to the force of adhesion and cohesion. Adhesion force is the force of attraction between the particles which are not similar while the cohesive force is the force of attraction between similar particles. Molecules of water (H_2O) is used as a solvent for adhesive and to form a thin layer on the surface of the particles that will increase the contact surface between the particles.

The obtained mixture was molded to obtain a uniform shape, to increase the selling price and to facilitate the packaging and the use. The purpose of compression is to increase the density between particles; it will affect the physical characteristics even the chemical characteristics of the briquettes made.

Drying in the oven was performed for 24 hours so that the reduction of the water content of the briquettes can be done as much as possible. Briquettes weight that have not been dried was ± 13 grams after drying was ± 9 grams

a. Density

The density is a comparison between the mass and volume of briquettes. Briquette density affects the quality of the briquettes. The results of the density measurement of coconut shell briquette with various levels of adhesives are listed in Table 4.3. There is a tendency of the effect of the addition of adhesive toward density of coconut shell charcoal briquette. The addition of adhesive caused the increased in density briquettes. The influence of both types of adhesive (tapioca and sago to the increase in density of briquettes is no different, it can be seen from the curves in Figure 1, where the two curves almost coincide with each other. It also can be seen from the correlation value and r square that is almost the same (Table4.5).

Table 4.3 Testing Results of Coconut Shell Charcoal Briquette Density

Adhesive	Cons. Of Tapioca (%)	Calorific value (kcal)	Adhesive	Cons. Of Sago	Calorific Value (kcal)
Tapioca	1	0,651	Sago	1	0,642
	2	0,648		2	0,643
	3	0,652		3	0,654
	4	0,761		4	0,774
	5	0,749		5	0,742
	6	0,790		6	0,809
	7	0,829		7	0,815
	8	0,854		8	0,856

Results of statistical analysis of briquettes density measurement data made with various concentrations of adhesives (tapioca and sago), as listed in Table 4.4 shows that both of the data (the concentration of tapioca, sago and density of briquettes) each concentration of adhesive is distributer normally.

Table 4.4 Statistical Analysis Results of Sago Concentration as Adhesives with Briquette Density Measurement Results

Aspects	Value	Information	Aspect	Value
N Test: Sig. of Sago consentration Sig. of density	1,00 0,823	Normal Normal	Pearson Cor. Sig.	0,950 0,00
R Square	0,902		tCal. Sig.	26,293 0,00

The correlation coefficient between the concentrations of sago with briquette density is 0.95, with a significance of 0.00 and r-square of 0.902, this means that the increase in the concentration of sago as adhesives affect the density of briquettes by 90.2%, so other factors that affect is less than 10%. These results are supported by t-count value that was obtained at 26.293 with a significance value of 0.00.

Similarly, the results of statistical analysis of the correlation between the concentration of tapioca with density of coconut shell charcoal briquettes as listed in Table 4.5, indicating that both data that are tapioca concentration and results of briquettes density measurement are distributed normally. The correlation between the two data was 0.950 with a significance of 0.00, similarly the r Square was 0.922, and the significant value of t count was 0.00.

Table 4.5 Statistical Analysis Results of Tapioca Concentration as Adhesives with Measurements Results of Briquette Density

Aspects	Value	Information	Aspects	Value
N Test: Sig. of tapioca cons. Sig. of density	1,00 0,766	Normal Normal	Pearson Cor. Sig.	0,95 0,00
R Square	0,922		t_{Cal}. Sig.	30,60 0,00

These statistic results showed that the correlation between the two data that are the concentration levels of starch with briquettes density are very strong. The increase in density of briquettes are influenced by the increased of briquettes concentration of 92.2%. So the influence of other factors is less than 8%.

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b. Ash content

Ash that is unburned parts that doesn't have carbon element anymore after a fuel was burnt. Ash consists of elements or minerals contained in the material that is burned, in this case the material to form briquettes, either from coconut shell charcoal, or from the briquette adhesive material. Ash content measurement results of coconut shell charcoal briquettes are listed in Table 4.6.

Table 4.6 Ash Content Test Results of Coconut Shell Charcoal Briquette

Adhesive	**Cons. Of Tapioca (%)**	Calorific value (kcal)	Adhesive	Cons. Of Sago	Calorific Value (kcal)
Tapioca	**1**	1,54	Sago	1	1,17
	2	1,48		2	*1,32*
	3	1,56		3	1,50
	4	1,60		4	1,51
	5	1,71		5	1,55
	6	1,54		6	1,58
	7	1,82		7	1,67
	8	1,77		8	1,87

Results of statistical analysis of the data of briquettes ash content measurement results made with various adhesives concentrations (starch and sago), as listed in Table 4.7 and Table 4.8, shows that both of the data (the concentration of starch, sago and briquettes ash content) any concentration of adhesive is distributed normally.

The correlation coefficient between the concentration of sago with briquette density was 0.95, with a significance of 0.00 and r-square of 0.956, this means that the increase in the concentration of sago as adhesives affect briquette ash content in the amount of 95.6%, so other factors that affect less than 5%. These results are supported by t-count value obtained at 22.156 with a significance value of 0.00.

Table 4.7 Statistical Analysis Results of Sago Concentration as Adhesives with Measurement Results of Briquette Ash Content

Aspects	Value	Information	Aspects	Value
N Test: Sig. of sago cons. Sig. of ash cons.	1,00 0,872	Normal Normal	Pearson Cor. Sig.	0,96 0,00
R Square	0,915		t_{Cal} Sig.	22,16 0,00

Similarly, the results of statistical analysis of the correlation between the concentration of tapioca with ash content of coconut shell charcoal briquettes as listed in Table 4.8.

Table 4.8 Statistical Analysis Results of Tapioca Concentration as Adhesives with Measurement Results of Briquette Ash Content

Aspects	Value	Information	Aspects	Value
N Test: Sig. of tapioca consentration Sig. of ash content	1,00 0,860	Normal Normal	Pearson Cor. Sig.	0,794 0,09
R Square	0,631		$t_{Cal.}$ Sig.	22,939 0,00

Ash content tends to increase along with the increasing levels of adhesive. This may be due to the addition of ashes from adhesive used. The higher levels of adhesive, then the ash content produced relatively higher as well. The high levels of ash influenced by the content of inorganic materials contained in briquettes derived from adhesive and coconut shell. The content of inorganic materials in the tapioca and sago adhesive, especially calcium, phosphorus and iron. Although the content of the inorganic material is owned by both of the adhesive, however, the composition of inorganic materials on starch adhesive are likely higher.

c. Duration of Combustion

Duration of Combustion is time required a fuel to burn out. The duration of combustion is one of the important factors to the quality of fuel. The longer time of combustion of a fuel, the higher energy produced and and thus the higher the quality of the fuel. The measurement results of combustion time of coconut shell charcoal briquettes made with various concentrations of adhesives are shown in Table 4.9.

Table 4.9 Testing Results of Coconut Shell Charcoal Briquette Combustion Time

Adhesive	Cons. Of Tapioca (%)	Calorific value (kcal)	Adhesive	Cons. Of Sago	Calorific Value (kcal)
Tapioca	1	6,744	Sago	1	6,673
	2	6,808		2	6,803
	3	6,790		3	6,666
	4	6,680		4	6,459
	5	6,653		5	6,384
	6	6,627		6	6,507
	7	6,484		7	6,346
	8	6,402		8	6,350

In Table 4.9, there's a tendency of the influence of the levels as well as the types of adhesives to the duration of combustion. The higher levels of adhesive, the higher (longer) time of combustion.

The results of statistical analysis (in Table 4.10) obtained r square values of 0,972, that means 97.2% increase in the duration of combustion of briquettes is determine by the size of the adhesive concentration, and less than 3% of other factors influencing. Pearson correlation value is 0.980 with significance of 0.00, an optimal number, it means that the relationship between the adhesive concentration with duration of combustion are very strong.

Table 4.10 Statistical Test Results of Starch Concentration (%) toward Duration of Combustion (Hours)

Aspects	Value	Information	Aspects	Value
N Test: Sig. of tapioca cons. Sig. duration combustion	1,00 0,995	Normal Normal	Cor. Pearson Sig.	0,98 0,00
R Square	0,972		t_{cal}. Sig.	48,80 0,00

In Table 4.10, it can be seen that how strong the relationship between starch adhesive concentrations toward the duration of combustion of coconut shell charcoal briquettes that were produced. R Square value = 0,972, which means 97.2% increase in the duration of combustion time of briquettes were influenced by the increase in the concentration of starch adhesive. These results are supported by the results of the test (t-hit = 48.8) with sig. = 0.00.

The same thing to the influence of sago adhesive concentration toward the duration of combustion of briquettes as outlined in Table 4.11, From that table it can be seen that both of the data are distributed normally (significance for sago concentration data is 0.00 and significance for the duration of combustion is 0.997), both are larger than 0.05. Correlation value of 0.980 with significance value of 0.00, it means that the correlation is very strong and significant. The magnitude value of the determination coefficient (r Square = 0.953), means that 95.3% of the increase of the duration of combustion is affected by briquettes concentration, and other factors are less than 5%.

Table 4.11 Statistical Results of Sago Concentration (%) toward Duration of Combustion (Hours)

Aspects	Value	Information	Aspects	Value
N test: Sig. of Sago cons. Sig. of duration combustion	1,00 0,997	Normal Normal	Pearson Cor. Sig.	0,980 0,00
R Square	0,953		$t_{Cal.}$ Sig.	16,61 0,00

d. Calorific Value

The calorific value of a solid fuel is the amount of heat energy that can be released at any weight unit of those fuels when they burn perfectly.

The calorific value depends on the nature of the fuel. Solid fuel will burn longer, so that the energy released by itself will be greater, and vice versa. For example the combustion time for coconut fiber with coconut shell even thought the weight are the same, will be very different.

Fiber is easier burnt, and will be burnt completely in a very short time compared to the coconut shell even though the mass are the same. Therefore, the amount of energy produced from the combustion of coconut shell is much higher than the energy produced from the fiber. That's why if you want to iron using charcoal, then generally people use coconut shell charcoal, and not coconut fiber charcoal or other soft materials such as mango tree charcoal.

Table 4.12 Testing Results of Coconut Shell Charcoal Briquette Calorific Value

Adhesive	Cons. Of Tapioca (%)	Calorific value (kcal)	Adhesive	Cons. Of Sago	Calorific Value (kcal)
Tapioca	1	6,744	Sago	1	6,673
	2	6,808		2	6,803
	3	6,790		3	6,666
	4	6,680		4	6,459
	5	6,653		5	6,384
	6	6,627		6	6,507
	7	6,484		7	6,346
	8	6,402		8	6,350

Statistical analysis Results of the correlation between the adhesive (sago and starch) with the calor produced by briquettes obtained are listed in Table 4.13, and Table 4.14.

Table 4.13 Statistical Test Results Starch Concentration (%) toward the calor produced (kcal)

Aspects	Value	Information	Aspects	Nilai Value
N Test:Sig.of tapioa cons. Sig. of calorific value	1,00 0,933	Normal Normal	Pearson Cor. Sig.	0,922 0,00
R Square	0,850		$t_{Cal.}$ Sig.	147,297 0,00

In Table 4.13, it can be seen that how strong the relationship between the concentration of starch adhesive toward the calorific value produced from the combustion of coconut shell charcoal briquettes produced. R Square Value= 0.850, which means 85% of the increase in the combusion calor of briquettes were influenced by the increase in the concentration of starch adhesive. Those results are supported by the results of test (t-count= 147.297) with sig. = 0.00.

The same thing toward the influence of sago adhesive concentration to the calor produced from briquettes combustion as listed in Table 4.14.

From that table it can be seen that both data are distributed normally (significance for sago concentration data is 1.00 and the significance for the calor data produced from the combustion is 0.973), both are above 0.5. The correlation value is 0.866 with significance value of 0.00, which means that both correlation data is very significant. The big amount value of the coefficient of determination (R Square = 0.750, means that 75% increase in duration of combustion of briquettes are influenced by the increase in the concentration of briquettes.

Statistical analysis Results that are listed in Table 4.13 and Table 4:14, shows that there is no difference between starch and corn flour as an adhesive in the manufacture of briquettes in terms of the characteristics of briquettes that are produced such as duration of combustion, ash content, density, and the calor produced by briquettes, t test significance value (t-test) is 0.00, r square each for starch is 0.850 and for sago is 0.750, not too much different. Similarly, the correlation of both of them with the calor produced is 0.866 for sago and 0.922 for starch, not too much different.

Table 4.14 Statistical Test Results of Sago Flour Concentration (%) toward the duration of Combustion (Hours)

Aspects	Value	Information	Aspects	Value
N Test:Sig. of Sago cons Sig. of duration combastion	1,00 0,997	Normal Normal	Pearson Cor. Sig.	0,980 0,00
R Square	0,953		$t_{Cal.}$ Sig.	16,61 0,00

In Figure 4.4, it can be seen the effect between adhesive and the type of adhesive to the calorific value. Briquettes that use sago adhesive 1% to 2% experienced an increasing. The calorific value of briquettes that use sago adhesives 1% that is 6673.0405 Kal/gram whereas, the calorific value of 2% is 6802.7661 Kal/gram. The calorific value of briquettes that use sago adhesives 2% is the highest calorific value than other calorific value. But if we compare it with starch adhesive, sago adhesive has a lower calorific value. It is also influenced by the amount of ash content in the briquettes. The existence of ash content can reduce the calorific value of briquettes. Ash content in sago adhesive is higher than in the starch adhesive. Therefore, the calorific value of those briquettes is also affected.

2. Determination of Adsorption Power toward Ion Cr(VI)

Activated carbon derived from coconut shell charcoal activation with 1 M HCl solution and then neutralized with NaOH and aquadest. HCl solution is used as an activator since HCl is a strong acid solution with low concentration in this case 1 M, has been able to expand the pores of the charcoal so the particles in solution can be absorbed well (Azis, 2000). After neutralized and filtered, charcoal powder then put into oven for 2 hours at a temperature of 110^{o}C to remove water content, acquired activated carbon in the shape of powder (powder).

The determination of activated carbon adsorption toward Cr (VI) is performed by adding consecutively 2%, 4%, 6% and 8% activated carbon into a 50 ml solution of Cr (VI) 50 ppm, then left while being shaked for 90 minutes. The mixture is then centrifuged at 6000 rpm. Filtrate solution of centrifugation results is separated with activated carbon that settles in the bottom of centrifuge tubes, then analyzed with Atomic Absorption Spectrophotometer (AAS) at a wavelength of 357.9 nm.

Measurement result data of activated charcoal adsorption of coconut shell toward ion solution of Cr (VI) with various adhesive concentrations can be seen in Table 4.5.

Data in Table 4.2 showed a tendency to increase the adsorption capacity of coconut shell activated carbon to Cr(Vi) in line with the increase in concentration of adsorbant (activated charcoal), and the highest was 0.549 mg/g at a concentration of adhesive 16%, with a concentration Cr(Vi) absorbed amount to 11.007 ppm and percentage adsorption power of 22.150%. while the lowest adsorption capacity is 0,365 mg/g, which is the adhesive concentration of 4%, the concentration of ion Cr(Vi) adsorbed of 7.314 ppm and percentage of adsorption power is 14.630%.

CONCLUSION

Based on the the result of the analysis, the following are a few grains of conclussion :

1. The concentration of gluten (starch and corn starch) significantly affect the increase in density, ash content, and the time of burning coconut shell briquettes. The higher the gluten content, then the higher density, ash content and the time of burning briquettes.
2. Adhesive levels significantly influence the heat produced from the burning of coconut shell charcoal briquette. The higher the levels pf adhesive, the lower the heat produced.

3. There is no significant difference netween starch and corn starch as an adhesive coconut shell charcoal briquettes on the characteristics of coconut shell charcoal briquettes (density, ash content, the time of burning, and the produced of calories).
4. The active charcoal from coconut shell charcoal that is activated with 1 M HCl, is quite effective to adsorb Cr(Vi).

SUGGESTIONS

1. The result of this research has produced briquette, charcoal, and activated charcoal which has a higher export value, considering the demand for such products from industry countries is quite high, then it is felt necessary for coconut farmers to get the knowledge or training to cultivate the quite abundant of coconut shells especially in central regions of coconut farmers and service centers, and also in the tradional markets. May all the competent authorities can provide adequate funding in order to disseminate the result of this study, especially the coconut farmer communities, and the traditional traders coconut.
2. Because the activated charcoal from coconut shell charcoal has potentials as an absorbent, then this potential can be further developed to :
   a. The development diarrhea drug manufacture in the form of norit.
   b. The development adsorbent manufacture mainly for prevention of pollution of heavy metals in water**,** and water consumption.

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