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The Difference of Clamp Pressure Measuring Toward the Briquette Charcoal Quality of Milas Wood

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ABSTRACT

This research concerned to the quality of the briquette charcoals of Milas wood (*Parastemon urophyllum*) based on the difference of clamp pressures in size 10 tons, 15 tons and 30 tons, and then compared to the standard used which is the Indonesian National Standard (SNI) on briquette charcoals. The study was conducted at the Department of Forestry, Laboratory of Forest Technology, Faculty of Agriculture, University of Palangka Raya, at the same time the test of briquette charcoal quality was managed at the Office of Research and Standardizati on Banjarbaru, South Kalimantan. The parameters tested include density test (gr/cm^3), pressure strength (kg/cm^2), moisture content (%), volatile matter content (%), ash content (%), levels of fixed carbon (%), calorific value (cal/g), and also the yield. The purpose of this research is also to know the quality of Milas briquette charcoals based on the different measure of clamp pressures to then be compared with SNI 02-6235-2000, it is expected to bring significant references for entrepreneurs especially those in briquette charcoal processing industry in order to improve the quality of briquette charcoals produced. The study result indicated the briquette charcoals of Milas wood contained total value of average density 0.87% gr/cm^3, pressure strength 38.58 kg/cm^2, moisture content 4.86%, volatile matter content of 36.56%, ash content of 4.13%, fixed carbon 59.31% and calorific value 6.487.36 cal/g, therefore the test results listed in the Indonesian National Standard (SNI) on briquette charcoals. The yield in the process of producing charcoal (carbonization) on Milas wood took about 3 days measured about 25.17% which was 38 kg of previous 151 kg weight.

Keywords: *briquette charcoal, Milas wood, test, clamp pressure.*

INTRODUCTION

The development of technology at present time is growing very fast, creating the need of timber supplies which is considered more increasing along with growth of the population number each year. Potential forest resources in Indonesia have the number of wood varied not less than 4000 species. From the estimated amount that has stated previously, there are 400 species considered essential. Many attempts on wood efficiency involve the improvement on the technology of wood usage are less recognized which then being directed to the acknowledging of its nature according to the object purpose.

In Indonesia, alternative resources of renewable energy are relatively more in quantity, one of them is biomass or organic waste materials that can be processed and made as analternative fuel, for instance the production of briquettes all this time is only processed from coal. **Kuncoro** and **Damanik (2005)**, biomass energy resources currently reach 30 millions of waste each year. Estimated total contribution of biomass energy resources is about 36% of total energy demands in Indonesia in the condition of more than 73% for household needs. Transactions for biomass energy (firewood, charcoal and biomass briquette) in Indonesia have reached US$ 2,317 millions on each year (**Prawiroadmojo** and **Armando, 2007**).

Wood charcoal is made by heating the wood directly or indirectly in the heap, kiln retort, oven with or without limited air **(Kirana, 1976)**. The technology still used in making charcoal is by using the stacking method of stacked wood, burnt and then covered with soil, next the wood will turn into charcoal through combustion. Other charcoal making technique is by making a kiln. This method is often mentioned as charcoal kiln method. The quality of good charcoal has the characteristics of containing fixed carbon above 75%, quite hard and not easily breakable and brittled, ash content up to 5%, moisture content not moret han 8%, volatile matter content not more than 15%, not contaminated by dangerous elements or other impurities and the charcoals are completely done. To meet the requirements of charcoal quality, we must pay attention to the raw materials in making charcoal, production tools,

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production techniques, charcoal production control prior to be delivered to consumers, and the disposition of the charcoal burners themselves (**Rifky, 2008**).

Briquette is one of the non-oil and natural gas energies, which has high potentiality to fulfill the long term demand of fuel beside oil and gas. Generally, briquettes are used as basic materials for household necessities such as for furnaces, as fuel for metal dilution and for combustion chambers intrains. The advantages of briquette charcoals compared to fire wood are; they have no smell, no smoke, thus they can ignite consistently without being fanned and therefore ease the transportation. **Sukandarrumidi** (**1995**), briquette is a fuel made of certain flammable materials such as coal, charcoal, peat, saw dust and others mixed with an adhesive and then clamped. Briquette charcoal is a transformation of wood charcoal product which has density and size through pressing charcoal powder mixed with adhesive materials. The production of briquette charcoals also contributes several benefits in which included the charcoal density can be increased so that the volume can be tightened (voluminous) and the shape and the size of briquette charcoal are customizable according to the need. It does not get dirty easily, practical and can be functioned as fuel, and for exported briquettes the packaging needs to be conducted at the first place in order to maintain the quality and to ease the transport process.

Adhesive is a material that can hold two objects based on binding surface, by extensive meaning as a substance where objects are possible to stick on or a substance that is able to just a pose some materials all together to a binding surface (**Sutigno, 1986**). The plus of tapioca adhesive are it is easy to find, economical, non-toxic and heat resistant.

Quality is characterized as the factors contained in a product/result that cause the requirements of the product/result (**Assauri, 1980** in **Ludang, 2004**). Quality is defined as the number of attributes or properties as it is described in the related product, it explains something specific for an item or a product related to the nature of the objects as well as the outer appearance (morphology) or the strength of it as combination, resultant unity from its intern properties or the characteristic the item has (**Prayitno, 1988** in **Ludang, 2004**).

Milas wood or *Parastemon urophyllum* or better known as the *kayu malas* by local people is a family of *Rosaceae* which originated from Sumatra and Borneo (Kalimantan). The wood is very profitable for the community because this kind of wood is still can be found in peat land swamp areas. It qualifies to be utilized in making floor, wood board, pads, building, shipping timber, charcoal and basic material for briquette charcoals. It has a specific gravity 0.76 and air dried moisture content 16.02%, included in natural durability class II-III also hardness rate class I. This wood is heavy and solid type also suitable for building material, but the local people do not take this type of wood for building material because of the firm myth they believe in that Milas wood will bring loss or misfortune for those who use it and this causes the less usage to this type of wood. Because of it, we try to use the wood as raw material in the making process of briquette charcoals.

This research aims to determine the quality of the wood briquette charcoals of Milas wood (*Parastemon urophyllum*) based on the difference of clamp pressures in size 10 tons, 15 tons and 30 tons, and then compared to the standard used which is the Indonesian National Standard (**SNI 02-6235-2000**) on wood briquette charcoals. Testing parameters include density test (gr/cm^3), pressure strength (kg/cm^2), moisture content (%), volatile matter content (%), ash content (%), levels of fixed carbon (%), calorific value (cal/g), and also the yield. This research is expected to bring significant offers for entrepreneur particularly those in briquette charcoal processing industry in order to improve the quality of briquette charcoals produced.

MATERIALS AND METHODS

Place and Time

The research was conducted at the Department of Forestry, Laboratory of Forest Technology, Faculty of Agriculture, University of Palangka Raya and the Office of Research and Standardization, Banjarbaru, South Kalimantan. The time needed for the research is due to 6 (six) months since December 2011 until June 2012. Implementations of the research include observation, research preparation and research activities including taking raw materials, charcoal making, briquettes sample test making, sample testing and data analysis. The preparation of the reports was managed from August until November 2012.

Materials and Tools

The material used is the lumbers of Milas (*Parastemon urophyllum*) about $\pm$ 15 meters long with diameter 15-20 cm, originated from the Tuwung village, Pulang Pisau Regency, Central Kalimantan province, as in **Figure1**. Other material used is tapioca starch adhesive and distilled water as a solvent.

Figure 1.Milaswood lumber (*Parastemon urophyllum*)

The equipment used in this study is clamp appliance/jack, hydraulic device (to compress the test sample), bomb calorimeter (to measure the heat value), oven (to get the kiln dried basis moisture content), incineration tool (for ash content), incineration basin (the place for sample test for incineration process), filter size 40 and 60 mesh (to filter charcoal powder), measuring cup of 200 ml volume (for mixing of test sample material), kiln ovenor muffle furnace (to measure the ash content and volatile matter), desiccator (to neutralize the test sample), analytical scale (to weigh the test sample), the plastic clipper (to store the test sample), a bottle of 1500 ml mineral water (to store charcoal powder), funnel (to put the powder into the bottle), gauge (wood metering instrument), mortar (to pound the charcoal), sacks (to store the charcoal), hoe and machete (to clean the kiln), stationery such as calculator, pencil, pen (to note the data), and camera (for documentation).

Work Procedures

The research operation of the charcoal process research and Milas (*Parastemon urophyllum*) wood briquette charcoal making process in the Department of Forestry, Laboratory of Forest Technology, Faculty of Agriculture, University of Palangka Raya. The wood partedinto $\pm$ 1 meter to ease the process of carbonization, arranged not in compact position one to another on the ground surface to let the distribution of fire, and then covered with leaves litter to avoid the soil infiltrates the crevice of the wood also to maintain the temperature from the surround influence, moreover covered by soil at the side part of the stack to make a kiln. This is the initial process of wood combustion, as shown in **Figure 2**.

Figure 2.The initial process of Milas wood charcoaling

After the fire sets, it must be kept burning by fanned so the distribution of fire going well and even. The stacks are also checked by using a wood stick to see if the smoke comes out means the burning process taking well. The charcoal process takes 72 hours $\pm$ 3 days marked by sinking piles and emerging charcoal at ground surface, then disclosed and water splashed to extinguish the remnants of live coals also at the same to cool the charcoal to support so as to enable the selection and separation of charcoal, as in **Figure 3**, then put into a sack to weigh in order to determine the yield of charcoal and next the charcoal is crushed with amortar to produce charcoal powder, sifted and air-dried to be separated in accordingly size.

Figure 3. Charcoal collecting and soil cleansing

Tapioca starch as the adhesive is filtered with a filtering instruments 60 mesh and then dried in an oven with a temperature of 60°C for $\pm$ 6 hours and then put into an air tight bottle of 1500 ml. The amount of starch is 10% of the charcoal powder, for adhesive measurement of 5:1 from the amount of starch used, after that the powder mixed with water, stirred until forming a mixture and heated to 70°C for $\pm$ 5 minutes until the adhesive thickened. The mixture of charcoal powder and tapioca adhesive solution is placed into cylindrical molds made of aluminium with diameter 3 cm and then formed by hydraulic press with capacity of 30 tons. Time required during the clamp process to mold 1 briquette sample is about 20 minutes. After that, the moldis taken out slowly so the briquettes do not crack, air-dried in a room temperature and weighed every day at the same time to obtain a constant weight, as shown in **Figure 4**.

Figure 4.The result of Milas wood briquette charcoal

The next stage is the tests covering the density, the strength of press, the moisture content, the rate of volatile matter, ash content, fixed carbon and calorific value and the yield. For more details, the Indonesian National Standard (SNI) specification toward the quality and the characteristic of briquette charcoals (**Sudradjat, 1983** in **Yustiningtyas, 2007**) is as in **Table1**. For the testing of Milas wood briquette charcoals was carried at the Office of Research and Technology, Banjarbaru, South Kalimantan.

Table 1. Specifications Indonesian National Standard (SNI) Quality and Nature of Briquette charcoals

The Characteristic of Briquette charcoal	Indonesian National Standard (SNI) SNI 02 – 6235 – 2000
Moisture (%)	$\leq$ 6
Volatile Substance (%)	$\leq$ 30
Ash Content (%)	< 8
Fixed Carbon (%)	$\geq$ 60
Calorific Value (cal/g)	> 6000
Density (gr/cm^2)	> 0.7
Press strength (kg/cm^2)	> 12.0

Data Analysis

This research used Complete Random Design (RAL), consists of 3 actions of clamp pressure size which are 10 tons, 15 tons and 20 tons each repeated 3 times. **Ruhendi (1976)**, the scale of the yield can be calculated by the output-input ratio formula as follows:

Charcoal Yield (%) = $\dfrac{\text{Charcoal weight (kg)}}{\text{Wood weight (kg)}} \times 100\,\%$

For density testing, the pressure strength, the moisture content, the rate of volatile matter, ash, fixed carbon and the calorific value, the Indonesian National Standard (SNI 02-6235-2000) is used as follows:

Density (gr/m^3) = $\dfrac{\text{Weight (oven dried)}}{\text{Volume}}\ \text{gr/cm}^3$

Moisture content (%) = $\dfrac{\text{initial weight (gr) - last weight (gr)}}{\text{initial weight (gr)}} \times 100\%$

Pressure strength (kg/cm^2) = $\dfrac{2 \times P}{\pi \times D \times L}\ (\text{kg/cm}^2)$

Where : **P=** Pressure load (kg)
D= Diameter of the briquette (cm)
L= Length of the briquette (cm)

Volatile matter/ VM (%) = $\dfrac{W_1 - W_2}{W_1} \times 100\%$

Where : **VM**= Volatile matter
W_1= Initial test sample weight (gr)
W_2= Test sample weight after heating process (gr)

Ash content (%) = $\dfrac{\text{Ash weight (gr)}}{\text{Test sample weight (gr)}} \times 100\,\%$

Fixed carbon rate (%) = **(100 – Moisture content – Ash content)**

Calorific value (calorie/gr) = $\dfrac{tw - el - e2 - e3}{m}$

Where : ***t*** = Temperatur difference
w = 24117 calorie /°C (according to the certification of the instrument used)
***e*l** = Titration being used in ml
***e*2** = 13.7 x 1.02 *x* Sample Weight
***e*3** = 2.38 x Burnt Fuse Length
m = Sample Test Weight

RESULTS AND DISCUSSION

The test result of Milas wood briquette charcoal is thorougly presented as in **Table 2.**

Table 2. Analysis Result of Milas Wood Briquette charcoal

Action	Repetition	ANALYSIS RESULT						
		Density (gr/cm^3)	**Pressure Strength (kg/cm^2)**	**Moisture Content (%)**	**Volatile Substance (%)**	**Ash Content (%)**	**Fixed Carbon (%)**	**Calorific Value (cal/gr)**
A (10 Tons)	1	0.84	45.31	4.13	39.14	4.13	56.73	6507.46
	2	0.85	37.54	5.04	36.85	4.09	59.06	6500.33
	3	0.85	40.51	5.05	35.03	4.09	60.86	6492.39
	Average	**0.85**	**41.12**	**4.74**	**37.01**	**4.10**	**58.88**	**6500.06**
B (15 Tons)	1	0.89	48.16	4.47	32.91	4.09	63.00	6482.46
	2	0.85	32.05	6.24	44.09	4.21	51.70	6483.37
	3	0.85	28.28	4.37	34.13	4.16	61.71	6468.26
	Average	**0.86**	**36.16**	**5.03**	**37.04**	**4.15**	**58.80**	**6478.03**
B (20 Tons)	1	0.88	33.73	4.92	36.64	4.14	59.22	6460.50
	2	0.89	43.91	6.68	32.78	4.18	63.04	6500.84
	3	0.92	37.74	4.68	37.48	4.07	58.45	6484.64
	Average	**0.90**	**38.46**	**5.43**	**35.63**	**4.13**	**60.24**	**6483.99**

Density (gr/cm^3)

The average of Milas wood briquette charcoal (*Parastemon urophyllum*) as in **Table 2**, for 10 tons of clamp pressure is 0.85gr/cm^3 and for 15 tons is 0.86 gr/cm^3 also for 20 tons is 0.90 gr/cm^3. The highest average of density rate on Milas wood briquette charcoal is at the clamp pressure of 20 tons about 0.90 gr/cm^3 and the lowest is at the clamp pressure of 10 tons about 0.85 gr/cm^3 while the average of total density rate is 0.87 gr/cm^3 where the density rate meets the requirements of Indonesian National Standard (SNI) which is > 0.7 gr/cm^3. According to **Sudrajat (1990)**, the good briquettes for fuel are those which have the density rate about > 0.7 gr/cm^3.

Based on analysis of variance, it shows that the actions of clamp pressure toward the density effect significantly to the level of 95%, but based on the analysis result of test value, there is a difference that clamp pressure of 10 and 15 tons does not effect significantly to the level of 95% while clamp pressure of 20 tons effects at the level of 95%. Therefore the clamp pressure of 20 tons toward the density of Milas wood briquette charcoal is better than the clamp pressure of 10 and 15 tons. It indicates that the smaller the powder size and the difference of pressing weight, the density of briquette charcoal is higher. According to **Komaryati** and **Gusmailina (1995), Nurhayati (1989), Boedjang (1973),** the smaller the powder size to make briquettes, the density and the pressure strength of the briquettes are higher. The larger particle size will complicate the process of sealing and thus will decrease the density of briquette charcoal consequently.

Pressure Strength (kg/cm^2)

The average of pressure strength value on Milas wood briquette charcoal as in **Tabel 2,** the clamp pressure of 10 tons about 41.12 kg/cm^2 and 15 tons about 36.16 kg/cm^2 also 20 tons about 38.46 kg/cm^2. The highest average of pressure strength value on Milas wood briquette charcoal on clamp pressure 10 tons is about 41.12 kg/cm^2 and the lowest on 15 tons is about 36.16 kg/cm^2 while the total press strength value is about 38.58 kg/cm^2 where the pressure strength meets the requirement of Indonesian National Standard (SNI) about > 130 kg/cm^2. **Alpian (2000)** stated that the cause of decreasing pressure strength on briquette charcoal is effected by chemical elements such volatile water, bound substance, lignin, resins also volatile oil while the adding pressure on a certain limit will cause the strength of briquette charcoal decreases again and the adhesive material will be disposed.

Based on the analysis of variance, it shows that the clamp pressure toward pressure strength does not differ significantly until the level of 99%. The purpose of pressure strength test is to ease in its delivery by transportation and packaging, if the hardness of the briquette is high enough therefore the briquettes are carriable through long distance trip because it is easily crack and (**Balai Penelitian dan Pengembangan Industri, 1986)**. The adhesive material factor can affect the value of pressure strength. Adhesive materials which have high amylopectin content (starch substance found in tubers) will have higher and firmer adhesion. It means the strength of the adhesive to binf the charcoal powder will be stronger therefore the charcoal powder bonded firmly **(Rajakino, 2005)**. If the charcoal powder can fuse firmly and adhere well therefore the ability of briquette charcoal to with stand the load on it is getting higher. **Haryanto and Pangloli (1992)** *in* **Rajakino (2005),** the high and low of the pressure strength value are influenced by the type of adhesive being used.

Moisture Content (%)

The average of moisture content of Milas wood briquette charcoal as in **Table 2**, clamp pressure for10 tons about 4.13% and for 15 tons about 5.03% also for 20 tons about 5.43%. The highest average moisture content of

Milas wood briquette charcoal occurs at the clamp pressure of 20 tons about 5.43% and the lowest occurs at the clamp pressure of 10 tons about 4.13% while the average of total moisture content is 4.86% where the moisture content value matches the Indonesian National Standard which is about 4.13 – 6.68%. **Rajakino (2005)** stated that the high and low of moisture content is influenced by the density rate, the higher the density rate therefore the hygroscopic characteristic of briquette charcoal declines in consequence of the porosity in the charcoal powder particle gets tighter as of the moisture's absorbing ability gets lower.

Based on the analysis of variance, it also shows the clamp pressure toward the moisture content does not differ significantly until 99% level. The characteristic of adhesive material made of tapioca starch is seen in the volatility of the moisture content influenced by the environment so it can increase the moisture content rate of briquette charcoal, while the higher rate of adhesive matter tends to increase the moisture content of briquette charcoal **(Rajakino, 2005)**.

Volatile Matter (%)

The average rate of volatile matter on Milas wood briquette charcoal as in **Table 2**, the clamp pressure for 10 tons about 37.01% and for 15 tons about 37.04% also for 20 tons about 35.63%. The highest average rate of volatile matter on Milas wood briquette charcoal is at the clamp pressure of 10 tons about 37.01% and the lowest is at the clamp pressure of 20 tons about 35.63% while the total average rate of volatile matter is about 36.56% where the rate of the volatile matter is higher than the Indonesian National Standard (SNI) about $\leq$ 30 % as a result the briquette charcoal quality is not good.

Based on the analysis of variance, it shows the clamp pressure on volatile matter differs significantly until 99% level. The rate of volatile substance is influenced by the density which is, if the density is high, the volatile matter rate will be low (**Rajakino, 2005)**. It is proved by the immensity of the volatile substance rate to all clamp pressures are considered being caused by there are still much micro pores amountin the powder particle. **Hendra (1992)** in **Alpian (2000)**, the higher rate of the adhesive being used, the higher volatile matters because there are volatile substance and adhesive added. **Hudaya** and **Hartoyo (1989),** the higher of moisture content results in the increase of volatile substance rate. **Sudradjat (1982),** stated that the wood with the high extractive substance rate tends to result in also high volatile substance rate.

Ash Content (%)

The average rate of ash content on Milas wood briquette charcoal as in **Table 2**, the clamp pressure for 10 tons about 4.10% and for 15 tons about 4.15% also for 20 tons about 4.13%. The highest average rate of ash content on Milas wood briquette charcoal is at the clamp pressure of 15 tons about 4.15% and the lowest is at the clamp pressure of 10 tons about 4.10% while the total average rate of ash content is about 4.13% where the rate of the ash content matches the Indonesian National Standard (SNI) about $\leq$8%.

Based on the analysis of variance, it shows the clamp pressure on ash content does not differ significantly until 99% level. **Pari (1996)**, the amount of ash is caused by the weight accumulation of the resin transformed into charcoal so that the elements such as calium potassium, sodium, magnesium and calcium will increase and the ash content is greatly influenced by carbonate salts from potassium, magnesium and the silica level of the wood. The factor of clamp pressing process influenced the ash content, due to the high levels of the volatile substance leading to the higher ash content. The size of the wood briquette charcoal ash produced will affect the calorific value of briquettes because the smaller size of ash produced therefore the calorific value of wood briquettes will increase. According to **Alpian (2000),** the good wood briquette charcoalis the one that shows the relatively small range of combustion remnant sranged about 0.67%-3.15% for the wooden briquette charcoal using starch adhesive.

Fixed Carbon Rate (%)

The average rate of fixed carbon rate on Milas wood briquette charcoal as in **Table 2**, the clamp pressure for 10 tons about 58.88% and for 15 tons about 58.80% also for 20 tons about 60.24%. The highest average rate of fixed carbon rate on Milas wood briquette charcoal is at the clamp pressure of 20 tons about 60.24% and the lowest is at the clamp pressure of 15 tons about 58.80% while the total average rate of fixed carbon is about 59.31% where the rate of the ash content is less than the Indonesian National Standard (SNI) requirements about $\leq$ 60%.

Based on the analysis of variance, it shows the clamp pressure on fixed carbon does not differ significantly until 99% level. **Pari (1996)**, the amount of fixed carbon is caused by the volatile substance rate and ash content. If the volatile matters and the ash content is high, the briquette charcoal will contain low fixed carbon rate, and otherwise.

Hartono *et al* (1973) in **Alpian (2000),** the low rate of fixed carbon may be caused by the maximum temperature of charcoal processing is not high enough that there are much volatile matter still inside the charcoal. It will decrease the fixed carbon rate.

The influence of clamp pressure to the fixed carbon rate shows the size of the carbon is affected by the rate of volatile matter and ash content. The rate of volatile matters and ash content will result in high carbon rate. This low carbon rate will cause high calorific value on the produced wood briquette therefore the briquettes can be used as one of alternative fuel energy resources.

Calorific Value (kal/gr)

The average rate of calorific value on Milas wood briquette charcoal as in **Table 2**, the clamp pressure for 10 tons about 6500.06 cal/gr and for 15 tons about 6478.03 cal/gr, also for 20 tons about 6483.99 cal/gr. The highest average rate of calorific value rate on Milas wood briquette charcoal is at the clamp pressure of 10 tons about 6500.06 cal/gr and the lowest is at the clamp pressure of 15 tons about 6478.03 cal/gr while the total average rate of fixed carbon is about 6487.36 cal/gr where the rate of the calorific value matches the Indonesian National Standard (SNI) requirements about > 6000 cal/gr**. Sudradjat (1983)** in **Khairurrazak (1997),** briquette charcoal which has low moisture rate and ash content, then the calorific value is high enough.

Based on the analysis of variance, it shows the clamp pressure on calorific value does not differ significantly until 99% level. According to **Komaryati** and **Gusmailina (1994)** in **Alpian (2000),** the variation of calorific value is influenced by the lignin content and extractive substance. High lignin content will increase the heat value of the wood and also the influence of extractive content depends on easy or not the extractive substance burns. Thus, the size of the value is also influenced by the volatile matters and the fixed carbon rate. The higher the fixed carbon rate, the bigger the calorific value.

Charcoal Yield (%)

The data result of yield measurement on Milas wood charcoal is resulted by conducting accumulation method at the condition of wood moisture rate < 25% produced the yield of 25.17%. Considered from the lumber total weight was 151 kg turned into net 38 kg charcoal yield. The yield result of Milas wood charcoal obtains low rate. It is assumed that it may be caused of the factor of fire distribution was not perfectly done at combustion process and also the influence of the temperature and the environment were not stable while processing.

Friede *et al* (1978), charcoal yield which is obtained from the accumulation method is higher compared to the yield result by using *kiln retort*. **Hartoyo (1973)** said that the low rate of charcoal yield resulted was influenced by defective charcoal making process. **Pari *et al* (1996)** stated that the influence of specific gravity tends to get higher and the yield type resulted also gets higher, consequently.

CONCLUSION AND SUGGESTION

The highest average of density rate on Milas wood briquette charcoal is at the clamp pressure of 20 tons about 0.90 gr/cm^3 and the lowest is at the clamp pressure of 10 tons about 0.85 gr/cm^3 while the total average rate of density is about 0,87 gr/cm^3 where the density rate matches the Indonesian National Standard (SNI) requirements.

The highest average of pressure strength on Milas wood briquette charcoal is at the clamp pressure of 10 tons about 41.12 kg/cm^2 and the lowest is at the clamp pressure of 15 tons about 36.16 kr/cm^2 while the total average rate of pressure strength is about 38.58 kg/cm^2 where the pressure strength rate matches the Indonesian National Standard (SNI) requirements.

The highest average of moisture content on Milas wood briquette charcoal is at the clamp pressure of 20 tons about 5,43% and the lowest is at the clamp pressure of 10 tons about 4.13%, while the total average rate of moisture content is about 4,86%, where the moisture content rate matches the Indonesian National Standard (SNI) requirements.

The highest average of volatile matter on Milas wood briquette charcoal is at the clamp pressure of 10 tons about 37.01% and the lowest is at the clamp pressure of 20 tons about 35.63 %, while the total average rate of volatile matter is about 36.56%, where volatile matter rate has not yet matched the Indonesian National Standard (SNI) requirements.

The highest average of ash content on Milas wood briquette charcoal is at the clamp pressure of 15 tons about 4.15% and the lowest is at the clamp pressure of 10 tons about 4.10%, while the total average rate of ash content is about 4.13%, where ash content rate matched the Indonesian National Standard (SNI) requirements.

The highest average of fixed carbon on Milas wood briquette charcoal is at the clamp pressure of 20 tons about 60.24% and the lowest is at the clamp pressure of 15 tons about 58.80%, while the total average rate of fixed carbon is about 59.31%, where fixed carbon rate has not matched the Indonesian National Standard (SNI) requirements.

The highest average of calorific value on Milas wood briquette charcoal is at the clamp pressure of 10 tons about 6500.06 cal/gr and the lowest is at the clamp pressure of 15 tons about 6478.03 cal/gr, while the total average rate of calorific value is about 6487.36 kal/gr, where calorific value rate compatible the Indonesian National Standard (SNI) requirements.

The yield result of Milas wood charcoal is about 25.17% from initial total weight of 151 kg to charcoal netto of 38 kg.

It is important to consider good maintenance and preservation by regional government toward Milas wood type. To obtain better quality of briquette charcoal, the molding system and the charcoal making process must be carefully considered.The tested Milas wood briquette charcoal has excellent potentiality as alternative fuel resources for household and small industries, therefore it is essential to apply appropriate technology for being used by public.

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