CHARCOAL BRIQUETTES FROM SOLID WASTE OF CRUDEPALM OIL PRODUCTION AS AN ALTERNATIVE ENERGY

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Abstract. This experiment have purposes for producing solid waste briquettes from the production of Crude Palm Oil, determining optimum condition from the composition and temperature of carbonzation, with the specifications such as moisture content, ash content, volatile matter, fixed carbon, and calorific value. Methods for this experiment are variations of carbonization temperature from 400^{o}C, 500^{o}C, 600^{o}C, 700^{o}C until 800^{o}C and variations of tapioca adhesion's composition from 7,5,12, until 14. The steps for producing briquettes are preparing material, analyzing material, and analyzing product. The result of experiment shows that briquette with carbonization temperature at 800^{o}C with comparison of solid waste material and tapioca adhesion at 88:12 has optimum moisture content, ash content, and calorific value (7569.21 cal/g). 800^{o}C is optimum temperature which is used to produce briquette with best quality fulfill SNI (Indonesian Standard) . The using of more adhesion will affect to the increasing of briquette's ash content. However, the using of less adhesion will affect to the increasing of briquette's volatile matter.

Keywords : briquette, carbonzation , calorific value, solid waste, volatile matter

I. INTRODUCTION

Charcoal briquettes is one of fuel has long been known in Indonesia, but this time the fuel consumption is not so optimal performance, this is due to not socialized charcoal briquettes in the life of the wider community. Charcoal briquettes are very good to be used in addition to cheap, does not pollute the environment and have a very high heat insulation value [11]. The results of the palm oil processing (solid waste) is a new way to get charcoal briquettes where the waste has only removed without thought of the benefits from the waste. In addition to the charcoal briquettes is a fuel without the smoke, so that the fuel is very good for the environment. Solid fuel is very effective and efficient when compared with other fuel, because the content of volatile matter isquite low so that the smoke that inflicted on its use will not interfere with the comfort of this type of fuel users.

Industry of Palm oil processing CPO (*Crude Palm Oil*) produce several kinds of side products (waste) that one of them is in the form of solid waste in the form of sludge that is often called the *solid.* That waste blackish brown and contains elements of chemical compounds which is a fraction of the main compounds forming the briquette. Solid waste palm oil processing result in South Sumatra is the largest waste products produced CPO industry. But the value of the utilization of this waste as fertilizer is not running properly, so that the solid waste is only allowed in the open environment and can cause environmental pollution. To increase the value of the benefits from the solid waste is then required further processing. One of which is implemented by making solid waste as fuel. To get briquette charcoal that meet the standard SNI (Indonesian Standard) and the value of the heat insulation high enough, then we must do the burning with perfect so that the process of carbonization. In the process of the above carbonization is closely related with temperature or the temperature of the mixture from burning and variation of the composition of the waste. The temperature variations that used is 300-800^{o}C [12], where temperature variations are able to produce charcoal briquettes that have the calorificvalue high enough, so also with the value of yield and ash content.

Turning point from the explanation above, so is necessary to do research on the making of briquettes with take advantage of solid waste (sludge/solid) from decanterunit Palm Oil Processing Plant in South Sumatra. In this case, it is expected that the solid waste can be enhanced the value of the benefits with processed into briquettes as an alternative energy fuel replacement. This

research was aimed at getting charcoal briquettes by utilizing the waste sludge decanter unit palm oil processing result as replacement alternative fuel energy fullfill the standard SNI also determine calorific value, percentage of yield, moisture content, ash and calorific value from charcoal briquettes produced.

II. RESEARCH METHOD

The method used in the process of making some briquette from the solid waste is using the method of the experiment using variations of temperature of carbonization and variations composition of adhesion material in the laboratory scale. Wake and Ruhendi define adhesive as a capable of uniting objects of this type or not a kind of through a bond or touch the surface and made the package having the nature of resistant to efforts separation. The composition of solid waste and the type of adhesion also used to determine the contents of volatile matter and the calorific value. The calorific value which full fill the standard SNI is 5000 - 6000 kcal, this will be achieved when the temperature variations and the composition mixture is optimum. The variable of carbonization temperature used is 400^{o}C, 500^{o}C, 600^{o}C, 700^{o}C, 800^{o}C. And variation composition of a mixture of raw material that is used is 92.5% solid waste, 7.5% tapioca; 98% solidwaste, 12% tapioca, and 96% of solidwaste, 14% tapioca. This research was done by the method of analysis of raw materials and products that includes analysis of yield, moisture content, ash, volatile matter, fixed carbon and calorific value.

Analysisdata used the method of tabulation and analysis regressionby graph. Analysis results obtained the yield content, moisture content, ash and calorific value from charcoal briquettes that full fill the standard.

A. Materials and Tools

Solid waste Decanter Unit, Tapioca, Oxygen,*Aquadest*,*Furnace*,Analytically Balance, Oven,Crusible, Porcelain,Stopwatch,Thermometer 250 ^{o}C,Adiabatic Bomb Calorimeter (IKA C-4000)

B. Design of the Experiment

The preparation of the raw material includes the provision of solid waste materials decanter unit, then do the drying, size reduction and carbonization, which aims to prepare the raw material that will be used in order to obtained a good briquette products. The raw material drying the solid waste is dried at a temperature ± 150^{o}C for 6 hours which aims to eliminate free moisture which is contained in the solid waste decanter *unit*. Solid waste at the time will be dried and printed first in order to make it easier when drying. After dry, raw material is relatively large did the size reduction so that later obtained the size of the raw material is smaller/smooth. Size reduction of this is done by using the appliance splitters *crusher*. Carbonization process aims to reduce the *volatile matter* and increase *fixed carbon*, so that obtained semi-coke (*coalite*) in the form of a black solid and free of pollution (not smoky and odorless). Carbonization raw material is done by using the temperature variable 400^{o}C, 500^{o}C, 600^{o}C, 700^{o}C, 800^{o}C and each for 0,5 hours.

III. RESULT and DISCUSSION

A. Analysis ofMoisture Content on the Briquette

In the figure 1, briquette with temperature of carbonization 800^{o}C with the composition 92.5% : 7.5%, 88% : 12% and 86% : 14% that each of the moisture content is 7.12%, 7.47% and 7.27% has full fill the standard. In carbonization temperatures briquettes 400^{o}C that full fill the briquettes standards that is briquette with the composition of the 86% : 14% moisture content is 7.27%. From the four briquette it the most optimal is carbonization temperature briquettes 800^{o}C, with composition 92.5% : 7.5%. Whileon the briquettes with the composition and other carbonization temperatures have not full fill the standard briquette moisture content because it still too high up to reach 12.96% on the briquettes with the composition 86% : 14% on temperature 800^{o}C.

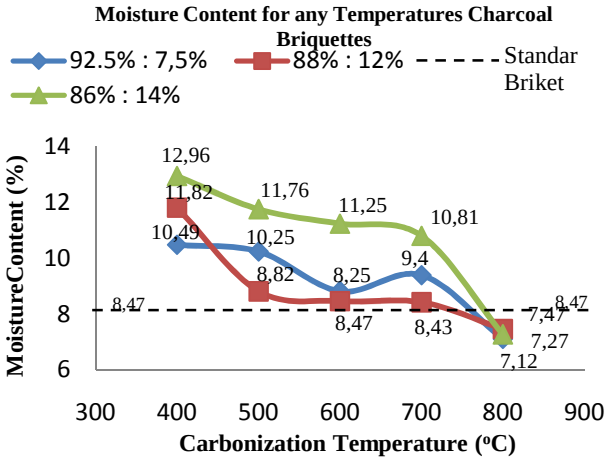

Fig 1. Graph relation of variations of carbonization temperatures and moisture content on the briquettes

Overall the produced briquettes hasmoisture content on each of the composition quite low. If seen from the standard briquettes produced [12], which produce charcoal briquettes with moisture content 8.47% to briquettes from the shell oil palm plantations and 9.77% from Empty Bunch of Palm Oil(TKKS) briquette,the briquette produced in this research has been in according with charcoal briquette standards. Especially at a carbonization temperature briquettes 600^{o}C, 700^{o}C, and 800^{o}C with adhesive material composition 12% and 7,5%. Increasing the temperature of carbonization, then the moisture content decrease and also if the composition of the adhesive material raised, the moisture content will also increase. This is because if the carbonization temperature increasing, then free moisturecontainedin the early raw materials (solid waste) will be more evaporated, so that the *inherent* moisture contenton semi-coke obtained will be decreased and so do too. The composition of the tapioca added to the briquette is very influential ofmoisture content briquette.

B. Analysis of Ash Content on the Briquettes

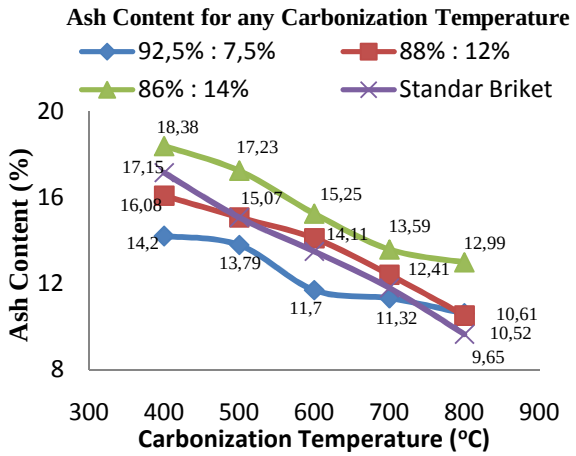

Fig 2. Graph relation of variations carbonization temperatures and ash content on the briquettes

On the graph above can be analyzed that overall briquettes produced have ash content that is full fill the briquette standards. The optimalbriquette containedfor the composition of 80% :12% at a temperature of carbonization 800°C is 10.52% and 500°C (15.07%). The lower ash content of briquette attemperature 700°C and 800°C because at least the mineralcontained in the briquette that can not be burned. During carbonization happened, mineral components such as sulfur,some alkali and water hydration,drop out with the volatile matter. While on the briquette with low temperature of carbonization (400°C) minerals that are found in the raw material cannot be drop out with maximum at this temperature,minerals and other alkali compounds not burned perfectly. This shows that the adhesive material is influential for ash content on the briquette.

C. Analysisof Volatile Matter on the Briquettes

Analysis of volatile matter on synthesis briquette can be shown in the figure 3.

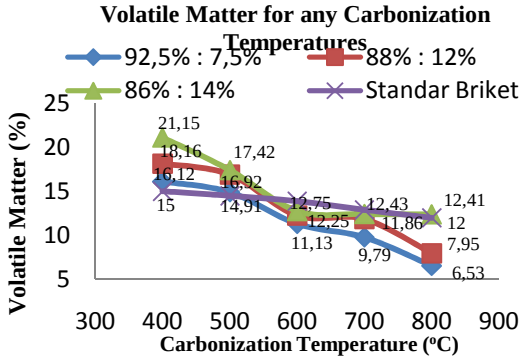

Fig 3. Graph relation of carbonization temperatures and volatile matter on the briquettes

From the figure3, the graphic that shows the influence of carbonization temperature and composition briquette concerningvolatile matter on the briquette. From the graph can be known that there are two types of the briquette has full fill the standard volatile matter of the briquette. At acarbonization temperature briquettes 500°C composition 92.5% :7.5% have volatile matter 14.91%, briquettes at the carbonization temperature 600°C composition 88% : 12%; and 86% : 14%, each volatile matter 12.25% and 12.75%, briquettes at the carbonization temperature 700°C composition 88% : 12% have volatile matter 11,86%, and briquettes at the carbonization temperature 800°C composition 14% tapioca contained 12.41%. This fifth briquette has fullfill the standard volatile matter for coal briquettes that have the volatile matter ranges from 12%-15%. But the most optimum is carbonization temperature briquettes 600°C with composition 14% tapioca, because the proportion of the volatile matter is not too high and not too low. The briquette has the highest volatile matter contain there on the briquette with carbonization temperature 400°C composition 86% : 14%. While the briquette with the lowest volatile matter found on carbonization temperature 800°C composition 92,5% : 7.5%.

In addition, adding ingredients like adhesive material also affects the biggest of the volatile matter content. The moreingredients of adhesive is used then the volatile matter content will also increase. This was influenced by the content that is found in the tapioca as phosphor, carbohydrates, calcium, vitamin C and protein can increase the volatile matter content.

D. The Influence of Variationsthe CarbonizationTemperatureandFixed Carbon of Composition Raw Material Mixture on the Briquettes

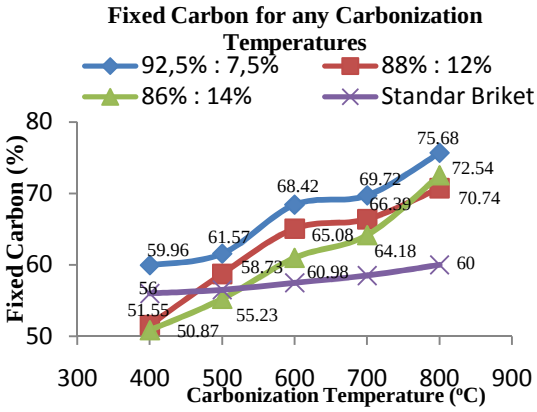

Fig 4. Graph relation of variations of carbonization temperature and content of fixed carbon on the briquette product

From the figure 4 can be known that the briquettes produced from solid waste materials decanter unit with a different carbonization temperature produced fixedcarbon is high. From the lowest temperature carbonization until the highest level of carbonizationfixed carbon content that produced very high. According to the standard of the briquettes produced [12], fixed carbon on charcoal briquettes from the bunches palm oil is 53.82% and briquettes from the shell oil palm plantations is 69.25%. On the briquette

research from the solid waste is produced some briquette composition according to the standards of briquettes with a carbonization temperature 500^{o}C composition 92.5% : 7.5%, 600^{o}C and 700^{o}C. While some briquette with carbonization temperature 800^{o}C has the highest carbon level on the composition of 92.5% : 7.5%is 75.68%. The lowest fixed carbon content that obtained at the briquettes with carbonization temperature 400^{o}C with the composition 86% : 14% is 50.87%.

The data above shows that the higher the carbonization temperature then will be more fixed carbon content to be found. This happened because with the high temperature then *volatile matter* content is missing or removed will be more, so that the fixed carbon content is increasing again. So also on the contrary if the carbonization temperature low then the volatile matter there on raw materials only despite some or a little, so that the fixed carbon briquettes to be exact will decrease but the *volatile matter*content increased.

E. Analysis of Calorific value on the Briquette

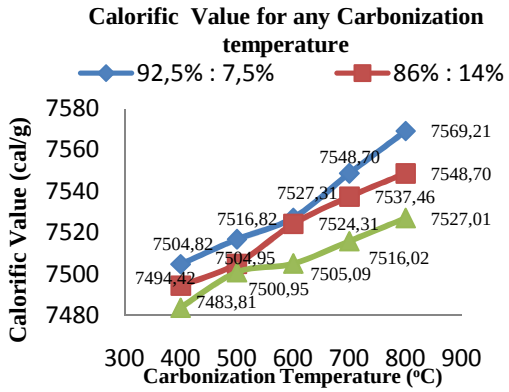

Fig5. Graph relation ofcalorific value and carbonization temperatureon the Briquette Products.

From the results of the analysis of the calorific value on the figure5, it is known that the value of the calorific valuebriquettes will increase along the increase carbonization temperature. The highest of calorific valueon the briquettes with the composition 92.5% : 7.5% at a temperature of 800 ^{o}C. The composition of tapioca that not too many affect the increase in the calorific value of briquette. But some briquette with the composition of the 88% : 12% indicate increased the calorific value which is not acute. On the briquette standards produced [12] the calorific value obtained from charcoal briquettes Empty Bunches Of Palm Oil(TKKS)is 5.578 cal/g and charcoal briquettes from the shell oil palm plantations 6.600 cal/g. While some briquette produced from solid waste on this research obtained thecalorific value> 7483 cal/g, so this shows some briquette from the solid waste produces the calorific value which is better.

IV. CONCLUSION

From this research can be concluded as follows :

In the process of the utilization of solid waste units to made some charcoal briquette obtained some of the briquette full fill the standard of charcoal briquettes, that is briquette with optimum moisture content acquired at a carbonization temperature 800^{o}C with the composition 92.5% : 7.5% with the moisture content 7,12%, lowest ash content obtained at the temperature 800^{o}C, composition 88% : 12% is 10.52%, the volatile matter contentdecrease with rising carbonization temperatures, fixed carbon achieved increased with the rise in carbonization temperature and thecalorific value produced hasfullfill the standard because the average above 6300 cal/g. The briquette produced from several different carbonization temperature are 400^{o}C, 500^{o}C, 600^{o}C, 700^{o}C, and 800^{o}C has different characteristics, from the analysis that has done obtained that the overall carbonization temperature briquettes 800^{o}C produced briquettes with the optimum quality, that the lowest moisture content (7.12%), the lowest of ash content (up 10.52), the highest fixed carbon (70.68%) and thehighestcalorific value(7569.21 cal/g). But the volatile matter too low that affect the quality of the briquette.

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REFERENCES

[1] Anang Aliansyah. 1984. *Pembuatan dan Kegunaan Briket Arang*. Balai Penelitian dan Pengembangan Industri Banjar Baru.

[2] Anonim. 1999.*Mutu dan Cara Uji Briket Arang Standard Industri Indonesia (SII) 0250-89*. Departemen Perindustrian, Jakarta.

[3] Archie, W, Culp. Jr. 1991. *Prinsip-prinsip Konversi Energi*. Erlangga, Jakarta.

[4] Cheremisinoff, P.N and I. Ellerbusch. 1998.*Carbon Adsortion Handbook*. Arbor Science Publisher Co, Inc, Michigan, USA.

[5] Fadarina, 2002. *Briket Arang dari Batubara Antracite*. Laporan Penelitian Politeknik Negeri Sriwijaya, Palembang.

[6] Hassler J.W.1974.*Purification With Activated Carbon Industri Commercial Enviromental*. Chemical Publishing, Co, Inc, New York.

[7] Heyne. 1978.*Tambahan Berguna Indonesia, Jilid II dan III*. Jakarta: Penerbit Yayasan Sarna Wanajaya

[8] Jovri, Iskandar. 1986. *Laporan Penelitian Briket Arang dari Batubara*. Teknik Kimia Universitas Sriwijaya, Palembang.

[9] Julius Bria Sera, 1990. *Bioarang Untuk Memasak*. Liberty, Yogjakarta.

[10] Soeyanto, T. 1982. *Cara membuat Sampah Menjadi Arang dan Kompos*. Jakarta: Yudhistira..

[11] Sudarmadji, Masrur Sidik. 1993. *Memacu Prospektif Briket Batubara di Sumsel dalam Rangka Penghematan Bahan Baku Minyak dan Penyelamatan Hutan*. Seminar Lingkungan Hidup. Palembang.

[12] Syahrul, E. 2004.Thesis.*Kajian Pembuatan Arang Aktif dari Batubara Antrasite Dengan Aktivator Secara Kimia dan Fisika*.ITB, Bandung.