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Beneficiation of canary shell as a mixture of coal briquette

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Abstract. Now days, renewable energy is always being the interest thing to be studied, one of the examples of friendly environment renewable energy is briquette. In this study canary shell and coal were being the main materials for briquetting that would be made because canary shell assessed has high calorific value and not much cultivated and suitable to combine with coal to increase the calorific value, thus the beneficiation of canary shell as a mixture of coal briquette is being the purpose of this study. Research methods of this study were coal and canary shell carbonation grinded being the size 28 mesh, 65 mesh and 80 mesh, then conducted briquetting process with the starch and water as glue with the composition 125 gr: 25 gr: 50 ml and every size consist of four kinds of briquettes that are 100% canary shell, 100% coal, 50% canary: 50% coal and 75% canary: 25% coal. Those samples were analyzed the proximate contents, sulfur content and calorific value to find their quality. The result of this study shows that on proximate analysis, the concentrations of moisture, ash, volatile matter and fixed carbon of briquettes are varies greatly while on total sulfur analysis, the highest concentrations are dominated by 100% coal and the lowest are 100% canary in all sizes. Meanwhile on the calorific analysis, the briquettes with the size 65 mesh in all compositions are having higher concentrations than size 28 and 80 mesh which is from four kinds of those briquettes, the highest calorific value is 100% canary with a concentration is 6354 cal/gr and the lowest is 100% coal with a concentration is 5539 cal/gr) while for the mixing of canary and coal 50:50% is 6020 cal/gr and 75:25% is 6096 cal/gr.

1. Introduction

Fossil fuels are currently the mainstay of human fuels in meeting the needs of daily life. Fossil fuels in the form of oil, gas, coal and oil shale have been utilized in various countries. Solid fossil fuels that are currently widely used are coal and oil shale. Research related to the characterization and utilization of coal in Indonesia has been carried out by many researchers, including [1,2]. Likewise for oil shale in Indonesia, research on characterization and utilization has been carried out by several researchers [3,4].

Coal is one of the energy that mostly used by humankind together with petroleum and natural gases. Beside the easiness to find coal in nature with the huge reserve, coal also easier to be mined than petroleum and natural gases. Although coal has big enough reserve, but it categorized as non-renewable energy, which mean one day the reserve of coal will decrease due to the necessity of energy that always increase annually.

Coal is an organic sedimentary rock that contains varying amounts of carbon, hydrogen, nitrogen, oxygen, and sulfur as well as trace amounts of other elements, including mineral matter [5,6].



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Regarding of handbook and energy and economic statistic of Indonesia 2018, the reserve of coal in Indonesia is around 24,239.96 million ton and estimated will be end around 76 years anymore. This data will increase or decrease depends on the finding new reserve or the using of coal overly. Thus, right know many researchers around the world try to minimize the utilizing nonrenewable energy and to look new renewable energy for saving the energy and create friendly environment energy. Furthermore, this research focused for looking new alternative energy that can be replacing the using of coal for example canary shell.

Canary is the plant that not much cultivated yet and canary is the endemic plant of Indonesia that spreads in East Indonesia. Morphology, canary shell consists of the peel (exocarp), the pulp (mesocarp) and the shell and the fill (endocarp). In the exocarp and mesocarp parts, the canary has different thick depend on it species. In the endocarp part, commonly called as nut-in-shell (NIS), consists of shell and seed that covered by epidermis. The shell dominantly used as fuel [7].

According to the international ISObr 17225 STANDARD, solid biofuels, fuel specifications and classes, a briquette is a "densified biofuel made with or without additives, having a cubic, prismatic or cylindrical shape, with a 25 mm diameter, produced from woody biomass compression or crushed herb." Briquettes are made of combustible material obtained from agricultural, forestry waste, or coal dust [8]. Furthermore, the combining of coal and canary shell become briquette and the finding of calorific value in different grain of briquette were being the purposes in this study.

2. Methods

In this study, canary shell was carbonated first. In carbonating process, the canary shell was burned in steal bowl until the canary being carbon and closed until there was not smoke exited from the bucket as long as 24 hours. Then, the canary shell comminuted gathering with coal.



Figure 1. (a) Canary, (b) Canary shell, (c) Canary shell carbonation, (d) Coal.

In comminuting process, there are four comminuting machines that used. those were Jaw Crusher, Double Crusher, Ball Mill and Screening Vibrator. In Screening process, every material was separated in 28, 65 and 80 mesh. After comminuting process, every material with different size is briquetted by briquetting machine with the composition 100% canary, 100% coal, the mixture 50% canary and 50% coal and the mixture 75% canary and 25% coal.

Every briquette was added starch and water as glue with the composition 125 gr : 25 gr : 50 ml, while the shape of briquette was shaping cylindrical with diameter 25 mm and high 50 mm. After briquetting process, the briquettes were dried on the sunlight for 6 hours, and then they were analyzed in laboratory to know the quality.

In laboratory, the briquettes were analyzed to determine proximate data that consists of moisture content, ash content, volatile matter and fixed carbon. While the other contents that analyzed are sulfur content by furnace total sulfur and calorific content by bomb calorimeter.

Analyses reported on a dry basis are calculated on the basis that there is no moisture associated with the sample. The moisture value is used for converting as determined data to the dry basis. Analytical data that are reported on a dry, ash-free basis are calculated on the assumption that there is no moisture or mineral matter associated with the sample. The values obtained for moisture, determination, and ash determination are used for the conversion. finally, data calculated on an equilibrium moisture basis are calculated to the moisture level determined as the equilibrium (capacity) moisture.

3. Results and Discussions

3.1. Result

In this study, the result of analysis showed in Table 1, consists of proximate analysis (moisture content, ash content, volatile matter and fixed carbon), sulfur analysis and calorific value analysis of 12 briquettes samples, one coal sample, one canary shell sample and one canary shell carbonation sample. Figure 2 shows briquettes with different grain size and composition, Figure 3 shows the effect of briquetting on the proximate analysis while Figure 4 shows the effect of the briquetting on the sulfur content and Figure 5 shows the effect of the briquetting on the calorific value.



Figure 2. Briquettes of 28, 65 and 80 mesh in different composition.

Table 1. Result of calorific value analysis

Type of Materials	Proximate Analysis				Total Sulfur (%)	Calorific (cal/gr)
	Moisture Content (%)	Ash Content (%)	Volatile matter (%)	Fix Carbon (%)		
Coal	13.32	1.30	44.83	39.95	0.080	6214
Canary	8.19	1.06	21.05	69.68	0.026	4387
Canary shell carbonation	1.92	3.83	27.79	66.46	0.016	6790
Canary (100%)	5.10	1.49	29.63	63.78	0.017	5420
Briquette Coal (100%)	11.05	1.51	46.98	40.46	0.079	5846
28 Mesh Coal & Canary (50:50)	7.35	1.51	35.65	55.49	0.039	5731
Coal & Canary (75:25)	6.66	1.52	40.36	51.46	0.052	5561
Canary (100%)	5.50	3.92	26.36	64.22	0.019	6354
Briquette Coal (100%)	16.70	3.29	43.18	36.83	0.074	5539
65 Mesh Coal & Canary (50:50)	9.22	2.57	32.68	55.53	0.026	6020
Coal & Canary (75:25)	6.98	1.69	39.85	51.48	0.048	6096
Briquette Canary (100%)	5.74	2.35	27.59	64.32	0.018	6308

80 Mesh	Coal (100%)	12.71	1.37	44.96	40.96	0.083	5814
	Coal & Canary (50:50)	10.39	1.96	34.96	52.70	0.032	5984
	Coal & Canary (75:25)	13.00	2.40	37.65	46.95	0.040	5716

3.2. Discussion

3.2.1. Effect of proximate analysis of the briquettes. On moisture content, 100% coal briquettes in all size are having high concentration values that range from 11.5% to 16.70 %. They may be due to congenital moisture of coal deposit and also due to the adding glue that consist of starch and water in the briquettes. while the moisture content of 100% canary briquettes of all size are relatively low, they happen due to carbonating process which reduce a moisture content of canary shell significantly with the concentrations are 5.10% in mesh 28, 5.50% in mesh 65 and 5.74% in mesh 80. On the compound of canary and coal briquette in all size with the briquettes ratio 50:50% and 75:25% are relatively medium between pure canary and coal briquettes, yet on mesh 80 the concentration of those moisture are higher than another mesh. Moisture content is one of the most important think in measure the quality of briquette, the more percentage of moisture content of briquette, the more negative impact that will be happened to the quality of briquette.

On Ash content, the highest concentration generally happen to briquettes in size 65 mesh that range from 1.69 to 3.92%. while on briquettes with the grain size 28 mesh, the concentration are relatively low that range from 1.49 to 1.52% and on briquettes in size 80 mesh, the concentration are range from 1.38 to 2.80. Ash content is one of important parameter in determining the quality of briquette because on burning process, the more ash concentration, the lower heat that obtained.

In the Figure 3, the concentrations of fixed carbon of 100% canary briquettes of all size are higher than other briquettes that are 63.78% on 28 mesh, 64.22% on 65 mesh and 64.32 %. The characteristic of canary shell that really massive and structure of canary shell that very hard makes those fixed carbon values are relative high. While the mixing of canary and coal briquettes in all sizes and ratios are relatively lower than 100% canary briquette but higher than all sizes of 100% coal briquettes. Fixed carbon is a measure of solid combustible material in solid fuel after the expulsion of volatile matter; its content is as an estimate of the amount of coke that will obtained on carbonization.

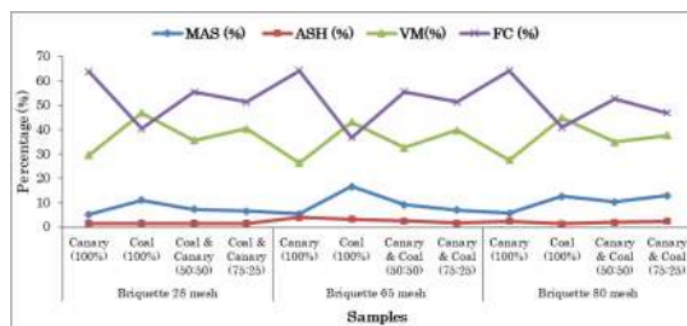


Figure 3. The effect of proximate analysis of the briquettes.

In Figure 3, volatile matter values of briquettes show that the concentration of 100% coal briquettes in all sizes are relatively high and 100% canary briquette in all size are relatively low. While the concentrations of canary and coal combinations are relatively medium. But if compared with all mixture either in ratio 50:50% or 75:25%, the lowest concentration is 32.68% with the ratio 50:50 % of 65 mesh and the highest is 40.36% with the ratio 75:25% of 28 mesh. In the volatile matter values, the percentage of concentration is inversely proportional with the fixed carbon concentration, which is

the higher concentration of fixed carbon, the lower concentration of volatile matter. The briquettes with the high volatile matter will produce more smokes. Hence the good briquette is produce less smoke.

3.2.2. Effect of briquetting on the Sulfur Content. In the Figure 4, the sulfur content shows that all kinds of 100% canary briquettes have low concentration that range from 0.017 to 0.019 and all kind of 100% coal briquettes have high concentration that range from 0.074 to 0.083. while the mixing briquettes in all size and ratio, the lowest sulfur content is coal and canary 50:50% of 65 mesh with the concentration is 0.026% and the highest sulfur is coal and canary 75:25% of mesh 28 with the concentration is 0.052%. Sulfur is one of the most important things in determining the quality of briquette due to it produces acids of sulfur dioxide and sulfur trioxide that corrodes combustion equipment and also cause the pollution.

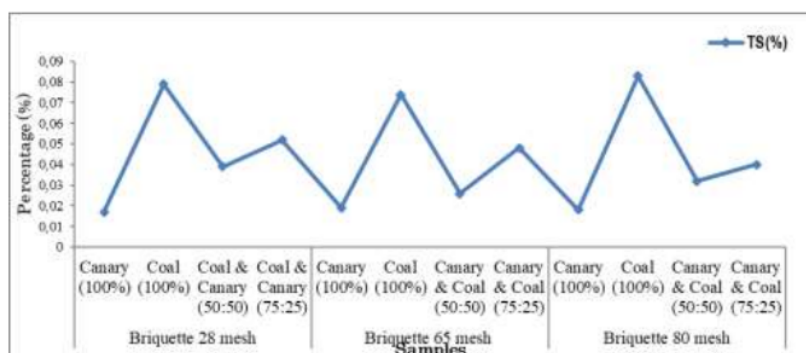


Figure 4. Effect of the briquetting on the sulfur content.

3.2.3. Effect of Briquetting on The Calorific Value. In Figure 5, the calorific value shows that the highest concentration is 100% canary of mesh 65 while the lowest is canary 100% of mesh 28. These happened may be due to carbonating process which is some samples can't be carbonated well. Thus, when screening process, those materials bated on screener mesh 28. If compared with coal, the canary shell briquette has calorific value higher which equal with range sub-bituminous of coal. It happen due to the structure of canary shell is really hard and compact thus has high calorific values. On the mixing coal and canary briquette of all size, the highest calorific value is on coal and canary 75:25% of mesh 65 that is 6096 cal/gr and the lowest is on the canary and coal 75:25% of mesh 28 that is 5561 cal/gr. Compared in all size of briquettes, the briquettes with mesh 65 size are having good composition because almost all kinds of briquette have high calorific. while the mixing canary and coal briquettes show positive impact on coal because by adding the canary shell matter, the calorific value of coal is enhance significantly.

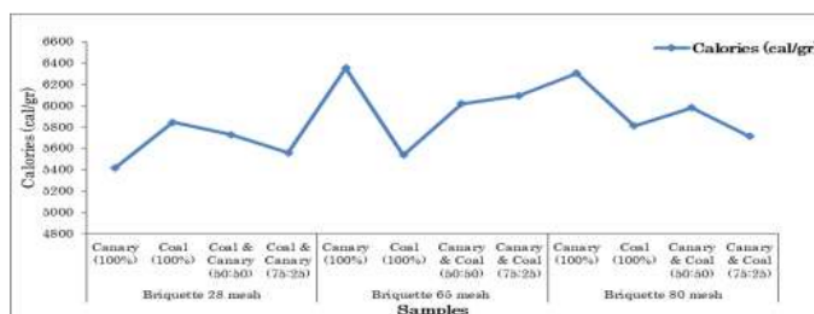


Figure 5. Effect of the briquetting on the calorific value.

4. Conclusion

On proximate analysis, the highest concentration of moisture content and volatile matter are dominated by coal briquettes 100% but contrary with fixed carbon which is the highest concentration are canary briquettes 100% and followed by combination canary and coal 75:50% and 50:50% while at the ash content the highest concentration are dominated by briquette in size 28 mesh in all size and the highest are in size 65 mesh. On the total sulfur analysis, the highest concentrations are dominated by coal 100% and the lowest are canary 100% in all size. Meanwhile on the calorific analysis, the briquettes with the size 65 mesh in all composition are having higher concentrations than size 28 and 80 mesh which is from four kinds of those briquettes, the highest calorific value is 100% canary with a concentration is 6354 cal/gr and the lowest is 100% coal with a concentration is 5539 cal/gr) while for the mixing of canary and coal 50:50% is 6020 cal/gr and 75:25% is 6096 cal/gr.

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