International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.12 No.03, pp 219-226, 2019

Combustion Properties of Briquette from Halaban (*vitex pubescens* vahl) Charcoal, Bottom Ash and Fly Ash

Ninis Hadi Haryanti[1*], Suryajaya[1], Sadang Husain[1], Henry Wardhana[2], Yulia Anggraini[1] and Nada Sofi[1]

[1]Physics Study Program FMIPA, Universitas Lambung Mangkurat, Banjarbaru, Indonesia, 70714
[2]Civil engineering Study Program FT, Universitas Lambung Mangkurat, Banjarbaru, Banjarbaru, Indonesia, 70714

Abstract : In this study, the combustion properties of briquette from halaban charcoal, bottom ash and fly ash has been carried out. For briquetting, the halaban charcoal and bottom ash was mixed in different composition, 100%: 0%, 90%: 10%, 80%: 20% and 70%: 30%. While for halaban charcoal and fly ash the composition ratio were 100%: 0%, 90%: 10%, 80%: 20%. The combustion properties of briquettes, the initial ignition time, duration of combustion and ignition rate, would be investigated. The results were 1.32-2.22 minutes,74-84 minutes and 0.22-0.34 g / minute, respectively. The data shows that the initial ignition time and duration of combustion would be longer while the burning rate would be faster when bottom ash and/or fly ash composition were increased.
Key words : ignition time, combustion duration, burning rate, halaban, composition.

1. Introduction

Along with the development of human life, the dependence on fossil fuels such as oil and gas were continuesly increased. The increased of energy needs that are not offset by its availability make the rise of fossil fuels price. While the source of fossil fuel itself were tended to decrease due to its nature. One of the energy alternatives to fossil fuels is briquettes. Briquettes are chosen because they are cheap and environmentally friendly. Briquettes could be produced in a simple process, have a very high calorific values, and the raw materials are readily-available [1].

In this work, briquettes would be made from waste of Halaban wood charcoal and coal ashes (bottom and fly ash). Charcoal fuel has many attractive features: low sulphur content, high carbon to ash ratio, relatively few and nonreactive inorganic impurities, specific pore structure with large surface area, good reduction ability, almost smokeless emissions, in addition, it is easy to store and handle [2, 3].

DOI= http://dx.doi.org/10.20902/IJCTR.2019.120328

In our previous work [4], calorific value for halaban charcoal was 6,833.1 cal/gr. It is very potential to use the charcoal waste as briquette material. The Halaban wood charcoal came from PT. Citra Prima Utama Banjarbaru, South Kalimantan. The Halaban charcoal waste at PT. Citra Prima Utama Banjarbaru reached ± 6 tons per day, which is obtained from the selection process for wood charcoal quality to be exported. The wood charcoal industry is located in Ranggang Village, Pelaihari, Tanah Laut Regency, South Kalimantan Province [5]. From his research, the best calorific value of briquette, about 5,109.97 cal/gr, was gotten when using composition 100% : 5% (charcoal waste : starch adhesive).

Bottom and fly ashes from coal combustion were obtained from steam power plant PLTU Asam-asam, Tanah Laut Regency. They would be used as a mixture in making briquettes. Fly and bottom ashes produced from the combustion process at the power plant were reaching 160 tons per day with the main composition of SiO_2, Al_2O_3, Fe_2O_3, CaO, MgO, alkali, and other materials [6, 7]. Research on bottom ash has been carried out containing coal compounds of $A1_2O_3$, CaO, MgO, MnO_2, SiO_2, and Fe_2O_3 by using filters 4, 8, 20, 60, 200 mesh [6].

Research conducted by Haryanti et al [8] on briquette from rubber shells and coal bottom ash. At different pressure the water contents, ash contents and calorific values obtained were in the range 4.35- 9.43%; 12.53- 12.94% and 3,597.59 - 4,549.88 cal/g, respectively. In our previous work, the characteristics of halaban charcoal, bottom ash and fly ash were investigated. The water contents were yield 4.22%; 1.64% and 0.9626% for halaban charcoal, bottom ash and fly ash, respectively [4]. The ash contents obtained were 41.93% for halaban wood charcoal, 82.03% for bottom ash and 89.69% for fly ash. The calorific values of halaban charcoal and bottom ash were yielded about 6,833.1 cal/g and 389.5 cal/g. While fly ash's calorific values were almost zero [9]. According to Anetiesia et al., bottom ash has a calorific value of 610 cal/g, water content of 2%, and ash content of 84% [10].

A research conducted by Anetiesia et al. used various composition of coconut shell charcoal and bottom ash while starch as much as 5% was used as a binder [10]. From the results, it was concluded that the best composition was a sample with a composition of 20% (bottom ash): 80% (coconut shell charcoal) because the sample is closed to the provisions of Indonesia National Standar (INS) No 01-6235-2000. From the results of research conducted by Haryanti, NH et al., halaban charcoal, bottom ash and fly ash could be used as a mixture in making briquettes. The percentage of material composition is suggested more in halaban charcoal [4].

The quality of briquette can be seen from its physical and chemical properties. Physically, there are several things that affect the quality of briquettes, namely the compressive strength, the duration of combustion and density. While the chemical analysis is also known as proximate and ultimate analysis [11]. Setyowati and Tirono conducted a study on the effect of pressing variations and material composition on the physical properties of charcoal briquettes. The results obtained were the most optimum briquettes with a composition of 100% coconut shell and pressures between 100-150 N / cm2 with test parameter values: density 0.634 gr / cm3, mechanical strength 43.167 N / cm2 and burning time 64.39 minutes [12].

The research of Haryanti, NH et al obtained the characteristics of briquettes from halaban charcoal and bottom ash such as water content (2,947-4,097)%, ash content (0,382-26,667)%, calorific value (4749,600-6621, 067) kal / g. While biobriquette of halaban charcoal mixed with fly ash obtained water content (3,907-4,304)%, ash content (0,382-17,387)%, Calorific Value (5283,933-6621,067) cal / gr [9]. It is necessary to conduct research to determine the quality of combustion of briquette from halaban charcoal waste, bottom ash and fly ash mixture. In this study, the quality of briquettes, made from halaban charcoal, bottom ash and fly ash, would be investigated, including the initial ignition time, combustion duration and the burning rate.

2. Materials and methods

The materials used were halaban charcoal from PT. Citra Prima Utama Banjarbaru, bottom and fly ashes from steam power plant PLTU Asam-Asam, starch and water. The combustion quality was carried out at Material Laboratory of FMIPA ULM. This research is a quantitative research. From previous works, the characteristics of halaban wood, bottom ash and fly ash were obtained as well as the characteristics of briquettes from the mixture.

For briquetting, the halaban charcoal was mixed with coal ashes, fly and bottom ashes, in different composition: 100:0, 90:10, 80:20 and 70:30. As binder, starch was used as much as 5 % of total weight. Quality combustion of briquettes observed was initial ignition time, combustion duration and burning rate.

a. Initial ignition time

It was done by burning briquettes using kerosene. The recording time was started when the briquette turned on and stopped when it becames the embers. Time measurement is done using a stopwatch.

b. Duration of combustion

Duration of combustion was done by burning briquettes using kerosene. Using stopwatch, the time was recorded when the briquette turned on until it runs out or becomes ashes.

c. Burning rate

The empty cup, lid and the mass of each briquette were weighed and the mass was recorded. Then the briquettes were burned to the point of exhaustion or ashes. The time was recorded. After that, the mass of each sample was re-weighed. These procedures were repeated three times. The burning rate would be calculated as equation (1)

$$\text{Ignition rate (g/menit)} = \frac{(M_2 - M_1) - (M_3 - M_1)}{t} \qquad \ldots\ldots\ldots\ldots \qquad (1)$$

where:

M_1 : weight of empty cup + lid (gr)
M_2 : weight of cup, lid and sample before ignition (gr)
M_3 : weight of cup, lid and sample after ignition (gr)
t : burning time (min)

3. Results and Discussions

The combustion properties of briquettes were presented in Table 1 and Table 2 below.

Table 1

Sample	Initial Ignition time (min)	Initial ignition time (sec)	Duration of combustion (min)	Duration of combustion (sec)	Burning rate (g/menit)	Burning rate (g/sekon)
100% : 0%	1,32	79	74	4440	0,34	0,006
90% : 10%	2,02	121	79	4740	0,26	0,004
80% : 20%	2,13	128	80	4800	0,24	0,004
70% : 30%	2,22	133	84	5040	0,22	0,004

Table 2

Sample	Initial	Initial ignition	Duration of	Duration of	Burning rate	Burning rate

	Ignition time (min)	time (sec)	combustion (min)	combustion (sec)	(g/menit)	(g/sekon)
100% : 0%	1,32	79	74	4440	0,341	0,006
90% : 10%	2,2	132	77	4620	0,328	0,005
80% : 20%	2,52	151	84	5040	0,211	0,004

From Table 1 and Table 2, it can be seen that the fastest initial ignition time of briquettes was belong to 100% halaban charcoal composition, which has 1.32 minutes (or 79 second), combustion duration was about 74 minutes (4440 seconds), and the burning rate of briquette was 0.34 g / minute or 0.006 g / second.

The results of the initial ignition time of briquettes, made from the mixture of halaban charcoal, bottom ash and fly ash, are presented in Figure 1.

Figure 1 (a)

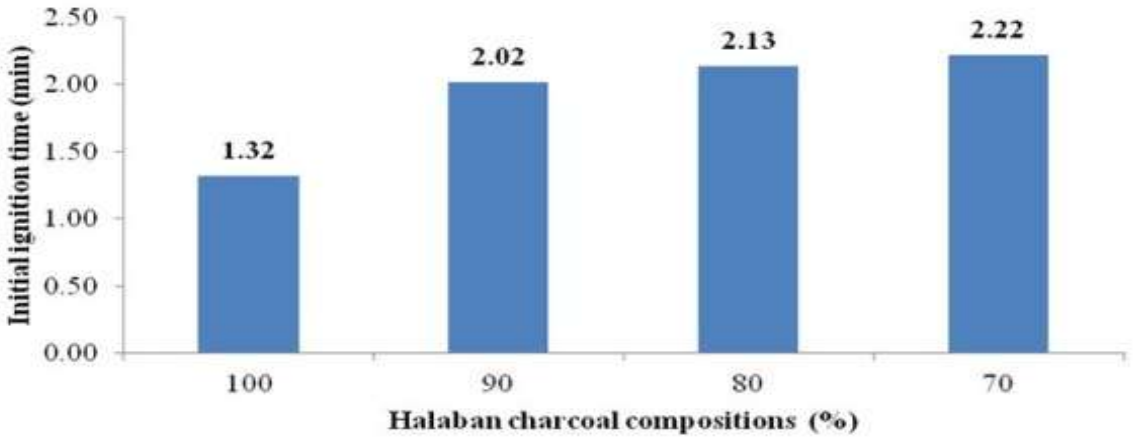
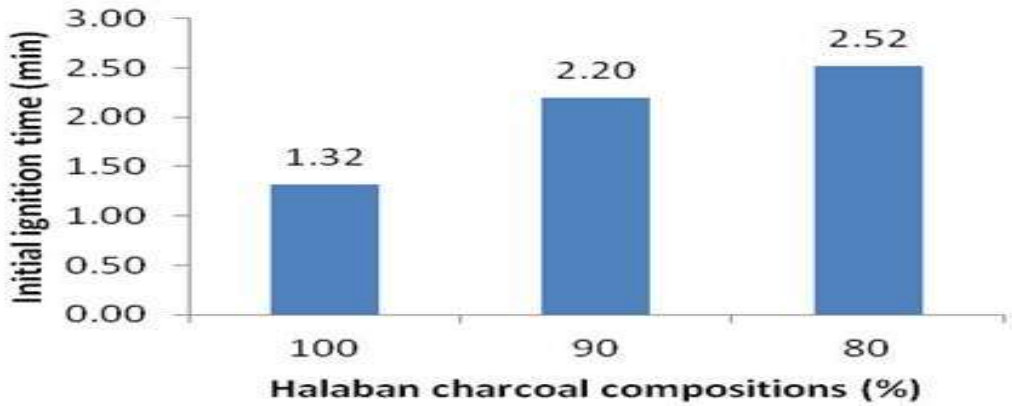


Figure 1 (b)



As can be seen in Figure 1 (a), the fastest initial ignition time briquette was 100% halaban charcoal briquette and the longest initial ignition time briquette was briquette with a composition of halaban charcoal 70% and 30% bottom ash. This is due to 100% halaban-bottom ash briquette has the highest calorific value, which was 6,621.067 cal / g [9], causing briquette burn more easily. On the other side the briquettes with halaban charcoal 70%: 30% bottom ash has the lowest heating value of 4,749.6 cal / g. If the bottom ash composition were increased, the initial ignition time becomes longer and the briquettes would be more difficult to be burn.

From Figure 1 (b), it can be seen that the initial ignition time of 100% halaban charcoal briquette was the fastest, which is 1.32 minutes (79 second). The slowest ignition time briquette was briquette with a mixture of 20% fly ash requiring 2.52 minutes (151 seconds). As the composition of fly ash increases, it was more difficult for briquette to be burn. The fast initial ignition time of briquettes is believed due to the low water content in the briquettes so as to facilitate ignition. Seen as a whole, the time needed to burn the briquette was good enough because it is quite short so it is not too difficult in the process of burning it on

In the research conducted by Nugraha et al., at the various pressure and composition of peat and palm fronds, the fastest initial ignition time for briquette was at composition 90%: 10% and pressure of 30 kg / cm2, which is 59.5 second and the longest was at composition 50%: 50% and pressure of 10 kg / cm2, which is 99 seconds or 1.65 minutes [13]. Therefore, when the composition of peat was increased, the ignition time would be longer.

The combustion duration of briquettes were presented in Figure 2 below.

Figure 2 (a)

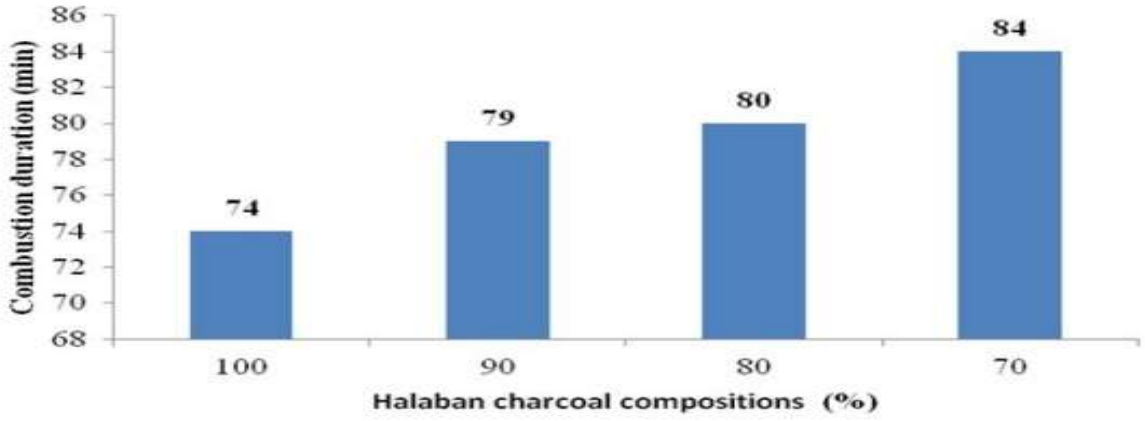
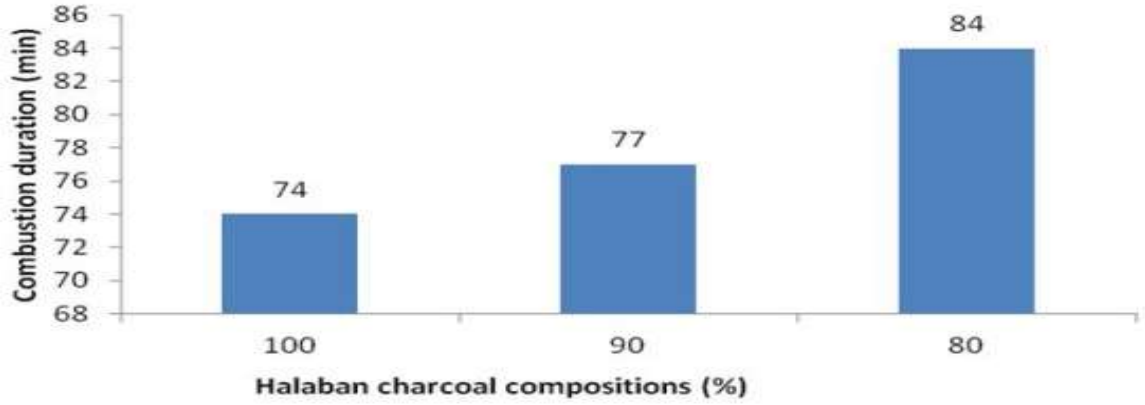


Figure 2 (b)



From Figure 2 (a). It can be seen that the increase in bottom ash composition make a longer combustion duration of briquettes. The fastest combustion duration was 74 minutes (4,440 s)for briquette with the composition of halaban charcoal and bottom ash 100%: 0%. And the longest was briquette with a composition of 70%: 30%, that is 84 minutes (5,040 s). It is believed cause by the ash content in the briquette. Composition 70%: 30% has the highest ash content which was 26.67% [9]. The ash content would block the ignition and cause a longer combustion duration.

From Figure 2 (b). 100% halaban charcoal briquette has the fastest burning duration of 74 minutes (4,440 second). Meanwhile, briquette with the longest burning duration was briquette with a composition of 20% fly ash mixture which was 84 minutes (5040 second). These results are in accordance with the highest density value that was also found in briquette with a mixture of 20% fly ash composition [9]. The longer the duration of combustion, then it is expected that the use of briquettes can be more efficient.

From the results of this study, it could be concluded that more fly ash in the mixture would make a longer of combustion duration of briquettes. This is caused by the briquettes is more packed. The fly ash particles were filled the empty space in the briquette. This is in line with Nugraha et al. [13], by adding more ashes, the combustion duration would be increased. The fastest combustion duration was at composition 90%: 10% which was 3718 s while the longest combustion duration was at composition 50%: 50% yielded 3123.5 s. Also Jamilatun's study [14] shows that briquettes from coconut shells gave flame to the ash, in 116.1 minutes. While the most rapidly burning coal are carbonized coal briquettes with a time of 60.57 minutes. Besides that the duration of briquette combustion is longer along with the addition of additional mixture composition in the form of peat. The higher of the density, the flow of air into the combustion of briquettes will decrease and slow down the burning of briquettes to ashes.

In Figure 3, the ignition rate of halaban-coal ashes briquettes were presented.

Figure 3 (a)

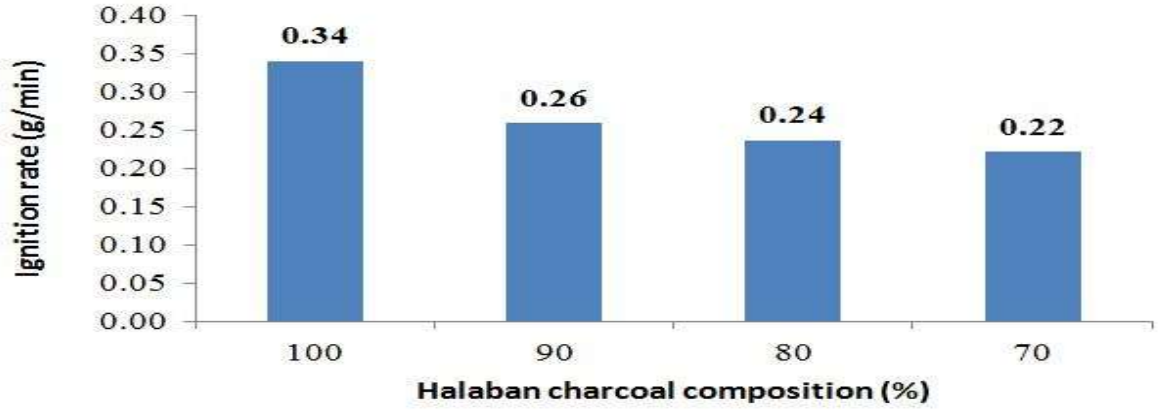
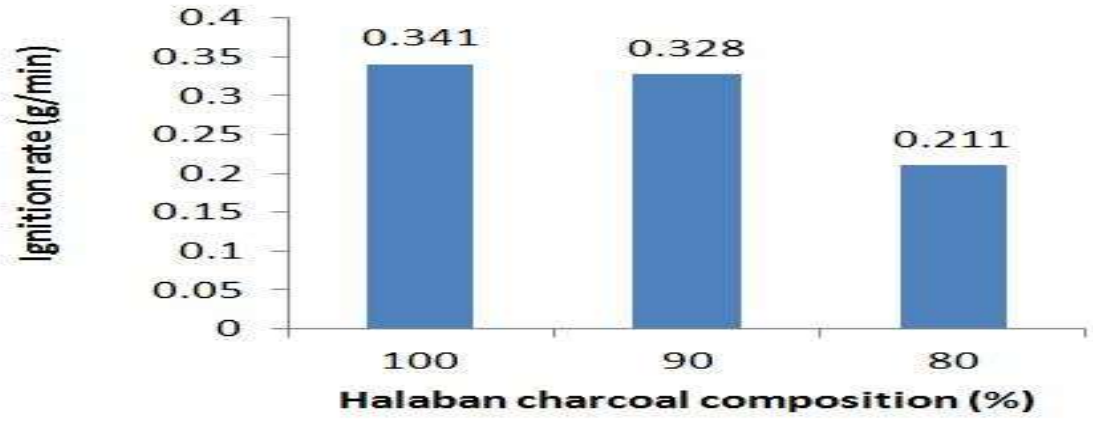


Figure 3 (b)



From Figure 3 (a). The more additions of bottom ash to the mixture, the smaller the ignition rate would become. It can be seen that the longest combustion speed was briquette with the composition of 100% halaban charcoal, which was 0.34 g / min and the greatest was briquette with a composition of 30% coal bottom ash, which was 0.22 g /minute.

In Figure 3 (b). 100% halaban charcoal briquette has the greatest ignition rate of 0.341 g / min. Meanwhile, briquette with the smallest ignition rate was briquette with a composition of 20% fly ash which was 0.211 g / min. It could be concluded, the more additions of fly ash to the mixture, the smaller igniton rate would become.

In line with Nugraha et al's study [13], the smallest ignition rate obtained was for briquette's composition 90%: 10%, which was 0.0028 g / s and the greatest was at composition 50%: 50%, which was 0.003 g / s. The more addition of peat added to the briquette mixture, the ignition rate of briquettes decrease.

4. Conclusions

Two type of briquette were made, halaban-fly ash and halaban-bottom ash briquettes. The combustion quality of halaban-bottom ash briquette, the initial ignition time, duration of combustion and ignition rate, were yields (1.32-2.22) minutes, (74-84) minutes and (0.22-0.34) g / minute, respectively. While the combustion quality of halaban-fly ash briquette, were yields (1.32-2.52) minutes, (74-84) minutes and (0.211-0.343) g / minute, respectively.

The effect of halaban charcoal, bottom ash and fly ash composition to the combustion quality of briquette is the initial ignition time and duration of combustion would be longer while the ignition rate would be faster when bottom ash and/or fly ash have a bigger portion.

Acknowledgement

Thank you to the ministries of research, technology and higher education and also Institute of research and community service Universitas Lambung Mangkurat for financial support.

References

1. K. A. Rafsanjani, S. Sarwono, R. D. Noriyanti, Study of potential utilization of biomass from organic waste as alternative fuel (briquette) in support of eco-campus in ITS Surabaya, Indonesian Journal Teknik Pomits, 1(1) (2012) 1–6.
2. M. J. Antal, M. Grønli, The art, science, and technology of charcoal production, Industrial Eng. Chemistry Res. 42(8) (2003) 1619-1640 doi: 10.1021/ie0207919.
3. W. Emrich, Handbook of charcoal making. The traditional and industrial methods. Solar Energy R&D in the European Community, Ser. E: Energy from Biomass 7, (1985) Springer Science+Business Media B.V
4. N. H. Haryanti, Suryajaya, H. Wardhana, Y. Anggraini, N. S. Andini, Characterization of Halaban wood charcoal (vitex pubescens vahl), bottom and fly ash as briquette mixture material. Proceeding UNNES Physics International Symposium in conjunction with 32nd National Seminar on Physics - Physical Society of Indonesia. Semarang May, 03, 2018.
5. M. F. Mahdie, Briquettes from charcoal waste from PT. Citra Prima Banjarbaru, Indonesian Jounal Tropical Forest. 10 (2010) 1-8.
6. H. Wardhana, N. H. Haryanti, Study of Bottom Ash as a Concrete Mixed Construction Material, Indonesian Jounal Info-Technique, Vol. 2 No.1 (2001) 39-41.
7. N. H. Haryanti, Investigation of Fly Ash from Asam Asam Power plant for Light Bricks Material, Indonesian Jounal FLUX ISSN 1829-796X. Vol. 11 no. 2 (2014) 127-137.
8. N. H. Haryanti, R. Noor, D.Aprilia, Characterization and emission of rubber shell and coal base briquettes, Proceeding physics education FKIP (2018), Universitas Lambung Mangkurat, Banjarbaru.
9. N. H. Haryanti, Suryajaya, H. Wardhana, S Husain, Y. Anggraini, N. Sofi, Characterization of briquette from halaban charcoal and coal combustion ashes IOP Conf. Series: Journal of Physics: Conf. Series1120 (2018) 012046 IOP Publishing doi:10.1088/1742-6596/1120/1/012046

10. S. E. Anetiesia, Syafrudin, B. Zaman, Briquettes from bottom ash and coconut shell charcoal as alternative energy sources, Thesis (2018) Universitas Diponegoro, Semarang.
11. A. P.T. Jupar, Analysis of the effect of Torrefaction method to the calorific value of biobriquette made from 75% cashew skin and 25% rice husk percentage of weight, Thesis (2013) Universitas Diponegoro, Semarang.
12. R. Setyowati, M. Tirono, Effect of pressure variations and composition of materials on the physical properties of charcoal briquettes, Indonesian journal Neutrino 7 (2014) 23-24.
13. A. Nugraha, A. Widodi, S. Wahyudi, Effect of pressure and percentage of peat and palm oil leaf mixture on characteristics of briquette burning, Indonesian Journal mechanical engineering 8 (2017) 29 – 36
14. S. Jamilatun, Quality of combustion of coconut shell briquettes, rice husk briquettes, coal briquettes and wood charcoal as alternative fuel, Indonesian journal Chemical companion paper. 2 (2011) 37-38.

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