

Analysis of the Quality of Mixed Coconut Shell Waste Briquettes with Various Biomass Additives as Alternative Fuels

(Analisis Kualitas Campuran Briket Limbah Tempurung Kelapa dengan Berbagai Aditif Biomassa Sebagai Bahan Bakar Alternatif)

Yusraida Khairani Dalimunthe^{1*}, Sugiarmo Kasmungin¹, Listiana Satiawati¹, Thariq Madani¹, Teuku Ananda Rizky¹

¹Petroleum Engineering Department, Universitas Trisakti, Indonesia

Abstract

The purpose of this study was to see the best quality of briquettes from the main ingredient of coconut shell waste with various biomass additives to see the calorific value, moisture content, ash content, and volatile matter content of the biomass mixture. Furthermore, further research will be carried out specifically to see the quality of briquettes from a mixture of coconut shell waste and sawdust. As for what is determined as the control variable of this study is coconut shell waste and as an independent variable, namely coffee skin waste, rice husks, water hyacinth, Bintaro fruit, segon wood sawdust, coconut husk, durian skin, bamboo charcoal, areca nut skin, and leather waste. sago with a certain composition. Furthermore, this paper also describes the stages of making briquettes from coconut shell waste and sawdust for further testing of the calorific value, moisture content, ash content, volatile matter content on a laboratory scale for further research. From various literatures, it was found that the highest calorific value was obtained from a mixture of coconut shell waste and bamboo charcoal with a value of 7110.7288 cal / gr and the lowest calorific value was obtained from a mixture of coconut shell waste and sago shell waste with a value of 114 cal / gr, then for the value The highest water content was obtained from a mixture of coconut shell waste and rice husk with a value of 37.70% and the lowest water content value was obtained from a mixture of coconut shell waste 3.80%, then for the highest ash content value was obtained from a mixture of coconut shell waste and coffee skin with a value of 20.862% and for the lowest ash content value obtained from a mixture of coconut shell and Bintaro fruit waste, namely 2%, and for the highest volatile matter content value obtained from a mixture of coconut shell and coconut husk waste with a value of 33.45% and for the value of volatile matter levels The lowest was obtained from a mixture of coconut shell waste and sago skin waste with a value of 33.45%.

Keywords: Briquettes; Biomass; Coconut Shell; Alternative Energy; Waste

Sari

Tujuan dari penelitian ini yaitu untuk melihat kualitas briket terbaik dari bahan utama limbah tempurung kelapa dengan berbagai aditif biomassa untuk melihat nilai kadar kalor, kadar air, kadar abu dan kadar volatile matter dari campuran biomassa. Selanjutnya akan dilakukan penelitian lebih lanjut secara spesifik untuk melihat kualitas briket dari campuran limbah tempurung kelapa dan serbuk gergaji. Adapun yang ditentukan sebagai variabel kontrol dari penelitian ini adalah limbah tempurung kelapa dan sebagai variabel bebas yaitu limbah kulit kopi, sekam padi, eceng gondok, buah bintaro, serbuk gergaji kayu segon, sabut kelapa, kulit durian, arang bambu, kulit pinang dan limbah kulit sagu dengan komposisi tertentu. Selanjutnya dalam tulisan ini juga dijelaskan tahapan-tahapan pembuatan briket dari limbah tempurung kelapa dan serbuk gergaji untuk selanjutnya diuji nilai kadar kalor, kadar air, kadar abu, kadar volatile matter dalam skala laboratorium untuk penelitian lebih lanjut. Dari berbagai literatur didapatkan bahwa nilai kadar kalor tertinggi diperoleh dari campuran limbah tempurung kelapa dan arang bambu dengan nilai 7110,7288 kal/gr dan nilai kalor terendah diperoleh dari campuran limbah tempurung kelapa dengan limbah kulit sagu dengan nilai 114 kal/gr, selanjutnya untuk nilai kadar air tertinggi diperoleh dari campuran limbah tempurung kelapa dan sekam padi dengan nilai 37,70% dan nilai kadar air terendah diperoleh dari campuran limbah tempurung kelapa 3,80%, selanjutnya untuk nilai kadar abu tertinggi diperoleh dari campuran limbah tempurung kelapa dan kulit kopi dengan nilai 20,862% dan untuk nilai kadar abu terendah diperoleh dari campuran limbah tempurung kelapa dan buah bintaro yaitu 2%, dan untuk nilai kadar volatile matter tertinggi diperoleh dari campuran limbah tempurung kelapa dan sabut kelapa dengan nilai 33,45% dan untuk nilai kadar volatile matter terendah diperoleh dari campuran limbah tempurung kelapa dan limbah kulit sagu dengan nilai 33,45%.

Kata-kata kunci: Briket; Biomasa; Tempurung Kelapa; Energi Pilihan; Limbah

*Corresponding author

E-mail: yusraida@trisakti.ac.id

Tel: +(62) 82160684379

I. INTRODUCTION

One of the basic human needs that continues to increase with time and level of life is energy. The

fuel that is still very dominant in meeting the national energy needs is held by BBM (BBM). The following is the composition of the national energy

consumption, BBM: 52.50%; Gas: 19.04%; Coal: 21.52%; Water: 3.73%; Geothermal: 3.01% and renewable energy: 0.2%. As a result of the past subsidy policies for fuel oil as an effort to spur economic growth acceleration, the consumption of fuel energy is very high compared to other energies. This resulted in a decrease in Indonesia's petroleum production due to a natural decline and the depletion of oil reserves. The high price of world crude oil and the decline in crude oil production will certainly greatly affect the capacity of the development budget. Up to now, fuel oil in Indonesia is still subsidized by the state through the state budget, this is of course a very heavy burden for the government. Therefore, various ways are sought and developed to obtain other energy sources that are cheap and easy to obtain so that it is hoped that it can reduce the burden of government subsidies [1].

Indonesia's vast territory contains a variety of energy potentials that have a huge opportunity to be utilized as an alternative energy source. The energy potential is in the form of renewable or alternative energy, including geothermal or geothermal water, biomass, mini/micro hydro, solar power, wind power, and even nuclear or uranium [2]. The alternative energy sources that will be discussed in this study are energy sources that come from biomass waste.

Biomass is a product of photosynthesis that absorbs solar energy and converts carbon dioxide, with water, into a mixture of carbon, hydrogen, and oxygen. Biomass is also a biological material that can be used as a fuel source, either directly or after being processed through a series of processes known as biomass conversion. Biodegradable waste that can be used as fuel is also part of the biomass but does not include organic material that has been converted by geological processes into substances such as coal or petroleum.

In theory, Indonesia's biomass energy potential is estimated at around 49,810 MW. This figure is assumed based on the energy content of the annual production of around 200 million tonnes of biomass from agricultural, forestry, plantation, and waste residues densely urbanized. However, in reality, the large amount of potential is not comparable to the installed capacity of 302.4 MW or 0.64 percent utilized. If only the existing potential can be maximized by increasing the amount of installed capacity, it will help fossil fuels which have been the foundation of energy use [3].

One of the applications of biomass waste as an alternative energy source is to turn it into briquettes that can be used as a substitute for fuel. Furthermore, what is discussed in this study is how to make briquettes from coconut shell waste and sawdust and the highest-quality value of briquettes when coconut shell waste is made into briquettes with the addition of various other biomass wastes.

II. METHOD

The following explains how the stages of making briquettes originating from coconut shell waste and sawdust with a predetermined composition as in Table 1, where T is coconut shell and S is sawdust.

Table 1. Treatment of composition between coconut shell and sawdust

Treatment	Compostion	
	T(g)	S(g)
K1	90	10
K2	80	20
K3	70	30
K4	60	40
K5	50	50
K6	40	60
K7	30	70
K8	20	80
K9	10	90

The work procedure of each of these stages can be explained as in Figure 1. The work procedure in this study begins with drying the raw materials, carbonization, milling, and filtering mixing adhesives, printing, and drying, then continues with the determination of the quality of the briquettes which includes heat value, moisture content, ash content, and volatile matter content on a laboratory scale as explained in Figures 2 to 7.

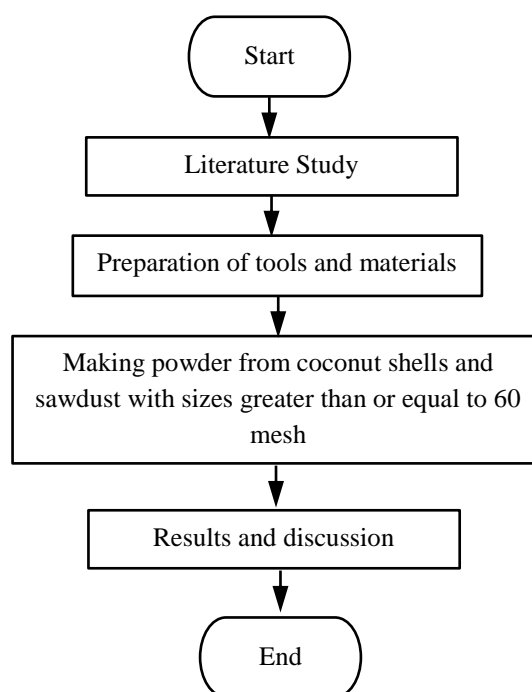


Figure 1. Research Procedure

1. Drying of Raw Materials

The coconut shell powder is first cleaned of impurities such as fiber, soil, and other impurities that stick to the shell, Fig. 2(a). Then it is dried it for 2 days in the sun to reduce the moisture content in the coconut shell and sawdust, Fig. 2(b).



(a)



(b)

Figure 2. Coconut shell and sawdust before carbonization

2. Carbonization

The dried coconut shell and sawdust are put into the furnace separately and gradually Fig. 3(a). Then the fire is ignited so that the material becomes charcoal Fig. 3(b).

made of pipe 6 cm in diameter and then pressed. Emphasis is placed on the briquettes for the briquettes to be solid and strong, Fig. 6.



(a)



(b)

Figure 3. The process of carbonization of coconutshell and sawdust

3. Milling and Screening

The charcoal that has been formed is then ground into charcoal flour, Fig. 4(a). Then it is sieved in order to obtain coconut shell charcoal powder and sawdust, each with a size of 60 mesh according to SNI 01-6235-2000, Fig. 4(b).



(a)



(b)

Figure 4. The process of making coconutshell and sawdust powder with a size of 60 mesh

4. Mixing with the Adhesive

The starch adhesive is made by cooking it in water with a ratio of 1: 2.5 at 70°C to form a gel, Fig. 5(a). Then it is mixed with coconut shell charcoal flour (T) and sawdust charcoal flour (S) as much as 20% of the combined mass between the mixture of T and S evenly to form a mixture, Fig. 5(b).

5. Printing and Pressing

The dough that has been made is put into a mold

6. Drying

The charcoal briquettes that have been formed are

then dried in an oven at a temperature of 120°C for \pm 30 minutes, Fig. 7(a). The resulting briquettes were tested for quality based on heating value, moisture content, ash content, and volatile matter, Fig. 7(b).

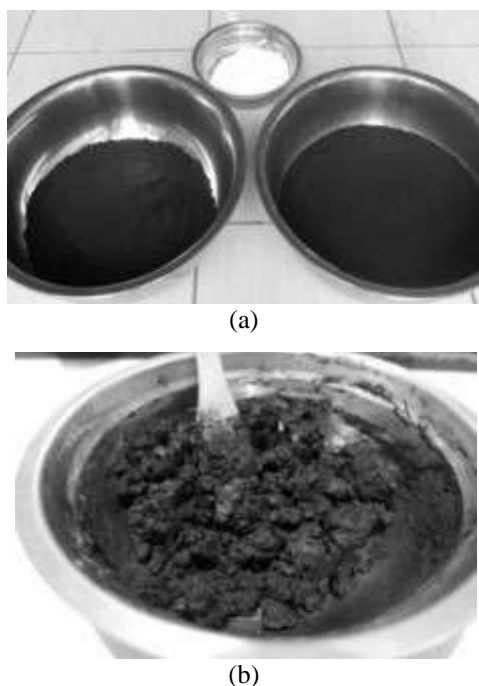


Figure 5. The process of mixing adhesives



Figure 6 The process of printing and pressing briquettes

III. RESULTS AND DISCUSSION

Based on the review of the method of making briquettes above, the following describes the results of research from various sources related to the use of coconut shell waste as an alternative energy source with the addition of various biomass additives to produce briquette quality based on the calorific value test, moisture content value, ash content value, and volatile matter respectively treat each other, as shown in Table 2.

Calorific value analysis

The calorific value is one of the most important

quality parameters of charcoal briquettes because the calorific value determines the quality of charcoal briquettes. The higher the calorific value contained by the briquettes, the better the quality of the charcoal briquettes so that it is feasible to become an alternative fuel. Water content and ash content contained in charcoal briquettes also affect the high and low calorific values. The higher the ash content and the water content, the lower the calorific value of the charcoal briquettes, and vice versa. Based on the table above, it was found that the highest calorific value was obtained from a mixture of coconut shell waste and bamboo charcoal with a value of 7110.7288 cal / g, and the lowest calorific value was obtained from a mixture of coconut shell waste and sago shell waste with a value of 114 cal/gr.

Water content analysis

The water content of the briquettes greatly affects the calorific value. The smaller the water content, the better the calorific value, and vice versa [14]. Based on the table above, it was found that the highest water content value was obtained from a mixture of coconut shell waste and rice husk with a value of 37.70%, and the lowest water content value was obtained from a mixture of coconut shell waste 3.80%.

Ash content analysis

How much is left of the combustion product can show the value of the ash content of a briquette and this ash content will determine the quality of the charcoal briquette. The more ash content in the briquette, the lower the quality of the briquette. This occurs because the high ash content in the charcoal briquettes will reduce the calorific value and carbon content [15]. Based on the table above, it was found that the highest ash content value was obtained from a mixture of coconut shell waste and coffee skin with a value of 20.862%, and the lowest ash content value was obtained from a mixture of coconut shell waste and Bintaro fruit, namely 2%.

Volatile matter analysis

The purpose of the volatile matter analysis is to determine the content of flying substances in the resulting briquettes. This volatile matter value affects the perfection of the resulting combustion and flame which can determine the selling power of the briquettes. Based on the table above, it was found that the highest volatile matter content was obtained from a mixture of coconut shell and coconut husk waste with a value of 33.45% and the lowest volatile matter content was obtained from a mixture of coconut shell waste and sago shell wastewith a value of 33.45%.

Tabel 2. Treatment of composition between coconut shell and sawdust

Feedstock	Calorific Value (cal/gr)	Feedstock	Calorific Value (cal/gr)	Feedstock	Calorific Value (cal/gr)
Coconut shell and coffee shell	3047.6–6152.4	12.487–14.966	20.05–20.86	NA*	[4]
Coconut shell and rice husk	4104 – 4132	28.56 - 37.70	NA*	21.88 – 25.61	[5]
Coconut shell and water hyacinth	4524 – 6267	6.45 - 9.07	4.77 – 20.78	NA*	[6]
Coconut shell and bintaro fruit	6710 – 7090	NA*	2 – 4.5	11 – 18	[7]
Coconut shell and sengon sawdust	4402 – 5732	NA*	NA*	NA*	[8]
Coconut shell and coconut husk	5824 – 6122	5.39 - 6.29	2.86 – 3.63	32.4–33.45	[9]
Coconut shell and durian shell	5333.4–6482.8	6.77 - 12.67	NA*	NA*	[10]
Coconut shell and bamboo charcoal	6367.2–7110.7	3.80 – 5.93	NA*	NA*	[11]
Coconut shell and betel nut shell	NA*	4.1 – 6.9	2.4 – 5.8	NA*	[12]
Coconut shell and sago stem shell	114 -168	NA*	4.23 - 14.4	3.15–3.71	[13]

*NA means not available



(a)



(b)

Figure 7. The drying process

IV. CONCLUSIONS

From the observations, it was found that the highest calorific value was obtained from a mixture of coconut shell waste and bamboo charcoal with a value of 7110.7288 cal / gr and the lowest calorific value was obtained from a mixture of coconut shell waste and sago skin waste with a value of 114 cal / gr, then for the value The highest water content was obtained from a mixture of coconut shell waste and rice husk with a value of 37.70% and the lowest water content value was obtained from a mixture of

coconut shell waste 3.80%, then for the highest ash content value was obtained from a mixture of coconut shell waste and coffee skin with a value of 20.862% and for the lowest ash content value obtained from a mixture of coconut shell and Bintaro fruit waste, namely 2%, and for the highest volatile matter content value obtained from a mixture of coconut shell and coconut husk waste with a value of 33.45% and for the value of volatile matter levels The lowest was obtained from a mixture of coconut shell waste and sago skin waste with a value of 33.4 5%.

ACKNOWLEDGEMENT

The authors express gratitude to Faculty of Earth and Energy, Petroleum Engineering Department, Trisakti University for internal grant to publish this paper.

REFERENCES

1. Imam, K. 2015. Pemanfaatan Energi Alternatif Sebagai Energi Terbarukan untuk Mendukung Substitusi BBM. *Jurnal IPTEK*. Vol.19. No.2, 75-91, <https://doi.org/10.31284/j.iptek.2015.v19i2.12>
2. Agung, A.I. 2013. Potensi Sumber Energi Alternatif dalam Mendukung Kelistrikan Nasional. *Jurnal Pendidikan Teknik Elektro*, Vol. 2. No. 2, 892-8971.
3. Bono, P., Marlin, P., Slivy, R.F., Syaiful, N. 2013. Biomass Potential Map as A Database of National Scale Biomass Energy Development. *Ketenagalistrikan dan Energi Terbarukan*, Vol. 12. No. 2, 123 – 130.
4. Bagus, S. and Rosiana, U. 2019. Analisis Mutu Briket Arang dari Limbah Biomassa Campuran

- Kulit Kopi dan Tempurung Kelapa dengan Perekat Tepung Tapioca. *Jurnal Pendidikan, Biologi dan Terapan*. Vol. 4, No. 02, 110 – 120, <https://doi.org/10.33503/ebio.v4i02.508>
5. Yayah, Y., Sri, Y., Khoirima, U. 2017. Penentuan Kadar Air Hilang dan Volatile Matter pada Bio-briket dari Campuran Arang Sekam Padi dan Batok Kelapa. *Jurnal Ilmu dan Inovasi Fisika*. Vol. 01, No. 01, 51 – 57, <https://doi.org/10.24198/jiif.v1n1.7>
 6. Dian, F., Priyo, H.A. 2014. Pembuatan Biobriket dari Campuran Enceng Gondok dan Tempurung Kelapa dengan Perekat Tetes Tebu, *JTM*. Vol. 03. No. 02, 315-322.
 7. Indah, S. , M. Yusuf, P.U., M. Hatta, D. 2012. Pembuatan Briket Arang dari Campuran Buah Bintaro dan Tempurung Kelapa Menggunakan Perekat Amilum, *Jurnal Teknik Kimia*. Vol.18. No. 1.
 8. Anggoro, D.D., Wibawa, M.H.D., Fathoni, M. Z. 2017. Pembuatan Briket Arang dari Campuran Tempurung Kelapa dan Serbuk Gergaji Kayu Sengon. *Teknik*, Vol.37. No. 2, 77, <https://doi.org/10.14710/teknik.v38i2.13985>
 9. Otong, N. and Sri, S. 2018. Komposisi Campuran Sabut dan Tempurung Kelapa Terhadap Nilai Kalor Biobriket dengan Perekat Molase . *Jiif (Jurnal Ilmu dan Inovasi Fisika)*. Vol. 02. No. 01, 8 – 14, <https://doi.org/10.24198/jiif.v2i1.15606>
 10. Muh, A.S. and Hernawati. 2020. Pengaruh Komposisi dan Ukuran Partikel Terhadap Kualitas Briket Kulit Durian dan Tempurung Kelapa. *Jurnal Fisika dan Terapannya*. Vol. 7. No. 1, 33-43, <https://doi.org/10.24252/jft.v7i1.13964>
 11. Ihsan. and Muh, A. 2019. Pengaruh Komposisi Terhadap Karakteristik Briket Kombinasi Arang Tempurung Kelapa dan Arang Bambu. *JFT*. Vol. 6. No.1. <https://doi.org/10.24252/jft.v6i1.12737>
 12. Frida, E., Darnianti, Pandia, J. 2019. Preparasi dan Karakterisasi Biomassa Kulit Pinang dan Tempurung Kelapa Menjadi Briket dengan Menggunakan Tepung Tapioka Sebagai Perekat, *Juitech*. Vol.03. No. 02, 2597-7261, <http://dx.doi.org/10.36764/ju.v3i2.252>
 13. Jerry, M.K., Budi, S., Sarman, O.G. 2019. Studi Karakteristik Bio-briket Berbahan Baku Limbah Kulit Batang Sagu dan Tempurung Kelapa, *Agritechnology*, Vol. 2. No. 1, 2620-4738. <https://doi.org/10.51310/agritechnology.v2i1.23>
 14. Maryono. And Rahmawati. 2013. Pembuatan dan Analisis Mutu Briket Arang Tempurung Kelapa Ditinjau dari Kadar Kanji. *Jurnal Chemica*. Vol. 14. No. 1, 74–83. <https://doi.org/10.35580/chemica.v14i1.795>
 15. Anggoro, D.D., Wibawa, M.H.D., Fathoni, M.Z. 2018. Pembuatan Briket Arang dari Campuran Tempurung Kelapa dan Serbuk Gergaji Kayu Sengon. *Teknik*. Vol. 38. No. 2, 76, <https://doi.org/10.14710/teknik.v38i2.13985>.