Analysis of the Potential for Alternative Fuels Refused Derived Fuel from Waste Briquettes at the Sidoarjo Regency Final Disposal Site

Achmad Ramadhan dan Lily Oktavia
Jurusan Teknik Lingkungan, Universitas Nahdlatul Ulama
Sidoarjo, Sidoarjo, Indonesia
***lilyoktavia.98@gmail.com**

OPEN ACCESS

Citation: Achmad Ramadhan dan Lily Oktavia. 2022. Analysis of the Potential for Alternative Fuels Refused Derived Fuel from Waste Briquettes at the Sidoarjo Regency Final Disposal Site. *Journal of Research and Technology* Vol. 8 No. 1 Juni 2022: Page 161–167.

Abstract
The Griyo Mulyo Jabon Final Waste Processing Site (TPA) in Sidoarjo Regency with a waste generation reached 350 tons/day had the potential to be processed into raw material for Refused Derived Fuel (RDF). RDF fuel had come from waste residue briquettes contained the composition of paper, wood, cloth, rubber, and plastic (4K1P). Briquettes that can be used as raw materials for RDF were those that have characteristics according to SNI standards. This study aimed to determine the percentage of the composition of briquettes that have the potential to produce RDF and the standard quality of the resulting RDF. The reseach was conducted by taking waste samples every week four times with variations in detention time of 2, 4 and 6 hours.a. The method of calculating the value of RDF standard quality was in accordance with SNI 01-6235-2000 with the parameters analyzed were water content, ash content, volatile/steam content and calorific value. The results showed that the best briquette composition produced from 4K1P waste residue was in samples with a composition of 20% wood, 10% paper, 10% rubber/fabric, and 60% plastic. The best quality briquettes with 5.5% moisture content, 4.9% ash content, 15.9% steam content, and calorific value 8996 cal/gram.

Keywords: *RDF, TPA Waste, Moisture Content, Ash Content, Volatile Matter Content, Calorific Value*.

Abstrak
Tempat Pemrosesan Akhir Sampah (TPA) Griyo Mulyo Jabon Kabupaten Sidoarjo dengan timbulan sampah mencapai 350 ton/hari, sehingga berpotensi diolah menjadi bahan baku Refused Derived Fuel (RDF). Bahan bakar RDF berasal dari briket residu sampah yang mengandung komposisi kertas, kayu, kain, karet, dan plastik (4K1P). Briket yang dapat dijadikan sebagai bahan baku RDF adalah yang memiliki karakteristik sesuai standar SNI. Penelitian ini bertujuan untuk mengetahui prosentase komposisi penyusun briket yang berpotensi menghasilkan RDF dan kualitas standar RDF yang dihasilkan. Penelitian dilakukan dengan pengambilan sampel

sampah dilakukan setiap minggu sebanyak empat kali dengan variasi waktu detensi 2,4, dan 6 jam. Metode perhitungan nilai kualitas standar RDF sesuai dengan SNI 01-6235-2000 dengan parameter yang dianalisis adalah kadar air, kadar abu, kadar volatile/uap, dan nilai kalor. Hasil penelitian menunjukkan komposisi briket terbaik yang dihasilkan dari residu sampah 4K1P adalah pada sampel dengan komposisi 20% kayu, 10% kertas, 10% karet/kain, dan 60% plastik. Kualitas briket terbaik dengan kadar air 5,5%, kadar abu 4,9%, kadar uap 15,9%, dan nilai kalor yang dihasilkan 8996 cal/gram.

Kata Kunci: *RDF, Sampah TPA, Kadar Kelembapan, Kadar Abu, Kadar Zat Menguap, Nilai Kalor*.

1. Introduction

The amount of waste that arises is also caused by the increase in population, the greater the population growth, the greater the accumulation of waste that occurs. The total amount of waste accommodated by the Jabon TPA reaches 350 tons/day. The waste was not handled at all, only 800 m3 or 20% (Widiyanti et al., 2019). According to data from the Department of Environment and Hygiene (DLHK) of Sidoarjo Regency, 91.77% of waste generated in the TPA comes from plastic waste and 8.23% is residue.

Waste treatment technology, formed into briquettes or smaller sizes during the homogenization process can be called RDF. Criteria that must be met for briquettes such as flammability, no smoke, emission of non-toxic combustion gases, water resistance, long-term storage of combustion products without mold, appropriate combustion speed (time, combustion speed and combustion temperature). The result is used as a renewable energy source by burning coal to produce energy. The description of the potential of the Sidoarjo Regency TPA can be used as an innovation for waste processing. Such ideas and thoughts require community participation to support opportunities, and the wheels of economic circulation must be better for a better community economy (Febrina, 2018).

The process of making briquettes starts from collecting raw materials, reducing waste particle size, sifting, weighing raw materials, mixing raw materials, carbonation, printing, drying, and testing the quality of briquettes. It was found that differences in RDF quality may be based on material costs or environmental variations in solids and the same composition or deposition fatigue. Good quality briquettes are briquettes with low moisture, ash, volatile matter and ash content, but high density, calorific value and charcoal or coal content. Because it can prevent combustion air pollution (Izaty, 2018). Previous studies have shown the quality of briquettes from biomass content, therefore the aim and objective of this research is to find out the potential quality of briquettes from waste in the landfill to be used as fuel for RDF.

2. Method

The research was carried out on a field scale by conducting quantitative observations on the time variable for taking test samples from waste at the landfill 4 times on Mondays, then measuring the water content, ash content, vapor content, and heat content, with detention times of 2, 4, and 6 o'clock. The manufacture of RDF is carried out by analyzing the characteristics of the raw materials for making RDF, collecting and weighing waste, refining, sifting and printing the waste into RDF and then drying it. Refuse derived fuel is fuel that is produced from various types of waste such as urban solid waste, industrial waste or commercial waste.

2.1 Volatilization Test Method

Weight 1-2 grams of briquettes into a cup whose weight is known, cover the cup and put it in the furnace with a temperature of 950℃. Heat for 7 minutes, then remove and cool in a desiccator. Weigh and calculate the volatile matter content (SNI 01-6235-2000).

2.2 Calorific Value Test Method

Weight 1 gram of crushed briquettes, then press them in the form of pellets. Measure 10 cm fuse wire, connect to each electrode. Fill oxygen into the bomb with a maximum of 30 atm. gas flow control cap, fill bucket with 1.5 liter distilled water. Put the bucket in the calorimeter, put the bomb in the bucket, close the calorimeter. Record the initial temperature on the claorimeter, press the ignition unit 5 minutes. Record the temperature rise on the thermometer. Wait 3 minutes and record the final temperature on the thermometer. Open the calorimeter and remove the bomb, remove the remaining gas in the bomb, rinse the surface of the bomb. Measure the remaining unburned fuse wire. Titrate the water from the bucket with the Na2CO3 solution using the methyl red indicator (SNI 01-6235-2000).

2.3 Preliminary Research

The study begins with sorting the waste that goes to the TPA to determine the composition of the waste composition consisting of organic, inorganic and residue waste, namely wood, paper, cloth, rubber, and plastic (4K1P). The collection of 4K1P waste raw materials is placed in containers that have been prepared with various types. Screening is done to determine the percentage of types of waste after being weighed. Enumeration is carried out with a shedder machine with the aim of reducing the particle size so as to facilitate the carbonation process. Furthermore, the process of mixing raw materials with the percentage of waste that has been recorded previously. The carbonation process was carried out for 2 hours and then the molding was carried out to form briquettes. After that, the briquettes are dried so that the briquettes do not get moldy if stored for a long time and increase the briquette flame time. Based on the measurement results at the preparation stage, the composition of the waste that enters the Sidoarjo TPA has the composition: 8% wood, 2% paper, 2% cloth, 1% rubber, and 15% plastic. This means that the waste in the Sidoarjo TPA has the potential to be used as briquettes.

2.4 Main Research

Before determining the standard quality of the briquettes produced, the waste composition is measured and then laboratory tested to determine the quality of the briquettes against the parameters of water content, vapor content. Ash content, and heat content. The sampling of the test was carried out 4 times with the results shown in Table 1.

Table 1. The Results of the Weighting of Waste Residue as Raw Material for RDF

Sample	Item Scales (residue)	Mass (kg)	Total (kg)	Briquettes (kg)	Composition (%)
A	1	4670	30380	1519	50% wood
	2	7500			10% paper
	3	4230			5% cloth
	4	7740			5% rubber
	5	5010			30% plastic
	6	1230			
B	1	4420	31420	1571	60% wood
	2	8380			10% paaper
	3	5960			8% cloth
	4	5890			5% rubber
	5	6770			30% plastic
C	1	5220	30250	1512	30% wood
	2	8390			10% paper
	3	5790			10% rubber
	4	9140			10% cloth
	5	1710			40% plastic
D	1	7750	30440	1522	20% wood
	2	5010			10% paper
	3	8490			10% cloth
	4	8490			10% rubber
	5	9190			60% plastic

Source: Observation Results, 2022.

3. Result and Discussion

Based on the results of observations, the amount of residual waste in the Sidoarjo TPA after the sorting process with an average weight of 30622 kg/day of waste. Sample A with a waste weight of 30380 kg was able to produce 1519 briquettes, sample B with a weight of 31420 kg produced 1571 briquettes, sample C with a weight of 30250 kg produced 1512 kg briquettes, and sample D could produce 1522 kg briquettes. The average briquette produced from 4 times sampling reached 1531 kg/day.

The percentage of 4K1P waste residue in the Sidoarjo TPA in samples A and B was dominated by wood waste by 50% and 60%, respectively, while in samples C and D it was dominated by plastic waste by 40% and 60%, respectively. The waste is considered suitable as raw material for briquettes because of the flammable characteristics of plastic. According to research conducted by Sawir (2016) briquettes from plastic raw materials will produce types of briquettes with high heating value and volatile substances due to the flammable nature of plastic, while according to research conducted by Kalsum (2016) briquettes with raw materials from wood have characteristics of high ash content because wood contains silica which when burned produces ash.

The standard value of briquette quality is measured according to SNI. The parameters of water content, ash content, vapor content, and calorific value are shown in Table 2.

Table 2. Standard Quality of RDF from Briquettes of TPA Garbage in Sidoarjo

Sample	Week -	Detention Time (hour)	Water Content (%)	Ash Content (%)	Volatile Content (%)	Calory Value (cal/g)
A	1	2	8.8	8.2	12.1	4559
		4	8.1	8.1	12.8	4986
		6	7.9	7.1	11	5509
B	2	2	9.2	8.2	14.7	4478
		4	8.5	7.9	13.4	5033
		6	7.8	7.3	11.2	5749
C	3	2	7.7	6.3	19.2	6988
		4	7.3	5.7	16.3	7349
		6	6.7	5.1	15.5	8037
D	4	2	7.9	5.6	21.3	7025
		4	6.1	5.6	17.5	7658
		6	5.5	4.9	15.9	8996
Quality standard			*8	*8	*15	*5000

Source: Laboratory test results, 2022
Note: Quality standard according to SNI 01-6235 Year 2000

The water content in samples A to D ranged from 5.5 to 9.2%, the lowest water content occurred in sample D with a detention time of 6 hours at 5.5%. The moisture content in samples A and B tended to be higher than samples C and D because the raw material was dominated by wood, respectively, 50 and 60%. This is possible because during the manufacture of briquettes with a detention time of 6 hours, the water content contained in the raw material undergoes evaporation, so the carbonation process (composing) can be maximized and meet the SNI standard for briquettes, which is 8%, while samples B and C are dominated by by wood is difficult to dry its moisture content. The high water content is because the raw material is waste residue that has been mixed with organic waste, mostly from rotting fruit and vegetables and needs to be dried to reduce the water content so that the carbonation process can be maximized. The process of ignition of briquettes can be difficult if the water content of the briquettes is high because the calorific value is influenced by the water content in the briquettes, if the water content is high then the calorific value is low and vice versa (Sani, 2009).

The ash content affects the corrosion rate of the tools used so that if the ash content is high then the tool will be damaged quickly because the ash content is an impurity in the briquettes. SNI stipulates the ash content of briquettes which is a maximum of 8%. There are 2 samples that exceed the quality standard in samples A and B ranging from 8.1% to 9.2% at detention times of 2 hours and 4 hours. This is due to the composition of the briquettes in samples A and B 60% of wood waste. Wood contains the main components of cellulose and hemicellulose in the form of dolomite, magnesite or silicate which when burning will produce

P-ISSN No. 2460–5972
E-ISSN No. 2477–6165

ash (Kalsum, 2016). The lowest percentage of ash content occurred in sample D of 4.9%. The value of low ash content is because the raw material for briquettes in sample D contains 60% plastic waste, according to Ruslinda et al., (2017) plastic waste raw materials produce low ash content.

The lowest volatile substance content in sample A is 11% and the highest volatile substance content in sample D is 21.3%. A lot of smoke when briquettes are burned is caused by the carbon monoxide reaction so that the vapor content is high (Hendra, 2007). The type of raw material affects the levels of volatile substances so that the difference in raw materials has a large effect on the amount of volatile substances, the more materials that contain plastic, the more flammable the briquettes formed. The volatile substances in briquettes serve to stabilize the fire and accelerate combustion (Sinurat, 2011). Substances that evaporate in large briquettes will make the briquettes flammable and the flame of the briquettes faster (Ruslinda, 2017).

The quality of briquettes is also determined by the amount of calorific value. High calorific value will improve its quality. As a result of a chemical reaction when a compound reacts and the termination of atoms to form a new compound causes the calorific value of a hydrocarbon compound to be formed. The length of the atomic bond affects the calorific value, the longer the bond, the greater the calorific value formed. Based on Table 4.2, it can be seen that the highest calorific value in sample D is 8996 cal/gram. This is because the water and ash content in sample D is low. Triono (2006) stated that. Moisture content and ash content also affect the calorific value. If the water content is high, the calorific value will be low. Briquettes with high water content have a low calorific value. Another factor that causes the calorific value in sample D is high because 60% of the raw materials come from plastic. Plastic raw materials have a carbon content. The cause of this flammable plastic is due to the carbon content (Ruslinda et al., 2017).

4. Conclusion

The conclusion of this study is that the remaining waste from TPA Sidoarjo Regency which consists of 60% plastic, 20% wood, 10% paper, 10% leather/fabric has a quality that meets SNI standards, namely water content, ash content, and heating value respectively. 5.5%, 4.9% and 8996 cal/gram, but the resulting volatile matter content of 15.9% does not meet the quality standards set by SNI. Efforts to improve quality so that it meets the standards set by SNI are to take waste samples of different compositions so that the volatile matter content can meet the maximum content of 15%.

Suggestion

Suggestions for further research can use a carbonization temperature above 400oC so that the maximum carbonation process and waste can be perfected into charcoal, add variations in raw materials from biomass, and analyze the carbon content in briquettes.

REFERENCES

Febrina, Wetri. 2018. Potensi Sampah Organik sebagai Bahan Baku Pembuatan Briket Bio Arang. *Unitex* Vol 11 No.1. Hal. 40 – 50.

Indonesia. 1991. Standar Nasional Indomesia Nomor 19-2454-1991 tentang Tata Cara Teknik Pengelolaan Sampah Perkotaan.

Indonesia. 2000. Standar Nasional Indonesia Nomor 01-6235-2000 tentang standard Pengujian dan pengukuran kadar air, zat mudah menguap, kadar abu.

Izaty, Fatimah Nurul. 2018. Analisis Komposisi dan Identifikasi Potensi RDF (*Refuse Derived Fuel*) pada Sampah Zona 1 TPA Piyungan Bantul dengan Analisis Proximate dan Nilai Kalor. Tugas Akhir. Universitas Islam Indonesia.

Kalsum, Ummi. 2016. Pembuatan Briket Arang dari Campuran Limbah Tongkol Jagung, Kulit Durian dan Serbuk Gergaji Menggunakan Perekat Tapioka. *Jurnal Distilasi*, Vol. 1 No. 1. Hal. 42-50

Ruslinda Yenni, Fitratul Husna, Arum Nabila. 2017. Karakteristik Briket dari Komposit Sampah Buah, Sampah Plastik *High Density Polyethylene* (Hdpe) dan Tempurung Kelapa sebagai Bahan Bakar Alternatif di Rumah Tangga. *Jurnal Presipitasi,* Vol. 14 No.1 Hal. 5 – 14.

Sani, H.R. 2009. Pembuatan Briket Arang dari Campuran Kulit Kacang, Cabang dan Ranting Pohon Sengong serta Sebetan Bambu. Skripsi. Jurusan Teknologi Hasil Hutan, IPB. (Tidak dipublikasikan).

Sawir, Hemdri. 2016. Pemanfaatan Sampah Plastik Menjadi Briket sebagai Bahan Bakar Alternatif dalam Kiln di Pabrik Pt Semen Padang. *Jurnal Sains dan Teknologi,* Vol. 16 No.1 Hal. 1-113.]

Sinurat, E. 2011. Studi Pemanfaatan Briket Kulit Jambu Mete dan Tongkol Jagung sebagai Bahan Bakar Alternatif, Tugas Akhir, Teknik Mesin, Universitas Hasanuddin, Makassar.

Triono, A. 2006. Karakteristik Briket Arang dari Campuran Serbuk Gergajian Kayu Afrika (Maesopsis emini Engl.) dan Sengon (Paraserianthes falcataria L.) [Skripsi]. Bogor: Departemen Hasil Hutan. Fakultas Pertanian. Institut Pertanian Bogor

Widiyanti, A., Naja, M. M., & Wibisono, C. L,. 2019. Pengaruh Media Tanam Terhadap Pengolahan Lindi Tpa Kabupaten Sidoarjo Menggunakan Typha Latifolia. *Waktu: Jurnal Teknik Unipa*, Vol. 17 No. 1 Hal. 1–5.