Research Inventy: International Journal of Engineering And Science
Vol.13, Issue 10 (October 2023), PP 22-27
Issn (e): 2278-4721, Issn (p):2319-6483, www.researchinventy.com

The influence of particle size and adhesive on the calorific value and water content of household waste bio-charcoal briquettes

I M. Mara[1]*, I W. Joniarta[2], I M. Nuarsa[3]
[1] *Jurusan teknik Mesin, Fakultas Teknik, Universitas Mataram, Jln. Majapahit no. 62, Mataram, Nusa Tenggara Barat, 83125, Indonesia, Telp. 081917967987*
[2] *Jurusan teknik Mesin, Fakultas Teknik, Universitas Mataram, Jln. Majapahit no. 62, Mataram, Nusa Tenggara Barat, 83125, Indonesia.*
[3]*Jurusan teknik Mesin, Fakultas Teknik, Universitas Mataram, Jln. Majapahit no. 62, Mataram, Nusa Tenggara Barat, 83125, Indonesia*
Corresponding Author: made.mara@unram.ac.id

Abstract: *Household waste is waste that comes from daily activities in the household. Garbage that is not managed properly can accumulate every year and decompose, if not managed properly it can cause many diseases from bacteria and viruses. Utilization of household organic waste in the manufacture of briquettes is one of the solutions to overcome waste generation in household waste as well as being used as an alternative fuel to replace fossil fuel and LPG gas. The method used is an experiment with the carbonization process using a modified drum. Dependent variable, adhesive concentration of 5%, 10%, and 15% of 3 grams by weight of briquettes. Independent variable, particle size with sizes of 30 mesh, 60 mesh and 80 mesh. Tests include analysis of moisture content and combustion rate. The quality of the briquettes on the water content test complies with SNI No. 01-6235-2000 <8%, namely in the So5-30 treatment of 5.796%, S10-30 of 6.770% and S15-30 of 7.675% and the greatest calorific value was obtained in the S15-30 treatment with 15% adhesive concentration with a particle size of 30 mesh of 1,850.1cal/gr and the lowest calorific value was produced in the So5-80 treatment with 5% adhesive concentration with a 80 mesh particle size of 1,441.9 cal/gr.*

Keywords: *Household waste, Charcoal briquettes, Adhesives, Particles size, Carbonization.*

Date of Submission: 05-10-2023 Date of acceptance: 18-10-2023

I. INTRODUCTION

The main factor causing waste generation in Indonesia is the lack of public awareness about waste management, from the home sector to the industrial sector. Waste that is not managed can accumulate every year and rot if it is not managed properly, it can cause many diseases from bacteria and viruses such as diarrhea, typhoid, dysentery, fungus, cholera and various kinds of skin diseases. Waste generated from household activities can be sorted and disposed of according to its type, which will produce something useful for human life. As one example, it is used as renewable energy.

Basically, organic waste can decompose itself with the help of microorganisms, but anorganic waste such as food plastic, mineral bottles and so on cannot be decomposed. One use of organic waste is to process it into biomass briquettes which can later be used as energy. The organic waste received is dry organic waste such as dry leaves, dry twigs, anorganic waste such as plastic waste which can be used as adhesive in making waste bio briquettes (Saragih et al, 2020).

Briquettes are solid fuel that can be used as an alternative energy source that have a certain uniform shape, are obtained from pressing, powder, and have a relatively small or irregular size. (Hamzah, 2019). Study conducted by Ristianingsih (2015) aims to determine the effect of pyrolysis temperature on the biochar produced and determine the effect of starch adhesive concentration (5%, 10%, 15%) on the characteristics of the research briquettes (water content, volatile matter, ash content, fixed carbon , calorific value and combustion rate). It can be concluded that the lower the adhesive concentration, the lower the water content of the briquettes, resulting in a high heating value. The higher the adhesive concentration, the higher the ash and volatile matter content, while the fixed carbon content is lower.

Virgiawan, S. (2014) Carrying out tests using specimens with varying particle sizes of 30 mesh, 50 mesh and 70 mesh. The results of the research show that bagasse charcoal briquettes with a particle size variation of 70 mesh have a high heating value of 5238.58 cal/g and the lowest combustion rate of 0.00167 g/s.

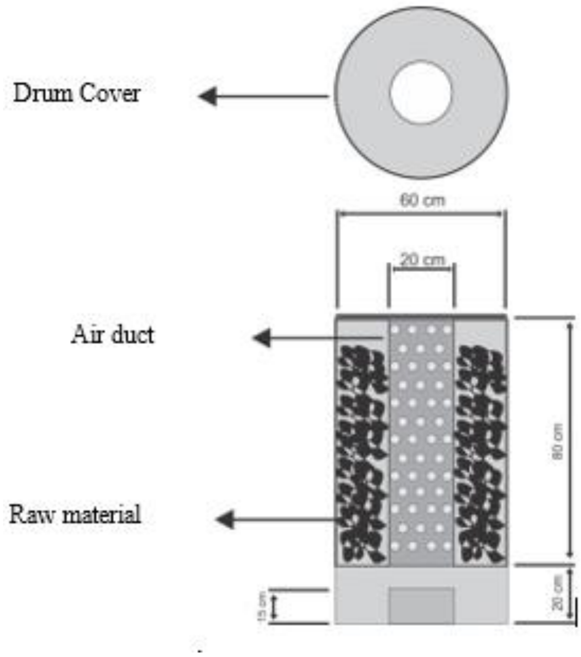
Adhesive is a substance or material that has the ability to bond two objects through surface bonding. There are several other terms for adhesives that have specific functions, including glue, mucilage, paste, and cement. Glue is an adhesive made from protein, usually used in the woodworking industry. Paste or starch adhesive is made by heating a mixture of starch and water until it forms a paste. Meanwhile, cement is a term commonly used for rubber-based adhesives that harden through the release of solvents (Ruhendi, 2007; Jannah 2018)

Utilizing waste from vegetable scraps from households to make charcoal briquettes is one solution to overcome the generation of organic waste in household waste and can also be used as an alternative fuel to replace petroleum and LPG gas. The aim of this research is to determine the best adhesive concentration and particle size to meet the Indonesian National Standard (SNI) for wood charcoal briquettes.

II. EXPERIMENTAL PROCEDURE

The stages carried out in this research include initial preparation, literature study, research procedures, preparation of tools and materials, testing and data collection, and analysis of research data.

Figure1. Charcoal making drum



The variables tested in this research were analysis of calorific value and water content. Meanwhile, variations in adhesive concentration used were 5%, 10% and 15% and particle sizes were 30 mesh, 60 mesh and 80 mesh.

2.1 Carbonization stage

The waste used is organic waste that has been dried in the sun to reduce the water content until it is dry so that the raw material does not produce smoke and is flammable. Organic waste is put into iron cans until they are full. The drum as a burning stove is lit with wood as fuel, then on top of the drum are placed 4 burning tins. The carbonization process is carried out for 20 minutes over a constant fire. The burning process is left until all the raw materials have become charcoal. It can be seen from the ventilation hole in the middle of the can that no smoke is emitted.

2.2 Adhesive formation stage

75 grams of starch dissolved in 350 ml of water is heated using the stove provided, while stirring until it boils and becomes thick, shaped like glue.

2.3 Charcoal briquettes making Stages

Charcoal resulting from carbonization of organic waste raw materials is ground using a prepared tool, then filtered using a sieve with sizes of 30 mesh, 60 mesh and 80 mesh. The sifted charcoal powder is completely added with starch adhesive which has been made like glue and mixed in a ratio of 5%, 10% and 15% of the total weight of the charcoal powder mixture. The finished dough is ready to be molded into cylindrical briquettes by placing the dough into the mold and then pressing it with the tool provided.

2.4 Drying of charcoal briquettes Stages

The resulting charcoal briquettes were then dried in an oven at 100ºC for 2 hours. The water content drying stage was carried out to determine the evaporated water content in each specimen from variations in adhesive concentration and particle size.

Figure2. Charcoal briquettes

III. RESULTS AND DISCUSSIONS

3.1 Calorific value

Calorific value testing was carried out using a bomb calorimeter whose aim was to determine the amount of energy contained in household waste briquettes with variations in adhesive concentration and particle size. Calorific value is one of the important properties for determining the quality of charcoal briquettes, especially those related to their use. To find out the extent of the combustion heat value that charcoal briquettes can produce, the calorific value must be known first (Sudira and Suroto, 2014). The following table1 shows the average calorific value of charcoal briquettes in calories/gram units

Tabel 1. Average calorific value of charcoal briquettes in cal/gram

	M30	M60	M80
So5	1,746.3	1,634.6	1,441.9
S10	1,798.8	1,597.3	1,482.5
S15	1,850.1	1,790.4	1,654.8

In table 1 the results of the calorific value produced by briquettes range from 1441.9 cal/gr to 1850.1 cal/gr where a high adhesive concentration with a larger particle size produces the largest calorific value and a low adhesive concentration with a larger particle size. small produces the lowest calorific value. The So15-30 treatment with an adhesive concentration of 15% with a particle size of 30 mesh had the highest calorific value of 1,850.1 cal/gr and the So5-80 treatment with a concentration of 5% with a particle size of 80 mesh had the lowest calorific value of 1,441.9 cal/gr.

Figure 2. The relationship between adhesive concentration and particle size on the calorific value of charcoal briquettes

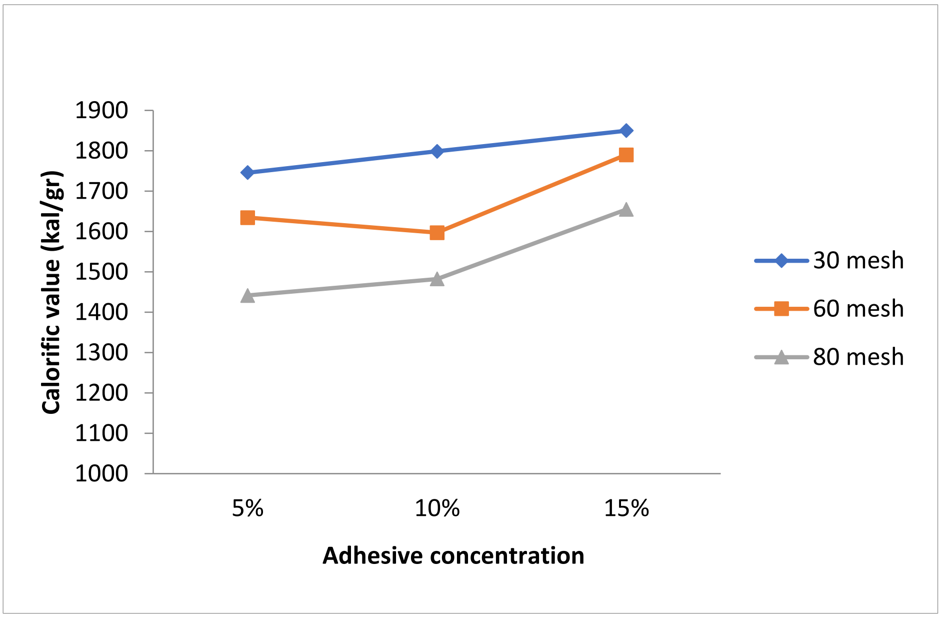


Figure 2 shows that the more adhesive used in the briquettes, the higher the calorific value produced. 15% adhesive has the highest heating value and 5% adhesive concentration has the lowest heating value. The results of the research are not in line with the initial hypothesis where the lower the water content value in the briquettes, the higher the calorific value produced. It is proven that the highest adhesive concentration of 15% produces greater value compared to an adhesive concentration of 5%. The factor that influences the high heating value is the increase in the amount of adhesive concentration. This is in line with research conducted by Pane et al (2015) which found that adhesive from tapioca flour increases the calorific value of organic briquettes. The higher the calorific value of a briquette, the better the quality. The quality of the briquette's calorific value will increase along with the increase in adhesive material in the briquette.

Factors that affect the low calorific value produced from the type of raw materials used, the time and temperature of the composition. The time that is too fast and the temperature in the unstable composting process result in briquettes from household vegetable waste having a relatively high water content and ash content. Another factor that affects the calorific value of briquettes is the drum that is used, there are air gaps that come in so that there is a possibility of organic matter being oxidized. This can cause the calorific value produced to be low and not exceed the standardization of charcoal briquettes.

In addition, Figure 2 shows that the smaller the particle size of the briquettes, the higher the calorific value produced. The 30 mesh particle size has the highest heating value and the 80 mesh particle size has the lowest heating value. The smaller the particle size, the cavity in the briquette pores becomes larger during the compression process, which causes a lot of adhesive to enter the briquette pores. Judging from the water content test, the 80 mesh particle size has a high evaporated water content which results in a low calorific value. This is also confirmed by the results of the tests carried out, the larger the particle size. then the combustion process will occur more quickly, because the distance between the particles is wider. The wider the space between the particles, the more oxygen (air) that enters between the particles so that the briquettes are easier to burn. This is in line with research conducted by Seo (2015) from the results of research conducted in research on making coconut shell charcoal briquettes, it was concluded that the effect of the smaller particle size (in mesh size) is the higher the calorific value, while the larger the particle size (in mesh size) then the heating value is low.

The calorific value produced in charcoal briquettes from household waste is lower compared to research conducted by Setyaningtyas (2018). The results of the research conducted show that the highest calorific value content is in briquettes from 100% vegetable waste composition, namely 5,645.52 cal/gram. . Higher than research conducted by Desgira (2021), the calorific value of tea leaf powder briquettes produced the highest calorific value of 112.86 cal/gram. The higher the calorific value of charcoal briquettes, the better the quality of the charcoal briquettes, making them suitable for being an alternative fuel. These results show that the calorific value of household waste briquettes does not meet the SNI 01-6235-2000 standard, namely ≤ 5,000 cal/gr

3.2 Water content

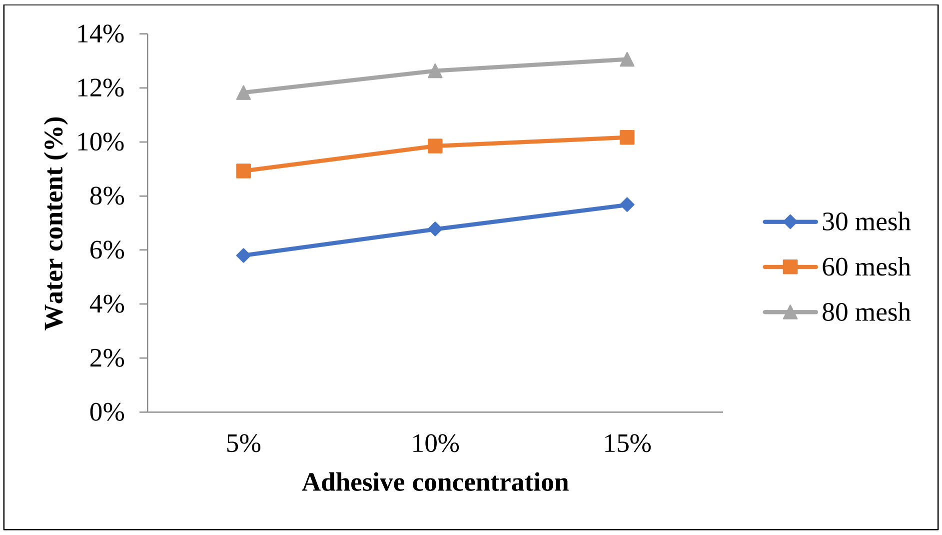
Water content is a parameter that is commonly used in briquette research, because the water content in briquettes will affect the quality of the briquettes. Water content has a direct influence on the strength of the briquettes to maintain the flame. Calculation of the water content value is carried out by comparing the initial weight with the weight of the briquettes after drying to the initial weight (Pratama et al, 2020). In the following table, the average value of water content from the test results is displayed as shown in table 2 below.

Table 2. Calculation results of water content in charcoal briquettes (%)

	M30	M60	M80
So5	5.74	8.36	12.91
So5	4.78	9.54	10.72
So5	6.87	8.87	11.84
Average	**5.80**	**8.92**	**11.82**
S10	7.11	9.24	12.55
S10	6.38	9.57	13.44
S10	6.82	10.73	11.90
Average	**6.77**	**9.85**	**12.63**
S15	7.79	10.08	13.01
S15	7.16	10.23	13.34
S15	8.72	10.19	12.82
Average	**7.89**	**10.17**	**13.06**

The calculation results in table 2 show that the highest water content was in the So15-80 treatment with an adhesive concentration of 15% and a particle size of 80 mesh had the highest value of 13.055% and the lowest water content was in the So5-30 treatment with an adhesive concentration of 5% and a particle size of 30 mesh of 5.796. %. This is in accordance with the initial hypothesis that the lower the adhesive concentration, the lower the water content.

Figure 3. Relationship between particle size and adhesive concentration on water content in charcoal briquettes



As seen in Figure 3, it shows that the more adhesive is added to the briquettes, the higher the water content produced. The resulting water content increases with increasing adhesive concentration. The more adhesive used will increase the water content value. Factors that cause high water content at greater adhesive concentrations. During the drying process using an oven, briquettes with a high adhesive concentration will evaporate more easily. Due to the high adhesive concentration, there is a higher water content. Thus, when calculating the water content value, briquettes with more adhesive concentration added produce a high water content. This is also in line with research conducted by Ulva and Romadhoni (2017), the higher the amount of adhesive used, the higher the water content.

In addition, Figure 3 also shows that the smaller the particle size in the briquettes, the higher the water content produced. The small particle size increases the water content value of the briquettes. The smaller the particle size, the easier it will be for the adhesive to enter the pores of the briquette, causing the briquette to have a higher density. The pores of the briquettes will become smaller and when dried, the adhesive in the briquettes' pores is easy to evaporate, so that during the drying process the small particle size is not good for absorbing the adhesive used. The high water content is due to the size of the pores between the particles which are able to absorb water in the adhesive. This is in line with research conducted by Priyanto et al (2018) on the water content of sengon wood briquettes in this study where the water content of the briquettes increased as the particle size of the sengon wood briquettes became smaller.

Based on the calculation of water content values, it shows that the So5-30 treatment has a water content value of 5.796%, the So10-30 treatment is 6.770% and the So15-30 treatment is 7.677%. These results indicate that the water content in briquettes with a particle size of 30 mesh with adhesive variations of 5%, 10% and 15% meets the SNI 01-6235-2000 standard, namely $\leq$ 8%.

IV. CONCLUSION

Based on the results of the research and discussions carried out, a conclusion was drawn that household waste charcoal briquettes have a calorific value that is still low, and cannot meet standards. Meanwhile, the lowest water content value was obtained when the adhesive concentration was 5% and the mesh 30 (So5-30) particle size was 5.80%, meeting SNI standard No. 01-6235-2000 < 8%

Conflict of interest

There is no conflict to disclose.

ACKNOWLEDGEMENT

The author would like to thank the Department of Mechanical Engineering, Faculty of Engineering, University of Mataram for the support of the facilities provided. Thanks are also expressed to colleagues who have contributed to the completion of this paper.

REFERENCES

[1]. Anonim 1. (2012). Pengelolaan sampah. Jakarta. Peraturan Pemerintah Republik Indonesia. PP RI no.18 tentang pengelolaan sampah rumah tangga dan sampah sejenis sampah rumah tangga.
[2]. Desgira, H. W. (2020). Pengaruh variasi perekat terhadap kualitas Briket dari serbuk daun teh (Doctoral dissertation, Universitas Islam Negeri Sumatera Utara).
[3]. Hamzah, M. (2019). Sampah plastik menjadi briket sebagai bahan bakar alternatif dengan penambahan paper waste. ALKIMIA: Jurnal Ilmu Kimia dan Terapan, 3(1), 20-25.
[4]. Jannah, R. (2018). Pengaruh jenis perekat terhadap nilai kalor briket arang tempurung kawista (Limonia acidissima) teraktivasi NaOH (Doctoral dissertation, Universitas Islam Negeri Maulana Malik Ibrahim).
[5]. Pane, J. P., Junary, E., & Herlina, N. (2015). Pengaruh konsentrasi perekat tepung tapioka dan penambahan kapur dalam pembuatan briket arang berbahan baku pelepah aren (Arenga pinnata). Jurnal Teknik Kimia USU, 4(2), 32-38.
[6]. Priyanto, A., Hantarum, H., & Sudarno, S. (2018, September). Pengaruh variasi ukuran partikel briket terhadap kerapatan, kadar air, dan laju pembakaran pada briket kayu sengon. Seminar Nasional Sains dan Teknologi Terapan (pp. 541-546).
[7]. Ristianingsih, Y., Ulfa, A., & KS, R. S. (2015). Pengaruh suhu dan konsentrasi perekat terhadap karakteristik briket bioarang berbahan baku tandan kosong kelapa sawit dengan proses pirolisis. Konversi, 4(2), 45-51.
[8]. Saragih, G. M., Marhadi, M., & Defriati, Y. (2020). Pengolahan sampah organik menjadi biobriket sebagai energi terbarukan. Jurnal Daur Lingkungan, 3(2), 58-61.
[9]. Suryaningsih, S., Anggraeni, P. M., & Nurhilal, O. (2019). pengaruh ukuran partikel terhadap kualitas termal dan mekanik briket campuran arang sekam padi dan kulit kopi. Jurnal Material dan Energi Indonesia, 9(02), 79.
[10]. Setyaningtyas, R., & Artiyani, A. (2018). Studi variasi komposisi bahan dasar briket dari sampah organik pasar. Jurnal rekayasa infrastruktur Hexagon, 3(2).
[11]. Seo, B., Yuniningsih, S., & Anggraini, S. P. A. (2015). Pengaruh kadar amilum dan ukuran partikel terhadap kualitas briket arang dari tempurung kelapa. eUREKA: Jurnal Penelitian Teknik Sipil dan Teknik Kimia, 1(1).
[12]. Ulva, S. M., & Romadhoni, W. (2020). Pengaruh variasi jumlah campuran perekat terhadap karakteristik briket berbahan dasar sekam padi dan serbuk gergaji. JPFT (Jurnal Pendidikan Fisika Tadulako Online), 8(2).
[13]. Virgiawan, S. (2014). Karakteristik pembakaran arang ampas tebu akibat ukuran partikel briket.