Performance Testing of Heating Value and Water Content on Organic Waste Biobriquette with Pressing System Capacity 8 Kg/Hour

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**Abstract.**  Biobriquettes are solid fuels from biomass such as sawdust, rice husks, straw, or other agricultural waste. Biobriquettes have the potential to be an environmentally friendly alternative energy source because biobriquettes have relatively lower carbon emissions than fossils. The biobriquette process involves refining biomass raw materials, mixing them with adhesives, and molding them with a press machine. Using bio briquettes as an alternative fuel can help reduce dependence on fossil fuels and reduce negative impacts on the environment. Biobriquette research has been widely conducted, but research using a variety of mixtures to make biobriquettes has not been widely conducted. This study is to determine how much the calorific value of bio briquettes and how much water content is in bio briquettes so that the optimal calorific value of bio briquettes is obtained. The problem that arises is how much the calorific value and the amount of water content in bio briquettes are more optimal. This research was conducted using an experimental method and data collection was carried out and tested in the laboratory to obtain the calorific value and water content. From the test and analysis results for sample 1 the average calorific value = 2576, 318 calories/gram, for sample 2 the average calorific value = 1765.024 Calories/gram and for sample 3: the average caloric value = 1029.076 calories/gram

**Keywords:** biobriquette; organic waste; performance; calorific value

# INTRODUCTION

Waste is still an unresolved problem and has no end in sight in Indonesia. According to the Ministry of Environment and Forestry (KLHK), around 37.3% of the 67.8 million tons of total waste in Indonesia is generated from household activities, then traditional markets contribute 16.4%, regions 15.9%, and 14.6% comes from other sources. Around 55.87% of waste was successfully managed throughout 2020, but the remaining 44.13% of waste is still left and has not been managed.

Until now, most Indonesians still think that waste accumulation is a government problem. To reduce the amount of waste accumulation in final disposal sites (TPA), it is necessary to process the waste. The results of a survey at several landfills, most of the waste is separated before being disposed of in final disposal. This separation is carried out to separate organic waste and inorganic waste. Organic waste usually comes from plant and animal remains. Inorganic waste usually consists of used bottles, clear plastic, glass, and iron. Inorganic waste in the form of plastic waste usually has resale value so this type of waste the disposal will still be collected. Sorting inorganic waste leaves piles of organic waste in the disposal. Organic waste is currently not widely utilized. The remaining organic waste is only collected and piled up in the final waste disposal site.

The large amount of waste can be an opportunity for the community to process and create alternatives for organic and inorganic waste effectively. With the use of abundant waste raw materials and a fairly easy process, the community can make briquettes. Processing organic and inorganic waste by making charcoal briquettes is certainly very useful and quite promising if the community is serious about pursuing it [1].

Briquettes are charcoal that comes from waste including straw, wood, bagasse, peanut shells, cotton stalks, rice husks, and their agricultural waste which has less carbon emissions. The briquette molding process is a technique for making solid fuel, the process involves binding together finely ground carbon materials, often with adhesives. The briquette-making process can be done manually and mechanically using a screw press, piston press, or hydraulic press. Mechanically where the machine is the driver and several other supporting components so that the pressing system can run perfectly. Briquettes have several factors, namely the materials used, the fineness of the carbonization results, the carbonization temperature, the density of the charcoal, and the density and pressure in the briquette molding process. The calorific content and water content are one of the determining factors as to whether bio briquettes are suitable for use by the community or not, because Indonesia has a standard for the quality of bio briquettes [2].

Biobriquette performance testing is very important to determine the calorific value and water content, to be able to produce perfect biobriquette products, and to be able to know where the deficiencies in the mixture used in the product lie, to minimize errors in the data used in further research [3, 4].

# METHODS

This research was conducted to evaluate the performance of organic waste biobriquettes in terms of heating value and water content using a pressing system with a capacity of 8 kg/hour. The study followed a structured approach, beginning with a literature review to gather relevant information on organic waste management, biobriquette production techniques, and the use of bomb calorimetry for caloric value testing. This phase helped in understanding previous studies and identifying gaps in knowledge, as well as optimizing the methodology for the biobriquette production process.

The next phase involved selection of organic waste raw materials based on availability and potential caloric content. The selected organic waste materials were then subjected to drying, where they were placed in controlled environments to reduce moisture content to an optimal level for carbonization. Following this, the organic waste underwent carbonization or charring, in which the materials were heated in a low-oxygen environment to convert them into a carbon-rich substance suitable for biobriquette production.

After the carbonization process, the carbonized material was mixed with a suitable adhesive in specific proportions to enhance the binding properties, followed by biobriquette printing using a pressing machine with an 8 kg/hour capacity. Once the biobriquettes were formed, they were subjected to performance testing. The caloric value was measured using a bomb calorimeter, and the water content was assessed based on standard methods for moisture analysis.

Finally, the results from the caloric value and water content tests were analyzed and compared with benchmarks from previous studies. The analysis phase also involved evaluating the efficiency of the pressing system and its potential for scale-up. The study concluded with a discussion on the viability of biobriquettes produced from organic waste as an alternative fuel source and the performance of the 8 kg/hour pressing system.

# RESULTS AND DISCUSSION

The study will discuss the percentage of water content and calorific value in each sample tested 5 times. while the analysis is as follows:

## Water Content Test Analysis

After testing using a moisture meter, the following **TABLE 1** shows average data results. The water content value with a percentage of 15% starch adhesive, then the average percentage of water can be known as follows:

Sample 1 = 14,41+12,21+14,20+13,87+11,19

5

= 14.39 %

**TABLE 1** : Water content test results

|  |  |  |  |
| --- | --- | --- | --- |
| Name of Material | Moisture Content Before | Moisture Content After | Reduction Moisture Content |
| Sample 1 | 15% | 14.41% | 0.59**%** |
| Sample 1 | 15% | 12.21% | 2.79% |
| Sample 1 | 15% | 14.20% | 0.80% |
| Sample 1 | 15% | 13.87% | 1.13% |
| Sample 1 | 15% | 11.19% | 3.81% |
| Sample 2 | 30% | 21.41% | 8.59% |
| Sample 2 | 30% | 23.43% | 6.57% |
| Sample 2 | 30% | 22.93% | 7.07% |
| Sample 2 | 30% | 24.26% | 5.74% |
| Sample 2 | 30% | 22.46% | 7.54% |
| Sample 3 | 50% | 41.37% | 8.63% |
| Sample 3 | 50% | 44.13% | 5.87% |
| Sample 3 | 50% | 41.89% | 8.11% |
| Sample 3 | 50% | 41.02% | 8.98% |
| Sample 3 | 50% | 43.75% | 6.25% |

The water content value with a percentage of 20% starch adhesive, then the average water percentage can be known as follows:

Sample 2 = 21,41+23,43+22,93+24,26+22,46

5

= 22.898 %

The water content value with a percentage of 25% starch adhesive, then the average water percentage can be known as follows:

Sample 3 = 41,37+44,13+41,89+41,02+43,75

5

= 42.632 %

**SAMPLE 1**

4.50%

4.00%

3.50%

3.81%

3.00%

2.50%

2.00%

1.50%

1.00%

0.50%

0.00%

2.79%

1.13%

0.59%

0.80%

Testing- 1 Testing- 2 Testing- 3 Testing- 4 Testing- 5

**FIGURE 1.** Graph of the relationship between sample testing and water content reduction in sample 1

In the first sample, 5 tests were carried out and the average water content shrinkage value was 1,824%, as shown in **FIGURE 1**.

**SAMPLE 2**

10.00%

9.00%

8.00%

7.00%

6.00%

5.00%

4.00%

3.00%

2.00%

1.00%

0.00%

8.59%

6.57%

7.07%

7.54%

5.74%

Testing- 1 Testing- 2 Testing- 3 Testing- 4 Testing-5

**FIGURE 2.** Graph of the relationship between sample testing and water content reduction in sample 2

In the second sample, 5 tests were carried out and the average water content shrinkage value was 7.102%, as shown in **FIGURE 2**.

**SAMPLE 3**

10.00%

9.00%

8.00%

7.00%

6.00%

5.00%

4.00%

3.00%

2.00%

1.00%

0.00%

8.63%

8.98%

8.11%

5.87%

6.25%

Testing-1 Testing- 2 Testing- 3 Testing-4 Testing- 5

**FIGURE 3.** Graph of the relationship between sample testing and water content reduction in sample 3

In the third sample, 5 tests were carried out and the average water content shrinkage value was 7,568%, as shown in **FIGURE 3**.

Based on the test results of 3 biobriquette samples, the effect of starch adhesive was obtained from the water content test results. Where the largest reduction in water content in organic waste biobriquettes was found in a mixture of 70%: 25%



**FIGURE 4.** Graph of sample relationship to percentage of water content shrinkage

Based on the data obtained in **TABLE 2**, a graph is obtained as above with 3 biobriquette samples where the percentage of organic waste material with starch is 50%: 15%, 50%: 20%. 50%: 25%. Based on the data and graphs obtained, it can be described that the more starch mixture used, the higher the water content in the biobriquette. This is because starch has the property of not being resistant to humidity so it easily absorbs water and air.

## Calorific Value Data Analysis

**TABLE 2**. Calorific Value Test Results

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Number** | **Code of Sample Name** | **Sample Mass (g)** | **Temperature (°C)** | | | **Calorific Value (cal/gram)** |
| **Beginning** | **End** | **ΔT** |
| 1 | Sample 1 | 1 | 25.5 | 26.64 | 1.14 | 2764.37 |
| 2 | Sample 1 | 1 | 25.5 | 26.58 | 1.08 | 2680.06 |
| 3 | Sample 1 | 1 | 25.4 | 26.56 | 1.06 | 2668.03 |
| 4 | Sample 1 | 1 | 25.5 | 26.51 | 1.01 | 2406.87 |
| 5 | Sample 1 | 1 | 25.4 | 26.37 | 0.97 | 2362.26 |
| 6 | Sample 2 | 1 | 25.8 | 26.22 | 0.42 | 1023.72 |
| 7 | Sample 2 | 1 | 25.5 | 26.44 | 0.94 | 2328.71 |
| 8 | Sample 2 | 1 | 24.9 | 25.57 | 0.67 | 1627.73 |
| 9 | Sample 2 | 1 | 25.6 | 26.63 | 0.76 | 1887.29 |
| 10 | Sample 2 | 1 | 25.6 | 26.43 | 0.83 | 1957.67 |
| 11 | Sample 3 | 1 | 25.4 | 25.83 | 0.43 | 1048.81 |
| 12 | Sample 3 | 1 | 24.9 | 25.32 | 0.42 | 1023.72 |
| 13 | Sample 3 | 1 | 24.9 | 25.32 | 0.42 | 1022.87 |
| 14 | Sample 3 | 1 | 25.3 | 25.30 | 0.40 | 1019.27 |
| 15 | Sample 3 | 1 | 25.8 | 26.21 | 0.41 | 1032.21 |

After testing using a moisture meter, the following average data results were obtained. The calorific value with a percentage of 15% starch adhesive, then the average percentage of heat can be known as follows:

Sample 1 = 2764.37+2680.06+2668.03+2406.87+2362.26

5

= 2576.318 cal/gram

The calorific value with a percentage of 20% starch adhesive, then the average percentage of heat can be known as follows ;

Sample 2 = 1023.72+2328.71+1627.73+1887.29+1957.67

5

= 1765.024 cal/gram

The calorific value with a percentage of 25% starch adhesive, then the average percentage of heat can be known as follows :

Sample 3 = 1048.81+1023.72+1022.87+1019.27+1032.21

5

= 1029.376 cal/gram

SAMPLE- 1

2800

2764.37

2700

2680.06

2668.03

2600

2500

2400

2406.87

2406.87

2300

2200

Testing-1 Testing- 2 Testing-3 Testing-4 Testing- 5

**FIGURE 4**. Graph Of The Relationship Between Testing And Calorific Value In Sample 1

The **FIGURE 4**, In the first sample, 5 tests were carried out and the average calorific value was 2576.318 cal/gram.

SAMPLE- 2

2500

2328.71

2000

1887.29

1957.67

1500

1627.73

1000 ~~1023.72~~

500

0

Testing- 1 Testing- 2 Testing- 3 Testing- 4 Testing- 5

**FIGURE 5**. Graph Of The Relationship Between Testing And Calorific Value In Sample 2

Based on **FIGURE 5**, in the second sample, 5 tests were carried out and the average calorific value was 1765.024 cal/gram.

SAMPLE-3

1055

1050

1045

1040

1035

1030

1025

1020

1015

1010

1005

1000

1048.81

1032.21

1023.72

1022.87

1019.27

Testing-1 Testing- 2 Testing-3 Testing-4 Testing- 5

**FIGURE 6.** Graph Of The Relationship Between Testing And Calorific Value In Sample 3

Based on **FIGURE 6**, for the third sample, 5 tests were carried out and the average calorific value was 1029.376 cal/gram.

3000

2500

2576.318

2000

1765.024

1500

1000

500

0

Sample- 1

Sample- 2

1029.076

Sample-3

**FIGURE 7.** Graph of the relationship between the average heating value of sample variations and the heating value

Based on the data in **TABLE 1**, a graph is obtained with 3 biobriquette samples where the percentage of organic waste material with starch is 50%: 15% (sample-1), 50%: 20% (sample-2). 50%: 25% 9sample-3). Based on the data and graphs, it can be described that the more starch mixture used, the higher the water content in the biobriquette. This is because starch has the property of not being able to withstand humidity so it easily absorbs water and air [5]

Waste is goods or objects that are no longer useful and must be discarded. Waste is a daily problem faced by all levels of society, both in cities and villages, in developed and developing countries. Many uses and management of waste are inadequate, even though if the waste produced by urban communities is utilized, it will be able to produce heat energy. Waste has the potential to become a more environmentally friendly fuel and has a high calorific value, namely through the bio-drying process followed by the densification or briquetting process to form a briquette. The presence of this heat energy can be done, one of which is by using a bomb calorimeter. The calorific value of waste depends on the water content in the waste, food waste has a calorific value of 5875.5689 cal/gr, leaf waste is 5334.4857 cal/gr, wood/twig waste is 5975.5871 cal/gr, the highest percentage of water content is wood/twig waste around 13.7495% of the total volume of waste in the landfill. The calorific value of organic waste can be increased through the Bio-drying process, which is the management of organic fractions of municipal and household solid waste (MSW) to reduce water content so that it can be used for energy recovery because it allows energy production. This is done to obtain the best materials and have high calorific value in making briquettes as alternative fuels.

Based on the data in **FIGURE 7**, a graph is obtained with 3 biobriquette samples where the comparison of organic waste material used is 50% : 15% (sample-1), 50% : 20% (sample-2), and 50% : 25% (sample-3). The largest average data obtained is with a comparison of 50%: 15% which obtains a value of 2576.318 cal/gram

# CONCLUSIONS

From this study, it can be concluded that :

1. From the study of the 3 samples, the water content value of organic waste bio briquettes is found in samples with a percentage of 20%, namely with a value of 22,898% where this value is still far from the standard quality of briquettes in indonesia, namely with a value of 8%.
2. For the three studies, the calorific value of organic waste biobriquettes is at a percentage of 15% with a value of 2576,318 cal/gram, this is considered appropriate because biobriquettes can burn perfectly. however, this is considered lacking because the value obtained is still very far from the standard calorific value in indonesia with a value of 5000 cal/gr.

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