Jurnal Reaksi (Journal of Science and Technology)
Jurusan Teknik Kimia Politeknik Negeri Lhokseumawe
Vol. 22 No.02, Desember 2024 ISSN 1693-248X

APPLICATION OF *BIODRYING TECHNOLOGY* IN THE PROCESSING OF BRIQUETTES FROM ORGANIC WASTE IN LHOKSEUMAWE CITY

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ABSTRACT

Waste is unwanted waste material after the end of a certain process. There are various processes that can be applied to produce dry waste using *biodrying* technology. The purpose of this study is to study *biodrying technology* for the processing of organic waste in Lhokseumawe City to become briquettes and the length of the biodrying process on the quality of briquettes produced from EM4 variations. This study used two independent variables, namely 14 and 21 days of biodrying process and EM4 variations, namely 100 ml, 200 ml, 300 ml, 400 ml and 500 ml. The results of this study show that those that meet the SNI No.1/6235/2000 standard are only ash content testing, volatility content and flame length test, while the moisture content test does not meet SNI No.1/6235/2000 standard.

Keywords: Organic waste, *biodrying* and SNI No.1/6235/2000.

ABSTRACT

Waste is unwanted leftover material after the end of a certain process. There are various processes that can be applied to produce dry waste using biodrying technology. The aim of this research is to study biodrying technology for processing Lhokseumawe City organic waste into briquettes and the length of time for the biodrying process on the quality of briquettes produced from the EM4 variation. This research used two independent variables, namely 14 and 21 days of the biodrying process and variations of EM4, namely 100 ml, 200 ml, 300 ml, 400 ml and 500 ml. The results of this research show that the only things that meet SNI No.1/6235/2000 standards are the ash content, volatile content and flame duration tests, while the water content test does not meet SNI No.1/6235/2000 standards.

Keywords: Organic waste, biodrying and SNI No.1/6235/2000.

1. INTRODUCTION

Waste is a very serious problem for the environment globally, where each individual produces an average of 0.45 kilograms of waste in one day [1].

In the city of Lhokseumawe, 16 tons of waste are produced in a day based on data obtained by the author from the Central Statistics Agency of Aceh Province in 2022, where the waste is obtained from households, shopping centers, offices and others [2].

Waste is something that is not used, not used, not liked and not useful so it must be thrown away, while according to the *World Health Organization* (WHO) waste is something made from human activities that does not occur by itself [3].

One of the waste processing processes, especially organic waste, is by making

briquettes using *biodrying* technology , which is to utilize municipal waste in Lhokseumawe to become a source of renewable energy, this is considering the amount of waste produced in a very large amount in one day. If renewable energy sources are found from waste, it can help the energy supply where the national energy reserves are depleting so that it is very worried about the energy crisis in the future. *Effective Microorganism* 4 (EM4) is a microorganism (bacteria) that can help the process of decaying organic waste so that it can be beneficial for plant growth and others.

Biodrying is the process of removing higher moisture content in organic waste by using the heat generated during aerobic degradation of organic waste substances [4].

The biodrying *process* can be carried out by aeration which aims to introduce oxygen for the growth of microorganisms as well as bring out the steam formed in the reactor. By aeration, the water will partially evaporate and seep into the bottom of the reactor. The *biodrying* process in Lhokseumawe City waste is more focused on removing moisture content so that it can be used as renewable energy, namely briquettes.

The following are previous research on waste to become a source of renewable energy, including research that has been conducted by [5] with the title of research on organic waste and biomass waste processing with waste treatment technology at the source. From the results of the study, it was obtained that biomass pellets with a diameter of 10 mm and a length of between 10-40 mm have a calorific value of 3000-4000 kcal/kg and a moisture content as high as 15%. Based on research that has been conducted by [6] with the title of research on the use of food waste as alternative fuels by *the biodrying method*. From the results of the study, it was obtained that the use of a 14-day stay with an air discharge of 7 liters/minute had a calorific value of 4952 cal/g while in an air discharge of 4 liters/minute 4064 cal/g was obtained. Based on research that has been conducted by [7] with the title of research on *biodrying* technology to increase the calorific value of waste and its projection as an alternative fuel in 2028. From the results of the study, it can be concluded that the longer the waste is in the *biodrying* reactor, the higher the calorific value produced from the briquettes.

From the results of previous research, in this study the researcher tried to do a variation of EM4 in the *biodrying* process using organic waste.

2. RESEARCH METHODS

2.1 Place and Time

This research will be carried out for 4 months, starting from February 2024 to May 2024. The location of the research was carried out at the Water and Waste Treatment Laboratory at the Department of Chemical Engineering, Lhokseumawe State Polytechnic.

2.2 Tools

The tools used in making briquettes from organic waste by applying *biodrying* technology are as follows:

1. Biodrying *reactor.*
2. Press machine .
3. *Stopwacth.*
4. Scales.
5. caliper.
6. Filter.
7. Blower.
8. Electrical equipment.

9. Briquette printer.
10. *Crusher*

2.3 Materials

The materials used in making briquettes from organic waste by applying *biodrying* technology are as follows:

1. Organic waste in Lhokseumawe City
2. Tapioca flour and water

2.4Research Variables

2.4.1 Fixed Variables

The fixed variables that will be used in this study are:

1. Total weight of organic waste: 5000 grams
2. Tapioca flour adhesive weight: 300 grams
3. Briquette drying time: 15 days
4. Briquette shape: Cylinder (4.5 cm long, 2 cm diameter)
5. Briquette particle size: $\leq$ 40 mesh

2.4.2 Independent Variable

The independent variables that will be used in this study are:

Immersion time in *biodrying* reactors: 14 and 21 days

EM4 Volume: 100 sampai 500 ml

2.2.3 Bound Variables

1. Moisture Test
2. Volatile Test
3. Ash Test
4. Long test/start-up time

2.5 Research Procedures

2.5.1 Preparation of Raw Materials

Organic waste that will be used as the main raw material for making briquettes is organic waste from Lhokseumame City. The main stage that will be carried out is the drying process using *biodrying* technology which aims to reduce the moisture content of the organic waste. The *biodrying* steps for organic waste are as follows:

1. Put 5000 grams of organic waste into *the biodrying* device for one experiment.
2. Add 100 ml of EM4 to 5000 grams of organic waste for one experiment.
3. Starting the wind blower engine.
4. Immerse organic waste in *a biodrying* device for 14 and 21 days.
5. For the other variables, the same experiment can be done.

2.5.2 Crushing and Sieving

The process of destroying organic waste after the drying process is carried out using *biodrying* technology with *a crusher.* After the destruction of the organic waste, it was filtered with a sieve measuring 40 mesh.

2.5.3 Manufacture of Adhesive Materials

The process of making adhesive is by mixing 300 grams of tapioca flour and 700 ml of water, then stirring until homogeneous. After that, the adhesive material that has been homogeneously mixed is heated to a temperature of 100^{o}C until the adhesive thickens and is clear white to brass.

2.5.4 Mixing Adhesives with Organic Waste

After the organic waste is 40 mesh in size, it is mixed with adhesive material.

2.5.5 Printing Process

After perfect mixing, pressing is carried out with a pressure of 200 kg/cm2.

2.5.6 Drying Process

Briquettes that have been printed are dried in the sun for 15 days until the lowest moisture content. The briquette drying process aims not to be disturbed by

the calorific value and combustion rate at the time of testing.

3.5 Testing

3.5.1 Long Test/Ignition Time

The long/time test data collection is as follows:

1. Take one specimen of Lhokseumawe City organic waste briquettes for each use of EM4.
2. Burn the specimen until it becomes ashes.
3. The duration/time of ignition is calculated from the time it has burned using the stopwacth.

3.5.2 Up to Air

Moisture content analysis using the Moisture Analyzer Mx-50 tool. The testing steps using the tool are as follows:

1. Prepare the Mx-50 Moisture Analyzer tool.
2. Connect the cord to the mains current.
3. Press the open button to turn on the Mx-50 Moisture Analyzer tool.
4. The device is set for biobriquette charcoal measurements using:
   a. Temperature: 120^{o}C
   b. Heating program: 1
   c. *Acuracy* MID Program Sample Weight: 5 grams
   5. Prepare the material to be analyzed, each sample is crushed first.

3.5.3 Up to Abu

The ash content test aims to determine the ash waste produced after the briquettes undergo the combustion process. The procedure for measuring the ash content of the resulting briquettes is as follows:

1. Weigh porcelain cups or sample containers with analytical balances.
2. Weigh the weight of each briquette sample.
3. The sample in a porcelain cup is put in an oven at 600^{o}C for 1 hour.
4. The material is cooled in a desiccant then weighed and the result of the weighing is reduced by the weight of the porcelain cup.
5. Take samples for burning.
6. After the incineration process is completed, the ash waste produced is weighed using a scale to find out the ash content produced. Calculate the ash content with the following equation:

   Ash Content = × 100% $\frac{M3-M1}{M2-M1}$

   Where

   M1 : Weight of empty cup + lid (g).

   M2: Cup weight + lid + sample (g).

   M3 : Cup weight + lid + sample after heating (g).

3.5.4 Volatile Up

1. Tools and materials are prepared in a clean state.
2. Empty cups on the scale.
3. After that, the samples were weighed as much as 5 grams each.
4. Then the sample is put into *furnance* and set at a temperature of 950^{o}C for 7 minutes.
5. Wait until the temperature on the *furnance* decreases.
6. The sample is removed from the *furnace* and weighed to obtain a dry weight.
7. After that, *the furnance* is turned off and the appliance is washed with water. Volatility calculation formula:

   Volatile Test = × 100% - IM $\frac{w1-w2}{w1}$

   Where

   w1: Sample weight (g)

w2: Weight of place after heating(g)

IM : Moisture content (%)

3. RESULTS AND DISCUSSION

3.1 Research Result Data

Based on the results of testing briquettes from organic waste in Lhokseumawe City using *biodrying* technology which was carried out on June 27, 2024 at the Testing Laboratory of the Department of Chemical Engineering, Lhokseumawe State Polytechnic which aims to determine the value of moisture content, ash content, volatility content and flame time for EM4 variations both 100 ml, 200 ml, 300 ml, 400 ml and 500 ml, The data from the test results can be seen in Table 1.

Table 1 Data of briquette test results

No	Sample name	Biodrying time	Specifications (ml)	Testing			
				Moisture (%)	Ash (%)	Volatile (%)	Ignition time (Minutes)
1	2	3	4	5	6	7	8
1	Briquette	14 days	100 ml	14,12	8,27	7,2	8,50
2			200 ml	14,37	8,64	8,17	8,20
3			300 ml	15	8,16	8,04	04
4			400 ml	15,96	8,89	7,16	3
5			500 ml	15,39	9,44	8,60	4,50
1	Briquette	21 days	100 ml	12,17	5,27	4,2	15
2			200 ml	12,37	5,64	4,17	10
3			300 ml	12,69	6,16	5,04	08
4			400 ml	13,96	6,89	5,16	07
5			500 ml	14,39	6,44	5,60	05

3.2 Discussion

3.2.1 Effect of EM4 Variation on Moisture Content Test Results

In this study, the moisture content tested for each EM4 variation for each sample had gone through a biodrying process for 21 days and 14 days. Testing the moisture content of briquettes that have been biodried for 21 days and 14 days is carried out to find out how much moisture content is contained in the briquettes. If the high moisture content value in the organic waste briquettes in Lhokseumawe City can cause the ignition process to become more difficult and produce a lot of smoke. The moisture content value that must be achieved in the briquettes that have been produced must be based on the SNI standard No.1/6235/2000, which is ≤ 8%.

The data from the moisture content test results in organic waste briquettes in Lhokseumawe City for each variation of EM4 are either 100 ml, 200 ml, 300 ml, 400 ml and 500 ml, as can be seen in Figure 1

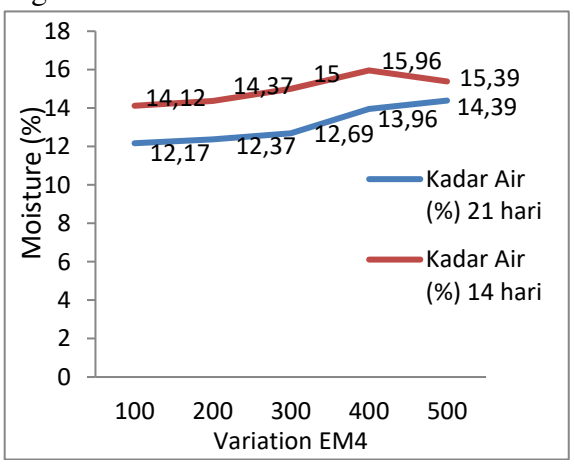

Figure 1 Effect of EM4 variation on briquette moisture content value

Based on Figure 1, it can be seen that the moisture content values in organic waste briquettes in Lhokseumawe City after the biodrying process for 21 days with EM4 variations of 100 ml, 200 ml, 300 ml, 400 ml and 500 ml have moisture content values of 12.17%, 12.37%, 12.69%, 13.96% and 14.39% respectively.

Meanwhile, for 14 days, it has water content values of 14.12%, 14.37%, 15%, 15.96% and 15.39% respectively.

From the results of the study, the water content value for the biodrying process for 21 days and 14 days in the briquettes is directly proportional to the addition of EM4, but this is inversely proportional to the opinion expressed by [8] stating that the addition of EM4 can accelerate the fermentation reaction so that it can reduce the fermentation time. Thus, it can be said that with the increase in the volume of EM4, organic waste will be drier. However, the results of the study obtained with variations of EM4 100 ml, 200 ml, 300 ml, 400 ml and 500 ml are inversely proportional to the previous opinion, this occurred not during the biodrying process for 21 days and 14 days, but during the drying of briquettes such as:

1. The adhesive properties of tapioca flour are not resistant to moisture so that it easily absorbs water from the air.
2. The drying of the briquettes after the printing process is not perfect so that there is still water content in the briquettes.

From the results of the moisture content test on organic waste briquettes in Lhokseumawe City, it can be said that the higher the moisture content, the more difficult the briquettes are to be ignited when burned and cause a lot of smoke. In this study, the moisture content values for the 21-day and 14-day biodrying processes have not met the SNI criteria No. 01-6235-2000, which requires a maximum moisture content value of 8%.

3.2.2 Effect of EM4 Variation on Ash Content Test Results

Ash content is one of the important parameters in determining the quality of briquettes because ash-free fuel has better combustion properties. The determination of ash content is carried out with the aim of finding out the unburned parts that no longer have carbon elements after the briquettes are burned. According to SNI standards, the ash content that must be owned by briquettes is not more than 8%. The smaller the ash content, the better the quality of the briquettes, because if the ash content is high, it can be interpreted that the briquettes contain high silica as well. The element silica is an element that has a bad influence on the quality of briquettes.

The data on the results of ash content testing in organic waste briquettes in Lhokseumawe City for each variation of EM4 is either 100 ml, 200 ml, 300 ml, 400 ml and 500 ml, as can be seen in Figure 2

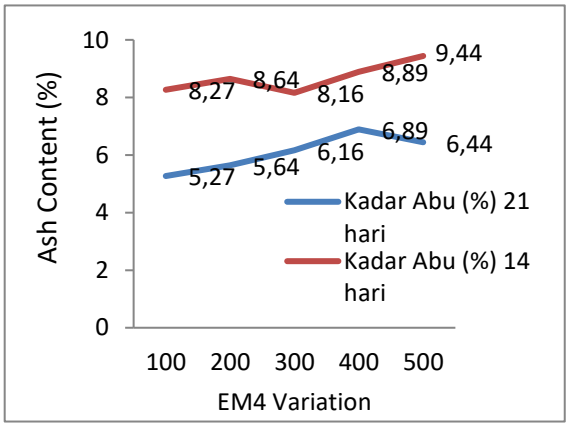

Figure 2 Effect of EM4 variation on briquette ash content value

Based on Figure 2, it can be seen that the ash content values in organic waste briquettes in Lhokseumawe City after the biodrying process for 21 days with EM4 variations of 100 ml, 200 ml, 300 ml, 400 ml and 500 ml have ash content values of 5.27%, 12.37%, 5.64%, 6.89% and 6.44% respectively. Meanwhile, for 14 days, the ash content values were 8.27%, 8.64%, 8.16%, 8.89% and 9.44% respectively.

From the test results, the ash content value increased at 100 ml to 400 ml for 21

days, at 500 ml on 21 days there was a decrease in ash content from the use of EM4 at 400 ml, while on 14 days there was a decrease in ash content at 300 ml. The increase in ash content for each variation of EM4 both 21 days and 14 days is influenced by the raw materials used and the imperfect carbonization process so that the ash content becomes higher, where the higher the ash content in the briquettes affects the combustion rate due to the low heat transfer to the inside of the briquettes and the diffusion of oxygen to the surface of the charcoal briquettes during the combustion process and the high ash content can produce dust emissions that are causing air pollution and affecting the volume of its combustion.

As for other factors that cause high ash levels due to the silica element in the briquettes, this is in accordance with the opinion put forward by [9] where, the increase in silica has a bad influence on the quality of briquettes. In this study, the ash content value produced from organic waste briquettes in Lhokseumawe City has been biodrying for 21 days to meet SNI standards No.1/6235/2000, because the ash content value is below 8%, while the 14-day biodrying process does not meet SNI standards No.1/6235/2000.

3.2.3 Effect of EM4 Variation on Volatility Test Results

In this study, the volatile levels tested for each EM4 variation for each sample had gone through a biodrying process for 21 days and 14 days. Testing of volatility levels in briquettes that have been biodried for 21 days and 14 days was carried out to determine how much carbon content was bound when burning organic waste briquettes in Lhokseumawe City after EM4 variations were carried out for one experiment starting from 100 ml, 200 ml, 300 ml, 400 ml and 500 ml. for more clarity on the volatility rate of each EM4 variation as can be seen in Figure 3

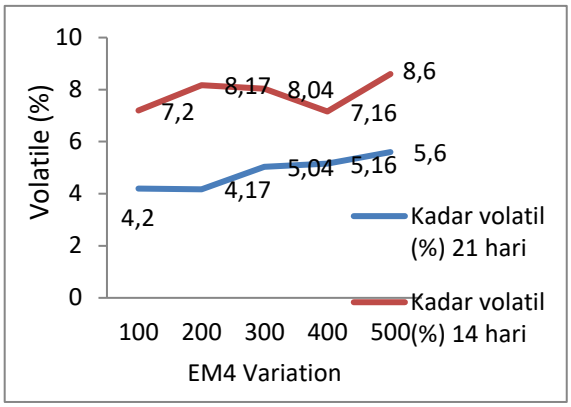

Figure 3 Effect of EM4 variation on the value of briquette volatility rate

Based on Figure 3, it can be seen that the value of volatility in organic waste briquettes in Lhokseumawe City after the biodrying process for 21 days with variations of EM4 of 100 ml, 200 ml, 300 ml, 400 ml and 500 ml has volatile content values of 4.2%, 4.17%, 5.02%, 5.16% and 5.60% respectively, while the biodrying process for 14 days has a volatile level of 7.2% consecutively. 8.17%, 8.04%, 7.16% and 8.6%.

From the results of testing the value of volatility content in organic waste briquettes in Lhokseumawe City, it increased along with the increase in the volume of EM4 for the biodrying process for 21 days, but in 200 ml of EM4 for the biodrying process for 21 days there was a decrease in the value of the volatile content of 0.3% from 100 ml of EM4, while in the 14-day biodrying process for 300 ml and 400 ml of EM4 decreased, However, the decrease in the volatility level for the 21-day biodrying process does not have a significant effect so that it can be said that the addition of EM4 is directly proportional

to the value of the volatile content obtained, this is influenced by the moisture content in the briquettes both in the 21-day and 14-day biodrying processes.

The higher the amount of volatility, the higher the amount of smoke will be caused when the briquettes are burned, this is due to the reaction between carbon monoxide (CO) and alhokol derivatives [10]. The high carbon monoxide content has a bad impact on health and the environment. Another factor that causes high volatility levels in organic waste briquettes in Lhokseumawe City is influenced by the briquette drying process. The longer the drying time of the briquettes, the lower the moisture content, the more volatile the level also decreases so that the smoke disappears and the quality of the briquettes increases. In this study, the value of the volatile content produced from organic waste briquettes in Lhokseumawe City has met the SNI standard No.1/6235/2000, because the value of the volatile content is below 15% for both the biodrying process for 21 days and 14 days.

3.2.4 Effect of EM4 Variation on Flame Length Test Results

In this study, the flame time test is very necessary so that the flame time for each sample for organic waste briquettes in Lhokseumawe City is determined after EM4 variations are carried out both 100 ml, 200 ml, 300 ml, 400 ml and 500 ml. for more clarity on the flash time of each EM4 variation as can be seen in Figure 4

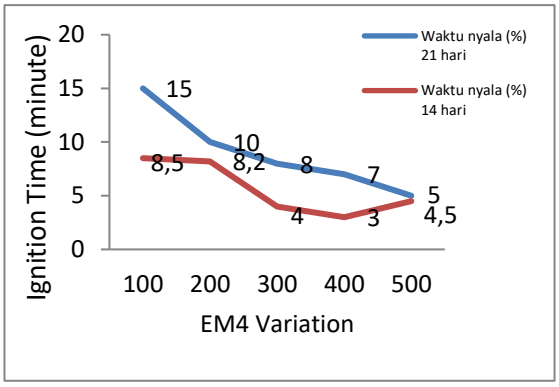

Figure 4 Effect of EM4 variation on flame time

Based on Figure 4, it can be seen that the flame time of the briquettes is inversely proportional to the EM4 variation for the 21-day biodrying process, this is due to the moisture content that has increased at 200 ml of EM4 to 500 ml so that the flame time decreases, while the moisture content in the EM4 variations of 200 ml, 300 ml, 400 ml and 500 ml has a water content value of 12.37% respectively, 12.69%, 13.96% and 14.39%. As for the 14-day biodrying process, the ignition time is below 21 days of the biodrying process.

In the results of the flame time test, the results are inversely proportional to the opinion put forward by [11] saying that the longer the flame time of the briquettes, the better the quality of the briquettes produced. However, in this study, the results obtained are inversely proportional, this is influenced by the moisture content in each specimen.

3.3 Effect of Biodrying Process Duration on Briquette Quality

For the results of the test on the effect of the biodrying process on the quality of organic waste briquettes in Lhokseumawe City for the 21-day and 14-day biodrying processes, as shown in Figure 5

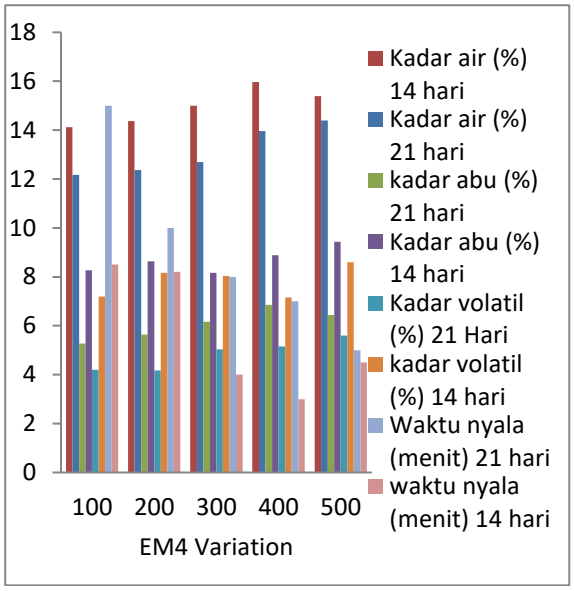

Figure 5 Effect of biodrying process time on briquette quality

Based on Figure 5, it can be seen that the effect of the biodrying process duration for 21 days and 14 days on the quality of briquettes can be said that the longer the *biodrying* process , the better the quality of the briquettes produced, this can be seen from *the biodrying* process for 21 days has met the SNI No.1/6235/2000 standard for ash content and volatile content. As for the *biodrying process* for 14 days, it does not meet the SNI No.1/6235/2000 standards both moisture content, ash content and volatile content.

4. CONCLUSION

1. The more EM4, the better the quality, this is marked by the increase in testing carried out on organic waste briquettes in Lhokseumawe City, namely moisture content tests, ash content, volatility levels and flame duration tests.
2. The longer the process time, the quality of the briquettes produced, the better the quality of the briquettes produced. Of the test results that meet the SNI No.1/6235/2000 standard, only the ash content, volatility and flame duration test are tested, while the moisture content test does not meet the SNI No.1/6235/2000 standard.

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