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POTENSIAL OF TOFU WASTE AS BIOGAS WITH THE ADDITION OF MANURE AND SAWDUST

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ABSTRACT

The use of fuel contributes to emissions to the air, burning plastic waste as fuel in tofu factories and cattle farms contains dioxins which pollute the surrounding environment moreover its fume is very concentrated and emits very fuel smells. From a health perspective, it causes cancer and respiratory problems. Green fuel replacement is needed to reduce emissions released into the air. The biogas product is a fuel that contains methane (50% - 75%) and carbon dioxide (25% - 40%), with small amounts of hydrogen sulfide, nitrogen and oxygen. This research used manure, tofu waste, tofu dregs, and sawdust varied by 10% NaOH pretreatment method. The process is carried out anaerobically to produce methane gas on the 30th day of (36.67%) with a ratio of manure: tofu dregs: tofu waste: saw dust (without pretreatment) (1 : 1 : 2 : 2), the content of CO_2 (4.044%) and air content (59.28%). The color of the fire and the duration of the flame were analyzed every 10^{th}, 15^{th}, 20^{th}, 25^{th}, 30^{th} day and the largest flame duration was 6.39 minutes with a blue flame.

KEY WORDS : Biogas, Methane, Tofu waste

INTRODUCTION

Mr Muhajir's tofu and cow milk factory located in Krian, Sidoarjo Regency is one of several tofu industrial centers in Tropodo Village. Reviewing the production process which is carried out using plastic waste as fuel. The losses resulting from the production process of plastic waste fuel, namely plastics containing dioxins, which can release when the plastic is burned so that it pollutes the surrounding environment such as air because the smoke produced is very thick and stings each other. Dioxins as toxins can interfere with human health and can cause cancer.

Tofu waste and cow dung from Mr. Muhajir's factory production process is processed to produce biogas. Sawdust will be added to the biogas manufacturing process to increase the production of biogas produced. Before the biogas manufacturing process is carried out, the researcher will undertake pretreatment the sawdust. The purpose of pretreatment is to minimize energy loss during anaerobic processes. So that the enzyme is easier to degrade lignin, cellulose and hemicellulose in sawdust and the process of forming biogas is faster.

This study aims to determine the quality of the biogas produced by looking at changes in pH, temperature and pressure in the digester. Test the gas produced by looking at the color of the fire and the length of time burning. The biogas quality was analyzed on the 30^{th} day.

MATERIALS AND METHODS

Raw Material

In this study, using tofu pulp and tofu waste water from the rest of the production process at the tofu factory. Cow manure from cow's milk farm. These materials were obtained in one place belonging from Mr. Muhajir's factory.

Sawdust is obtained by collecting it from wood craftsmen around the tofu factory. Preparation of sawdust before being used as biogas material, first performed pretreatment. Pretreatment method using chemical-physics, with 10% NaOH for 6 hours and drying at room temperature 35 °C for 24 hours.

Process biogas

The process of making biogas is carried out using an anaerobic method. Materials that have been calculated for each ratio are entered into the digester. The digester uses 19 L gallons of mineral water with a total of ¾ of the volume of gallons of mineral water.

The length of time for the biogas production process in this study was 30th days. By analyzing the combustion and color of the fire on days 10th, 15th, 20th, 25th, 30th. Monitoring of the biogas process is carried out every 8 hours by recording changes in pH, temperature and pressure.

RESULTS AND DISCUSSION

Biogas quality

Digesters that were not pretreated were 1,2 and 4 and the rest were pretreated on sawdust. From the Fig. 1, the pretreatment process did not make a significant change in this study because the differences in digester 3, 4 and 5 flame duration were close to the same. According to (Sumada *et al.*, 2011) Selection of chemicals and their levels as a delignification process affects the cellulose content. Because NaOH has a large pH, some cellulose dissolves during the delignification process. This makes the fermentation process of the powder in the digester has no effect.

From Fig 1. The longest flame duration is in digester 4 (6.36 minutes). However, the highest pressure was found in digester 5 (187 N/m^2) and the flame duration was 6.21 minutes. From this statement, the high pressure but the length of the flame produced is 6.21 minutes because there is still gas other than the methane gas produced so that it creates high pressure, this is in accordance with the statement (Hidayat *et al.*, 2012). Other conditions, such as in digester 2, which has the lowest flame duration (4.46 minutes) and has a lower pressure than the other digesters, is caused by too many microorganisms participating in the organic degradation process so that the process becomes less perfect.

The flame test on days 20th -30th changes its color to dominant blue and blue. From these results, it can occur because the production of methane gas is more and the other gas mixture is reduced. According to Mu, (2019) blue color due to complete combustion between the combustion material and air and the level of blue over red. According to (Suliono *et al.*, 2017) The blue flame color indicates low CO_2 levels, increased temperature and increased combustion rate.

The biogas quality test was carried out by the gas chromatography method, seen from the presentation of each gas on the 30th day. The quality of the biogas can be seen in the following graph.

The relationship between methane gas content and pretreatment of sawdust process from Figure 2. shows that in digester 4 has a higher content of methane gas than other digester (36%) but in digester 4 there is no pretreatment. So that the pretreatment process has no effect on the fermentation process of organic matter in the digester. The success of the pretreatment process in the CH_4 content on the 31-st day showed methane gas levels with NaOH pretreatment (48.27%) and methane gas levels without pretreatment (31.63%). The quality of methane gas for each digester has a different percentage. Digester 1, which is the control of this study, has the lowest methane gas content, which is ± 20%, this can occur because the level of organic content is different from other digesters. In the digester 2, 3, 4, 5 has a higher methane gas content than control. However, the quality of methane gas shown in the graph above has a low percentage (<54%-74%) according to the statement (Kurniasari, 2018). This is because the rate of methane gas formation is highest on days 20th –

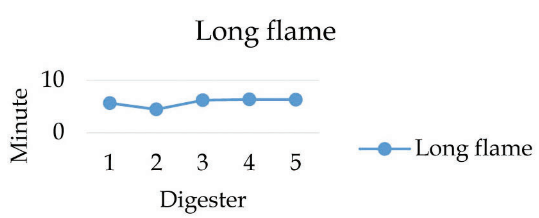

Fig. 1. Long flame

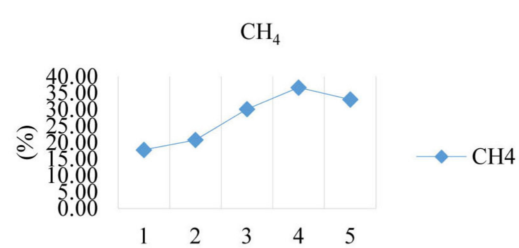

Fig. 2. CH_4 content

25th and there is a decrease in methane gas formation after day 25th (Kinasih, 2020).

The CO_2 content (1.5% - 4%) in Fig. 3. corresponds to the flame that has been experimentally carried out. That is, on the 30th day all digesters have a predominantly blue and blue flame which indicates that the CO_2 percentage is low. According to (Wisudawati, 2006) the percentage of CO_2 is inversely proportional to methane gas. This is because when the population of methane gas-producing bacteria in the digester is high, the methane gas produced will be high too, and the bacteria that produce CO_2 are low.

The air content of each digester is high, namely 59% -78%. This air content helps the combustion process so that perfect combustion occurs. This is in accordance with the flames that have been tested in the experiment. According to (Suliono *et al.*, 2017)

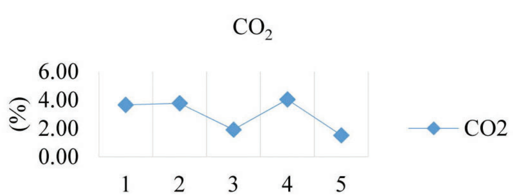

Fig. 3. CO_2 content

The composition of the air can be in the form of H_2, N_2, CO, CO_2, O_2 gases and these gases are in accordance with the organic material contained in the digester. The high H_2 content in the air causes flammable gases and dominates the color of the fire to turn blue.

Temperature, pH, pressure

The temperature changes in the digester as a whole undergo regular changes, namely up and down because the temperature of the digester in the morning and at night is 30°-C - 34°C and the temperature is around 29 °C - 35°C. This is due to the influence of the weather from outside which is in line with (Suyitno *et al.*, 2010) which states that the ambient temperature affects the anaerobic process due to the digester's wall material being in direct contact with the atmosphere and absorbing or releasing heat depending on the temperature gradient between the digester and the surrounding environment. This temperature condition allows the methane bacteria to work optimally, according to the statement (Edidiong, 2019) in the mesophilic temperature range (32 °C - 42 °C) or thermophilic temperature range (49 °C - 60 °C).

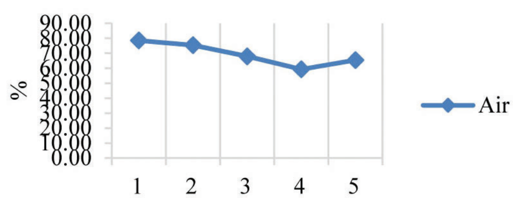

Fig. 4. Air content

From the graph data above, it can be seen that there is a decrease and increase regularly. On the day 1th – 4th digester (control) the results of the observation showed a low pH at number 5, this happened because the material in digester I contained acid. At this pH the methanogenesis process cannot work. According to Ni'mah, (2014) stated that the decrease in pH occurs in the hydrolysis to acidogenesis process which produces volatile organic acids. This process occurs because the metabolism of organic material by releasing cations. The reaction between ammonia and bicarbonate produces short chain fatty acids and carbon dioxide is present in the system to regulate the pH of the digester (Khanal *et al.*, 2019). After day 5th to day 30th, the pH goes closer to 5.5 - 7 at this pH, which is a pH range that can be tolerated by methanogenic bacteria. The increase in pH occurs because the acetic acid content in the digester decreases and is converted into methane and CO_2(Teknologi *et al.*, 2007).

According to Azhari *et al.*, (2015) microorganisms can reproduce optimally because of the pH conditions between 5.8-8.2. Since the methanogenic bacteria group is sensitive to pH, a pH that is below the range should be avoided because it causes the chemical reaction to stop and also a pH that exceeds the range will cause the final product to become CO_2.

The changes in each pressure are recorded and graphed. The pressure on each digester increased significantly, but after 25 days the decline started to occur. The first pressure increase occurred in digester 3,4 and 5 (30 N/m² - 40 N/m²) on day 2,

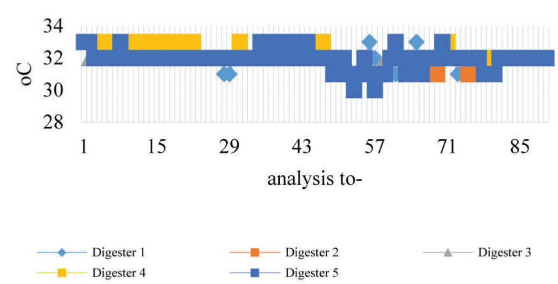

Fig. 6. Temperature changes

then the next day the pressure was seen in digester 1 and 2 (30 N/m^2). This pressure occurs to indicate that the gas in the digester begins to be produced and an increase will occur on the 10th – 30th to 50% day, this is in accordance with the statement of Pelatihan and Kinerja (2015).

However, in order to implement this unit, it requires not only a technical aspect approach but also a financing and institutional aspect. Putri *et al.* (2019) and Gemardi *et al.* (2019), explained that the community who used the biogas must pay the retribution cost for operation and maintenance. The amount of fee charged is between IDR 45,000-65,000.

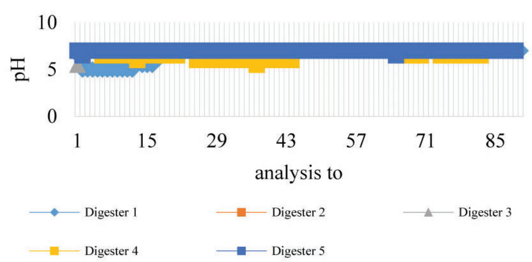

Fig. 7. pH changes

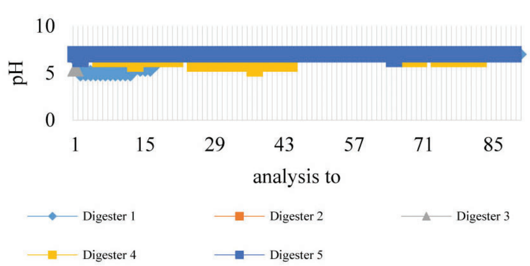

Fig. 8. Pressure change

CONCLUSION

In this study it can be concluded that the pretreatment process on sawdust does not affect the production of methane gas and flame duration in the digester. This failure can be caused by too high levels of NaOH, resulting in dissolved cellulose in wood dust in the solution and inaccurate chemical selection because the pH of NaOH is too alkaline.

The best quality of biogas in this study with length of the flame (digester 4 with a time of 6.39.92), flame color (blue) and methane gas content tested in the laboratory, the highest results were obtained in digester 4 (36.67%) with the ratio of cow dung: tofu dregs. : tofu waste: wood dust (without pretreatment) (1: 1: 2: 2). This factor can be caused by high C/N levels and supporting factors in the digester such as pH, temperature and pressure

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