

Increase The Production and Quality of Biogas from Waste of Cattle Rumen Content Through The Addition of Molasses and Zeolite

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Abstract. Currently, The requirements of domestic energy must be directed to the diversification of energy sources other than petroleum. One of them is biogas. This research aim to determine the number and quality of biogas production from waste of cattles rumen content through the addition of molasses and zeolite. This study uses an anaerobic digester which comprised four treatments: control; waste of cattles rumen content with the addition of molasses (B); waste of cattles rumen content with the addition of zeolite (C); as well as waste of cattles rumen content with the addition of molasses and zeolite (D) on a laboratory scale with total volume of 5 liters and a retention time of 21 days. the volume of biogas formed is measured and tested the levels of methane gas using gas chromatography. in addition to the pH and temperature are also measured as the supporting data that support this research. based on results the average production of biogas in control digester for 21 days as much as 21.57 ml, while in the addition of molasses as much as 200 grams increase production with the average volume is 26, 5 ml. as for the concentration of methane gas, the addition of molasses can increase the concentration of methane. while the zeolite has a negative effect on the amount of biogas production. Zeolites absorb the gases contained in the digester, thereby reducing the volume of gas in the digester.

Key word: biogas production, molasses, zeolites, waste of cattles rumen content

INTRODUCTION

The high rates of population growth in Indonesia resulted in the emergence of issues related to environment and energy. Human dependence on fossil fuels for energy particularly, causing these energy sources dwindling. Kompas (2014) reported that the need for fuel oil (BBM) in the country reached 1.25 million barrels per day (bpd), while the oil production approximately 649 barrels per a day. This fact shows, every day, Indonesia deficit 608 barrels of oil. To that end, the fulfillment of the country's energy needs to be directed to the diversification of energy sources other than petroleum.. One of them with the waste to energy program where garbage or waste that communities can not be used anymore can be converted into energy, biogas is one of examples. Biogas is a renewable fuel that is formed from organic materials through the process of methanogenesis by methanogenic bacteria. Biogas has advantages over other biofuel because it helps to overcome problems of garbage pollution and assist in providing a source of cheap and renewable energy.

One source of organic material that can be used as raw material for making biogas is waste of cattles rumen contents. The waste of cattles rumen content is one of the biggest wastes generated from Abattoirs, in the form of grass that has not been fermented and fully digested by animals. In the rumen contents contained *Methanosarcina sp.* that play a role in the formation of biogas (Fithry, 2010) and cellulolytic bacteria that can digest cellulose of grass (Gamayanti, 2012).

According Baller in Padmono (2005), one cow produces waste rumen content about 25-35 kg. in Tamangappa abattoirs, the number of slaughter cattles is 58, so, the estimated number rumen contents waste daily reach 1.5-2 tons. In 2012, the number of cattle slaughtered cattle reach 19 733. So in a year, Tamangapa

abattoirs produces rumen contents waste as much as 50-60 thousand tons (Asdar, 2014), which the waste is not used at all, so the rumen contents of this waste can be used as raw material for biogas.

Until now, biogas can be produced and utilized by the community however, the quantity or amount of biogas produced per once production is still low. This is caused by a lack of nutrients used as an energy source of bacteria used in fermentation process. One way that can be done to produce optimally of biogas is by adding more glucose. Padang (2011) states that the addition of sugar in the manufacturing process can increase the amount of biogas production by 25%.

Glucose is used to supply nutrients that improve the speed of microbial fermentation processes in biogas production. one source of glucose derived from waste is molasses. According Dellweg in Widyanti (2010) on molasses, sugar content reach 50%. In addition, Indonesia is one country with a high sugar production, and the amount of molasses in Indonesia reached 1.3 million tons / year, which will increase to 1.8 million tons / year.

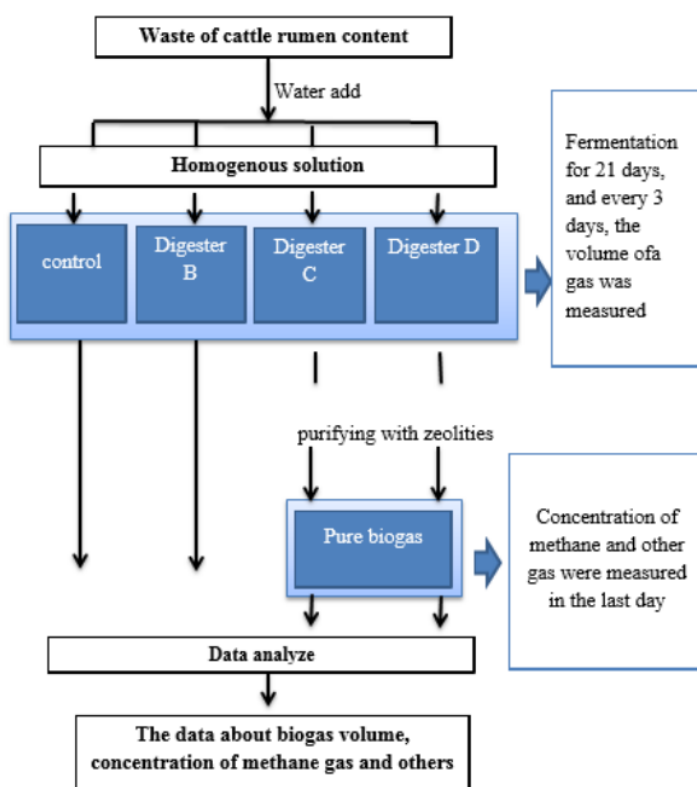
If the levels of CO₂ in the biogas is low, then the methane gas content increases so that biogas has a high calorific value. The ratio of methane gas and carbon dioxide determine the high and low quality of biogas produced. To improve the quality of biogas, it is necessary to purifying biogas through absorption of CO₂ (Price, 1981). Nurkholis (2011) concluded that the biogas can be purified by the zeolite so as to increase the methane content of up to 25%. Zeolites able to absorb CO₂ after activated by heating or chemically.

Waste of cattle rumen content and molasses respectively are a byproduct of slaughterhouses and sugar cane factories that are still underutilized, including in the production of biogas itself neither had much in demand, but these materials are very potential to be a source of raw materials biogas. The purpose of this study was to determine the number and quality of production of biogas from waste of cattle rumen content through the addition of molasses and zeolite.

METHOD

In this study, there were 4 treatments consisting of control (a mixture of waste of cattle rumen contents and water); mixture of waste of cattle rumen contents and molasses (digester B); mixture of waste of cattle rumen contents and zeolite (digester C); mixture of waste of cattle rumen contents, molasses and zeolite (digester D)

in this study, the substrate fed into the digester is only one time, not continuously. Substrates destroyed by means kneaded and mixed with a little water to be more easily crushed. Optimal conditions required for the initial filling into the digester is as much as 80% of the total volume (junus, 1987), so the volume that must be put into digester is 4 Liter. The ratio of the waste of cattle rumen content and water is 1: 2, and pursued the addition of 500 grams of molasses in the digester B and D did not change the final volume. In the digester C and D, add 100 grams of zeolite 60 mesh inserted previously been heated at a temperature of 300oC and activated by KOH 15%.



Samples were analyzed ie gas volume and the concentration of methane.

1. Volume of gas. The volume of biogas is measured by observing changes in the volume of water in the manometer U (assumption: the biogas produced is equal to the change in the gas-driven water hose). The volume of gas is calculated using the formula: $V = \pi \times r^2 \times t$
2. the concentration of methane. Levels of methane were analyzed using Gas Chromatography. Sample preparation using shirink 10 ml were injected into the hose out of gas and then immediately put into the vacuum container 10 ml which is already in a state of vacuum, then put into Gas Chromatography instrument.

RESULT AND DISCUSSION

The average volume of each digester biogas is presented in Table 1. In Table 1 we can see that on the first day to the third day has not seen the production of biogas. It can be seen from the lack of movement of water in a simple manometer. On the fourth day, the methane-producing bacteria have not shown activity for substrates needed for the production of biogas has not been there, this is what causes have not produced biogas. On the first day until the fourth day, the activity of hydrolytic and cellulolytic bacteria increased. these bacteria break down the organic material originating from undigested grass perfectly into the substrate which would then be used by methane-producing bacteria.

Tabel 1. Volume Gas pada Produksi Biogas

Day	Volume (ml)			
	control	B	C	D
3	-	-	-	-

6	20,6455	-	-	-
9	24,943	20,625	19,428	-
12	20,979	26,258	20,154	-
15	20,586	26,552	19,801	-
18	21,038	26,65	19,33	-
21	21,528	26,415	19,448	19,448

gas production in digester controls began to look at the end of the 5th and early 6th day. Then, the biogas production will be increased until the ninth day. Then will decrease gradually and then stagnate until the last day. In the digester B consisting of a mixture of waste of cattle rumen contents and molasses, gas production is produced at the end of the 7th day and peak production of biogas are in the 18th day. The increase in production caused by the activity of methanogenic bacteria optimum. This bacterial activity is influenced by the adequacy of the organic material used as a substrate by methanogenic bacteria. The more available the substrates, the more increase the production of gas. After pass the highest point, biogas production tends to stagnate. This is due to the formation of froth on the surface of the digester which can inhibit the production of gas or gas produced less (Sihombing et al., 1997). Additionally, in this study the stirring factor is eliminated, so that the resulting gas suspended between water and organic materials. additionally, it is caused by insufficiency of the substrate and a waste byproduct produced by the bacterium itself. On D digester, biogas production just beginning to appear on the 20th day shown on manometer U. This is caused by the activity of the zeolite in the digester. This zeolite absorb all kind of gas in digester, so it can not alter the position of the water in the manometer.

1 The proportion of gas contained in biogas which detected ie methane, carbon dioxide and nitrogen oxides. The proportion of gas contained in biogas which ie detected methane, carbon dioxide and nitrogen oxides. Concentrations of methane, carbon dioxide and nitrogen oxides in the biogas can be seen in Table 2.

Table 2. Concentrations of Methane, Carbon Dioxide and Nitrogen Oxides in The Biogas

Treatment	Concentration		
	$\mu\text{g CH}_4\text{-N g}^{-1}$	$\mu\text{g CO}_2\text{-N g}^{-1}$	$\mu\text{g N}_2\text{O-N g}^{-1}$
control	0,99	0,07	0,0000108
B	9,47	0,11	0,0006578
C	1,04	0,08	0,0005199
D	0,81	0,07	0,0005938

Concentration of methane in the digester B containing waste of cattle rumen contents and molasses is the highest among other digester. this shows that the addition of molasses had a positive impact on the formation of biogas and methane gas levels. The addition of molasses push selectivity toward formation of methane gas, if the conditioned as the need to grow flowers rumen bacteria such as the need for appropriate acclimatization conditions for bacterial growth and the process of adaptation to the subsequent treatment. Temperatures in the rumen is between 38 to 42 °C with a pH of 6.8 in the stomach of ruminants (Adger and Brown, 1995).

Excess substrate is fed into the bioreactor, causing acetogen and acidogen bacteria more active and faster to convert more organic matter (carbohydrates, protein and fat) into fatty acids that cause a decrease in pH. Methanogenic bacteria can not work optimally at low pH. This creates an imbalance between acidogenesis and methanogenesis because the process is dominated by the process of methanogenesis less acidogenic and activities both within the system.

6 In the digester C and D containing zeolite. the use of zeolite has no effect on the quality of biogas. This can be seen in the ratio of methane: carbon dioxide in the control and treatment. Zeolites just shows a negative effect on the amount of biogas production. In Table 1, the digester containing zeolite shows a slowdown in producing biogas. Zeolites absorb gases contained in the bio digester, thereby reducing the volume of gas in the digester.

Digester temperature at each treatment can be seen in Table 3. In general the temperature range in the digester for 21 days is 28-32oC. Temperature conditions affects the quantity of biogas produced. Temperatures that are too high cause biogas forming bacteria will die so it is not capable of producing gas, while the temperature is too low causing biogas forming bacteria can not thrive so that the biogas produced is low.

Tabel 3. Suhu Digester pada setiap Perlakuan

Hari ke-	Suhu (°C)			
	Kontrol	B	C	D
3	28,5	29	29	29
6	29	30	29	30
9	28,5	28,5	29,5	29
12	29	30	30	30
15	30,5	30	30,5	30
18	30	30	30	30
21	29	29	30	30

Results of pH measurement using universal indicator. The measurement results in early studies show the pH value is in the neutral condition which is 7, while at the end of the study the results of measurements of pH values are also at a score of 7. The pH determines the quality of the main products produced biogas if the pH value is too high is CO₂. The optimum pH value is between 7 to 7.2 when the pH drops will inhibit the formation of gas which can result in decreased volume of biogas. Saseray et al. (2012) states, methanogenic bacteria are very sensitive to acidity.

CONCLUSION

The addition of molasses in the production of biogas waste cow rumen contents can increase the volume and improve the methane biogas. While the addition of the zeolite does not affect the quality of biogas.

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