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Effect of Adding Palm Oil Mill Effluent (POME) and Slurry on Biogas From Cow Manure to Produced Methane Gas

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ABSTRACT

Biogas is a renewable energy source that is environmentally friendly and economical. High of Palm Oil Mill Effluent (POME) and cow manure have great potential as a source of raw material for making biogas. The purpose of this study was to determine the effect of the addition of POME and biogas slurry to the production of biogas from cow manure raw material. The composition of raw materials used are 40 L cow manure, 20 L water, 20 L POME in the first experiment and 40 L cow manure, 20 L water, 20 L biogas slurry in the second experiment. The composition of methane gas was analyzed using the Gas Chromatography. From the results obtained, the addition of POME produced 64.65% of methane gas with biogas production of 54 L and the addition of biogas slurry produced 53.83% of methane gas with biogas production of 58 L.

Keywords: Biomass, Renewable Energy, Biogas, POME

1. INTRODUCTION

Energy is a very important issue in the world is no exception in Indonesia, as the country with the largest energy consumption in the Southeast Asia region and fifth in the Asia Pacific in primary energy consumption, after the countries of China, India, Japan and South Korea. High Gross Domestic Product (GDP) growth, reaching an average of 6.04% per year over the 2017-2050 period. This causes an increase in Indonesia's energy needs in the future. In Government Regulation No. 79 of 2014 on National Energy Policy to prioritize the development of Indonesian energy that includes several things, namely the maximum use of renewable energy by paying attention to the economic level, minimizing the use of petroleum, natural gas utilization and new energy optimally, and make coal as the mainstay of the national energy supply [1].

The limitation of fossil energy requires diversification of energy resources in order to guarantee the availability of energy. Then the use of new and renewable energy must be intensified. Renewable energy is one of the options for the energy needs of the

future. Although it is based only on solar energy and the energy source is clean and infinitely, this solution has a number of problems in everyday life that have to be considered. The problems are related to resources, limited potential, base load, the grid, and primary resources [2].

One of the renewable energy that can be produced with appropriate technology that is relatively simpler for environmentally friendly and economical is biomass energy. Biomass energy sources that have great potential especially in Indonesia include biodiesel and biogas. Biodiesel is an alternative fuel sourced from plant and animal fats, Crude Palm Oil (CPO), waste cooking oil, and algal plants, while it is predicted that biodiesel consumption in Indonesia in 2025 will rise to 6.9 million kiloliters [3-6]. Biogas is a renewable energy that is formed from the anaerobic digestion process which is a microbiological process of decomposing organic matter without oxygen in a reactor and can be used as fuel [7-9].

Biogas production generally uses organic materials such as livestock waste, agriculture and industrial waste. In Indonesia, the amount of cow manure is always

increasing and most of it is left alone without further processing. This can be processed anaerobic digestion to reduce waste and can also produce biogas as a renewable energy source [10]. The composition of biogas consists of methane (50-70% vol), carbon dioxide (25-50% vol) and other gases such as hydrogen, and hydrogen sulfide [9][11-14].

In the last few years palm oil has developed very rapidly in the world and is controlled by Indonesia and Malaysia. 90 percent of palm oil production is dominated by the Indonesian state at 34.52 million tons and Malaysia at 17.32 million tons in 2016 [15]. On the other hand a very large production volume will release large quantities of palm oil mill effluent (POME). POME is a highly polluting waste due to high concentrations of COD, BOD and color, which can affect the environment, especially water sources. However, it is recognized as a renewable biogas source such as biomethane and biohydrogen [16][17].

Meanwhile according to [18], pretreatment in the form of setting the pH value in POME to increase biogas production by using an up-flow sludge blanket (UASB) type bioreactor. It is known that the pH characteristics possessed are acidic in the range of 3.4-5.2 which in the process of biogas formation requires microorganisms that can live at a certain pH. POME results were obtained which decreased the COD value by 96 percent with the addition of NaOH as a regulator of the pH value.

In general, methane-producing bacteria are sensitive to pH changes and have an optimum pH range of 6.5-8.5. Under this pH the decomposition can proceed but the decomposition efficiency will decrease rapidly and will produce acidic conditions which will inhibit the growth of methanogenic bacteria. If the growth of methane bacteria is inhibited, the rate of decomposition of volatile acids will decrease so there will be accumulation of volatile acids [19][20].

The use of POME as a raw material for making biogas has been widely developed. Among them making biogas from POME raw material with a mixture of oil palm bunches with variations in the size of oil palm bunches in a batch type bioreactor feed mixture. The optimal size of oil palm bunches in making biogas is 0.2 mm with a yield of 320 mL of methane with a gas concentration of 63-70 percent [21].

Making biogas from POME with and without a mixture of deer manure in a bioreactor type continuously stirred tank reactor (CSTR). It was found that the mixture of POME and deer manure produced 0.85 L/day of methane gas with a concentration of 59 percent compared to without deer manure which only produced 0.39 L/day of methane gas with a concentration of 20 percent where deer manure also accelerated the process of forming biogas [22].

In this paper carried out research biogas production using cow manure with the addition does POME and slurry in the mixture. The use of cow dung as the main raw material is due to the high population of cattle in Indonesia with a population increase of 4.7% per year [23]. While the addition of slurry to the mixture of raw materials can increase the rate and yield of biogas production [24][25].

2. RESEARCH METHODS

The tool used in this study is a prototype fixed dome type biodigester with a capacity of 100 liters equipped with a pressure gauge, pH and temperature control on the biodigester which can be seen in Figure 1.



Figure 1. Prototype fixed dome biodigester

The raw material for cow manure is taken from one of the cattle farms in the macan lindungan area, Palembang and POME at PT. Sriwijaya Palm Oil Indonesia Banyuasin, South Sumatra. The first experiment, a mixture of raw materials in the form of cow dung of 40 L and 20 L of water was put into biodigester with 20 L POME added. Whereas in the second experiment a mixture of cow dung of 40 L and 20 L of water added 20 L of slurry biogas from the first experiment.

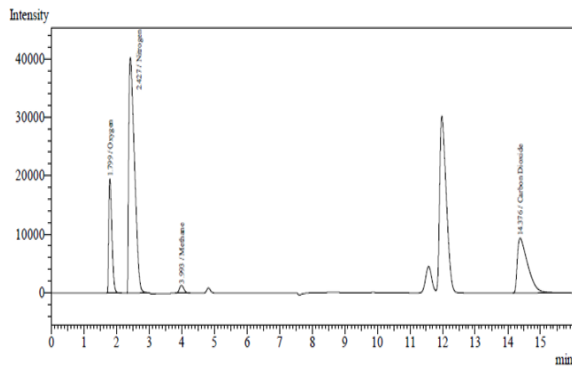
During the fermentation process, raw materials were analyzed every 5 days with analysis in the form of Chemical Oxygen Demand (COD), Total Suspended Solid (TSS) and Volatile Suspended Solid (VSS) which were carried out at the Chemical Engineering Laboratory of Sriwijaya State Polytechnic Palembang.

The results of biogas production during the fermentation process are analyzed at intervals every 5 days using the SHIMADZU GC-2014 Gas Chromatography at PT. Pupuk Sriwidjaja Palembang to determine the composition of biogas with parameters such as CH₄, CO₂, O₂ and N₂.

3. RESULT AND DISCUSSION

3.1. Biogas Composition Analysis

The results of the biogas composition in the mixture of raw materials for cow manure and POME which have been analyzed by gas chromatography every 5 days for 35 days of the fermentation process with the highest methane content of 64.65% on the 30th day which can be seen in Figure 2.



Peak#	Name	Ret. Time	Area	Conc.	Units
1	Oxygen	1.799	131720	4.20	%Mol
2	Nitrogen	2.427	493084	14.32	%Mol
3	Methane	3.899	129353	64.65	%Mol
4	Carbon Dioxide	14.376	206901	16.83	%Mol
Total				100.00	

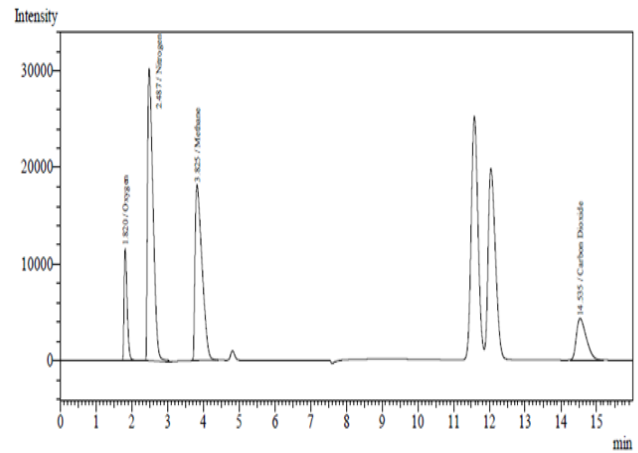
Figure 2. Biogas Composition Analysis Result From Cow Manure and POME at 30th day

All biogas composition analysis results from cow manure and POME for 35 days of fermentation can be seen in Table 1.

Table 1. Biogas Composition Analysis Result From Cow Manure and POME

Day	Biogas Composition (%)			
	CH ₄	CO ₂	O ₂	N ₂
0	0	0	0	0
5	0	0	0	0
10	16.35	0.23	21.9	61.06
15	20.28	0.85	19.64	59.19
20	31.60	1.92	16.25	50.23
25	42.54	3.03	13.72	40.71
30	64.65	16.83	4.20	14.32
35	62.17	28.61	2.18	7.04

In the mixture of raw materials for cow manure and slurry, the fermentation process occurred for 30 days with the highest methane content of 53.83% on the 25th day which can be seen in Figure 3.



Peak#	Name	Ret. Time	Area	Conc.	Units
1	Oxygen	1.820	69443	6.07	%Mol
2	Nitrogen	2.487	324558	17.29	%Mol
3	Methane	3.825	247704	53.83	%Mol
4	Carbon Dioxide	14.355	82799	22.81	%Mol
Total				100.00	

Figure 3. Biogas Composition Analysis Result From Cow Manure and POME at 25th day

All biogas composition analysis results from cow manure and POME for 35 days of fermentation can be seen in Table 2.

Table 2. Biogas Composition Analysis Result From Cow Manure and Slurry

Day	Biogas Composition (%)			
	CH ₄	CO ₂	O ₂	N ₂
0	0	0	0	0
5	24.61	4.67	21.52	49.2
10	29.47	8.42	19.07	42.84
15	37.53	13.28	17.44	31.75
20	45.06	16.92	16.28	21.74
25	53.83	22.81	6.97	17.29
30	51.72	32.16	5.59	10.53

From the analysis of the composition of the gas above the mixture of cow manure and POME raw materials produces higher methane gas content compared to the mixture of cow manure and slurry raw materials which can be seen in Figure 2. Where POME has a high content of organic compounds which is shown by the COD value of 41200 ppm which is a source of nutrition for microorganisms in the anaerobic fermentation process.

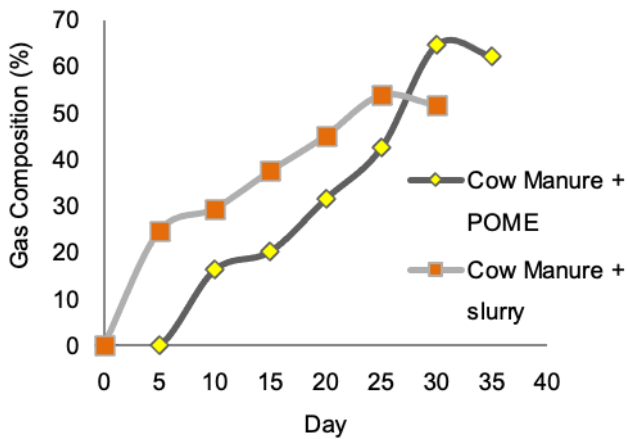


Figure 4. Comparisons of methana gas composition

According to [27], the addition of POME to biogas with cow dung can improve the composition of methane gas. In a mixture of 70% POME and 30% cow dung, the composition of methane gas was 61.13%.

3.2. Biogas Volume Analysis

The results of measurements of the total volume of biogas production produced in a mixture of cow manure and POME raw materials were 54 liters for 35 days of fermentation with a peak of biogas production of 16 liters on the 25th day which can be seen in Table 3.

Table 3. Biogas Production Result From Cow Manure and POME

Day	Biogas Production (Liter)
0	0
5	0
10	2
15	6
20	10
25	20
30	16
35	8

Whereas in the mixture of raw material for cow dung and slurry, the amount of biogas production volume is greater, that is 58 liters for 30 days of fermentation and the peak of biogas production is 16 liters on the 20th day which can be seen in Table 4.

Table 4. Biogas Production Result From Cow Manure and slurry

Day	Biogas Production (Liter)
0	0
5	4
10	8
15	10

20	16
25	12
30	8

From the measurement of biogas production volume produced above the mixture of cow manure and slurry raw materials produce biogas faster and produce a greater amount of biogas compared to the mixture of cow manure and POME raw materials which can be seen in Figure 5.

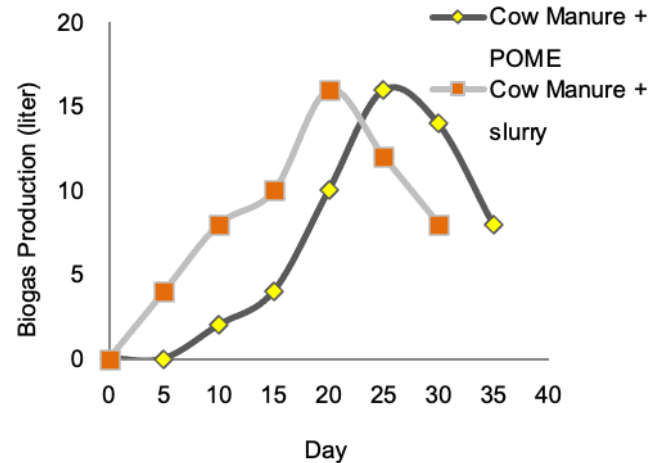


Figure 5. Comparisons of Biogas Production

The addition of biogas slurry to the biogas raw material mixture did not have much effect on the biogas production results. In addition, biogas slurry mixture of 80% on raw materials biogas generating biogas production amounted to 21,891 mL in which only increased by 11.21% yield from biogas production without biogas slurry mixture. The addition of biogas slurry can also increase the potential for methane production from the anaerobic digestion process. In addition, biogas slurry by 80% in the mixture of raw material produces methane gas production is higher compared to other mixture that is equal to 61.21% at day 23 and produce methane gas faster than without the addition of biogas slurry [24].

4. CONCLUSION

This research shows that making biogas from cow manure raw materials with the addition of POME and slurry can increase the composition of methane gas and biogas production produced. Where the addition of POME produces 64.65% of methane gas with biogas production of 54 L and the addition of biogas slurry produces methane gas of 53.83% with biogas production of 58 L. This shows that biogas has great

potential as an environmentally friendly renewable energy source and economical.

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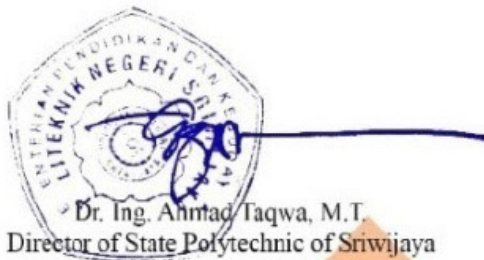
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