International Research Journal of Advanced Engineering and Science
ISSN (Online): 2455-9024

Biogas Purification Method from Cow Manure Using Coconut Shell Charcoal Adsorbent

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Abstract**—***Indonesia's oil reserves are only about 3.3 billion barrels remaining. If it continues to be consumed without the discovery of new oil reserves, it is estimated that these oil reserves will be exhausted in the next two decades. Biogas is an alternative energy that can be renewed as a substitute for petroleum energy sources. This study aims to determine the effect of flow rates on the purification process using coconut shell charcoal adsorbents on the chemical composition of methane (CH_4) and carbon dioxide (CO_2) contained in biogas. Flow rate variations (1.34, 2.68, 4.02, 5.36, and 6.7 liters/minute) as independent variables. Biogas produced from the biogas purification process of cow manure with variations in the flow rate of 6.7 liters/minute produces the highest chemical composition when compared to the flow rate of 1.36 liters/minute, 2.68 liters/minute, 4.02 liters/minute and 5.36 liters/minute, which is the chemical composition of CH_4 40.19% and CO_2 35.37%.*

Keywords**—** *Biogas, cow manure, purification, coconut shell, methane, carbondioxide.*

I. INTRODUCTION

In recent years, energy is a crucial issue in the world. Increased energy consumption due to population expansion, depletion of world oil reserves, and the problem of fossil fuel emissions put pressure on all countries to develop and use renewable energy as soon as possible. Indonesia's oil reserves are only around 3.3 billion barrels, if they continue to be consumed without the discovery of new oil reserves, it is estimated that these oil reserves will run out in the next two decades. To reduce dependence on fuel oil, the government has issued Presidential Regulation number 5 of 2006 concerning the national energy policy to develop alternative energy sources as a substitute for fuel oil. The policy emphasizes on renewable resources as an alternative to fuel oil.

Biogas is one of the renewable energies that is currently being developed as a substitute for petroleum energy sources. In general, biogas itself consists of methane gas (CH_4) 50% - 70% carbon dioxide (CO_2) 30% - 40%, hydrogen (H_2) 5% - 10% and other gases in small amounts [1]. The CO_2 content in biogas is still quite large, in the use of biogas as a new renewable energy, it is necessary to carry out a biogas purification process from carbon dioxide (CO_2) gas in biogas.

One other method to separate methane gas (CH_4) from carbon dioxide gas (CO_2) in biogas content can be done by adsorption method. Several studies on the use of the adsorption method in biogas purification have been carried out. Purification of biogas by adsorption method using activated carbon to reduce CO_2 levels by 10.503% in biogas [2]. Biogas purification by adsorption method uses activated carbon to reduce H_2S levels from hospital wastewater biogas. The optimal H_2S adsorption process is indicated by the use of 14 mesh size activated carbon [3].

In this biogas purification study, using the adsorption method with the adsorbent material used in this research is coconut shell charcoal because it has the potential to reduce the composition of carbon dioxide (CO_2) gas in biogas. In this study, it is expected that the level of methane (CH_4) in biogas can increase and the content of CO_2 gas can be reduced in order to get good biogas quality. In this study, the factors that influence biogas purification are studied, namely variations in the flow rate of biogas.

II. RESEARCH METHODS

This research uses cow manure as the main ingredient in making biogas. The ratio of mixing cow manure with water is (1:1) or 500 liters of water with 500 liters of cow manure. Biogas purification uses five variations of biogas purification flow rates, namely 1.34, 2.68, 4.02, 5.36, and 6.7 liters/minute and coconut shell charcoal as adsorbent.

Before the purification process is carried out, the biogas in the polyethylene plastic is pumped first to flow the biogas through a flow meter by adjusting the variation of the flow rate according to those studied, namely 1.34, 2.68, 4.02, 5.36, and 6.7 liters/minute and flowed to the coconut shell charcoal adsorbent so that into biogas that has been purified and then directly accommodated in polyethylene plastic. Each flow rate variation has its own plastic container measuring 100 cm x 100 cm before the next testing process is carried out.

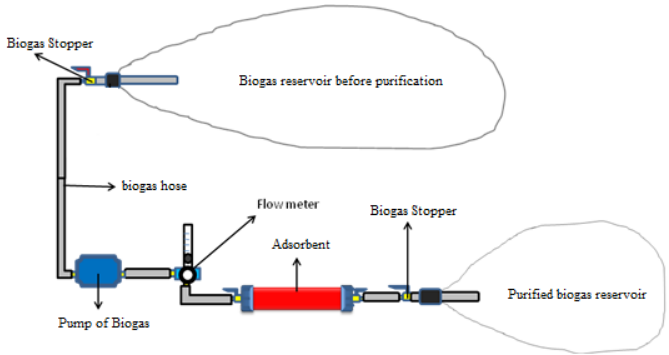

Fig. 1. Biogas purification process

III. RESULTS AND DISCUSSION

The results of testing the chemical composition (methane (CH_4) and carbon dioxide (CO_2)) contained in biogas from cow manure using Gas Chromotography (GC) carried out in

Nurchayati and Rudy Sutanto, "Biogas Purification Method from Cow Manure Using Coconut Shell Charcoal Adsorbent," *International Research Journal of Advanced Engineering and Science*, Volume 7, Issue 2, pp. 311-313, 2022.

International Research Journal of Advanced Engineering and Science
ISSN (Online): 2455-9024

the laboratory can be seen in table 1.

TABLE 1. Content of methane (CH_4) and carbon dioxide (CO_2) in biogas

Flow Rate (liter/minute)	Methane (CH_4) (%)	Carbon Dioxide (CO_2) (%)
0	39.91	33.61
1.34	38.16	33.35
2.68	38.47	33.75
4.02	39.29	34.60
5.36	39.84	34.84
6.70	40.19	35.37

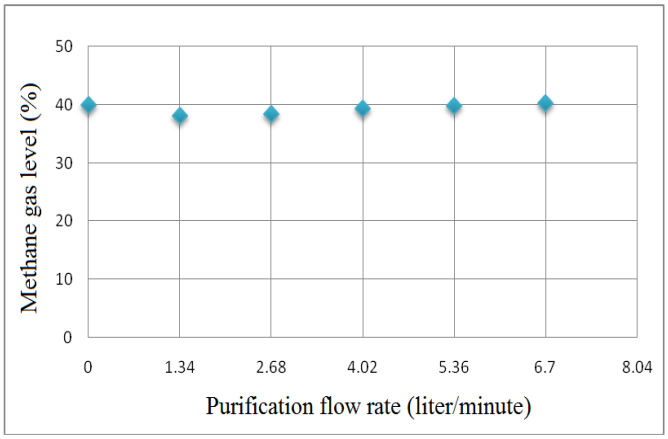

Fig. 2. Relation of purification flow rate with methane gas (CH_4)

Based on Figure 2, the graph of the percentage of methane (CH_4) at the flow rate of biogas purification 1.34, 2.68, 4.02, 5.36 and 6.70 (liters/minute) experienced a very small decrease in methane gas (CH_4) or not much different when compared to the methane content in biogas before purified. However, judging from the composition of the purified biogas, the percentage of methane gas content at each flow rate level almost does not change due to changes in the percentage of methane gas content (CH_4) which is not much different after being purified, which is on average below 2%.

The composition of ash and volatile substances (volatile) contained in coconut shell charcoal will affect the value of charcoal as an adsorbent because the pores in the charcoal are closed by ash and volatile substances so that absorption is reduced [4]. The silica content in the ash is also able to absorb water vapor [5] where coconut shell charcoal contains 13.08% ash [6]. According to research results [7] the percentage of water vapor content (H_2O) in biogas from cow manure is 3.37%, the presence of water vapor contained in biogas will reduce the heating value of biogas. Absorption occurs due to physical contact between biogas and coconut shell charcoal during the purification process so that the percentage of water vapor content (H_2O) is reduced, as a result of reduced water vapor content in biogas, causing the composition of methane (CH_4) content to increase with increasing levels. carbon dioxide (CO_2). The insignificant increase was due to the absorption of a small percentage of water vapor content (H_2O) in biogas from cow manure.

Judging from the flow rate in the biogas purification process with the largest flow rate of 6.7 liters/minute, the methane content (CH_4) is greater than the methane content in the biogas before it was purified. This indicates that biogas purification by using unactivated coconut shell charcoal as an adsorbent is less effective in increasing the methane gas content (CH_4) and biogas quality from cow manure.

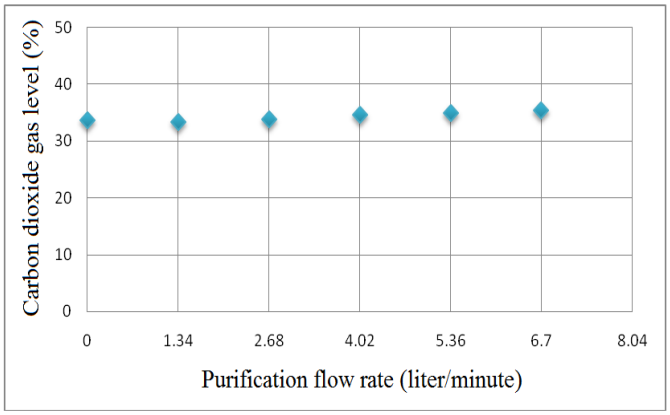

Fig. 3. The relationship between flow rate and levels of carbon dioxide (CO_2).

Based on Figure 3, the results of testing the levels of carbon dioxide (CO_2) in biogas show that the levels of carbon dioxide (CO_2) gas at each level of the flow rate almost do not change due to changes in the percentage of carbon dioxide (CO_2) gas levels which are not much different after going through the purification process, namely the average is below 2%. One of the elements contained in coconut shell charcoal is ash, where in the ash there is a silica content which has the property of being able to absorb water vapor (H_2O) [8]. The moisture content in the biogas will be absorbed by the silica contained in the adsorbent [7]. The content of water vapor (H_2O) in biogas that is absorbed by silica during the biogas purification process will increase the other chemical compositions of biogas such as CH_4 and CO_2, because if there is absorption in one type of chemical composition in biogas, the other chemical compositions will occur. Will increase. This shows that unactivated coconut shell charcoal does not react to carbon dioxide (CO_2) levels but can react to water vapor (H_2O) levels in biogas.

According to research results from [7] the percentage of moisture content (H_2O) in biogas from cow manure is 3.37%. So if you look at the difference in the percentage increase in carbon dioxide (CO_2) levels as shown in table 1 above, which ranges from 0.35%-1.76%, it makes a lot of sense with the absorption of water vapor (H_2O). This shows that coconut shell charcoal does not react to carbon dioxide (CO_2) levels so that coconut shell charcoal is not effectively used as an adsorbent in the biogas purification process which aims to improve the quality of biogas.

IV. Conclusion

The purified biogas with a flow rate of 6.70 liters/minute produces the largest chemical composition when compared to without purification and purification with a flow rate of 1.34 liters/minute, 2.68 liters/minute, 4.02 liters/minute and 5.36 liters/minute. The chemical composition at a flow rate of 6.70 liters/minute has a composition of 40.19% methane (CH_4) and

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35.37% carbon dioxide (CO_2). Judging from the difference in the chemical composition of biogas that has been purified and before it was purified it is very small, it can be concluded that biogas purification by using unactivated coconut shell charcoal as adsorbent is less effective in improving the quality of biogas.

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