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Effect of Flow Rate Biogas in Purification Carbon Dioxide Process with Coconut Shell Ash Adsorbent

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ABSTRACT
The long-term purpose of this research is to obtain quality biogas that is renewable natural gas and can be used as fuel for combustion of electric generators as an effort to diversify energy in the region of small islands that is sustainable. Specific target to be achieved is to obtain methods/techniques to adsorb impurities contained in biogas, especially the element of carbon dioxide (CO_2). The research was conducted to reduce CO_2 levels in biogas by using coconut shell ash adsorbent. Biogas flow rate is varied with 5 variations (2, 4, 6, 8 and 10 lt / min) when passing through the adsorber, then analyzed the levels of CO_2 absorbed and CH_4 (methane) produced using the gascromatography test equipment. The main component contained in coconut shell ash contain silica. Silica in coconut shell ash has the ability to absorb water vapor contained in biogas. The increase in CO_2 gas levels and CH_4 gas levels is more due to the reduced levels of water vapor in biogas so that the percentage of CO_2 and CH_4 volumes changes by the percentage of the volume of water vapor that can be absorbed by coconut shell ash. In the process of biogas purification with a flow rate of 10 lt / min which is passed into the coconut shell ash, the data obtained for methane gas content is 40,954% while CO_2 gas is 34,894%, this shows that an increase in methane gas levels by an average of 2, 62%, while carbon dioxide gas levels also increased by an average of 3,82%.
KEYWORDS; *Biogas, Adsorption, Coconut shell ash, Carbon dioxide, Methane*

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I. INTRODUCTION

Along with the rapid development of industrial technology, the need for renewable energy sources (renewable energy) becomes a very important consideration. This is due to the scarcity of petroleum energy sources and the higher world crude oil prices. Innovative research continues to be developed to find renewable energy sources. The research is not only to find new energy sources, but is able to find energy sources that are environmentally friendly.

This biogas can be a substitute solution for energy fuel that is cheap and environmentally friendly. Where the composition of biogas is CH_4, CO_2, N_2, H_2, O_2, and H_2S. Methane gas or CH_4 in biogas is the main element in biogas which is a component in combustion and also must be a large percentage, so that it can produce high heat. In addition to methane gas (CH_4) which is very much needed, there are also other ingredients which are actually disturbing or damaging. For example carbon dioxide (CO_2), the level of CO_2 in biogas ranks second after CH_4 and the percentage is approximately 40%. Where is known that the element CO_2 is the result of combustion and if this element is in combustion, it will disrupt the combustion process itself. Therefore, efforts are needed to reduce CO_2 levels which are expected to increase the quality of biogas.

The purity of CH_4 produced from biogas is a very important consideration. This is because it affects the heating value generated. So that the resulting CH_4 needs to be purified of other impurities. In this case the impurity which influences the heating value is CO_2, the presence of CO_2 in CH_4 gas is highly undesirable, this is because the higher CO_2 levels in CH_4 will further reduce the calorific value of CH_4 and very disturbing in the combustion process. This causes the CH_4 purity to be low.

Biogas purification was carried out by using absorbent concentration variations, namely a solution of $Ca(OH)_2$ 0,1; 1,5 and 2,5 M. The results of the gas chromatography test showed that the gas after filtering was 100% the area, whereas before purification there was a methane gas of 82,46% area [4] .

Research has been conducted on the reduction of CO_2 levels contained in biogas by using $Ca(OH)_2$ or limestone deposits. The analysis shows that the average CO_2 gas can be absorbed all at all variations in the flow rate of biogas (5. 10 and 15 lt/min). The most CH_4 produced at the biogas flow rate of 10 lt/min is 91% followed by the flow rate of 5 lt/min which is 76,2% and the flow rate of 15 lt/min is 72%. The most efficient use of biogas is found at a biogas flow rate of 10 lt/min, which is an average of 0,235 kg/hour. The biggest increase in effective power was obtained at a flow rate of 10 lt/min with an average increase in the effective power of unrefined biogas by 20,7% [5].

Gas separation technology that has been developed is the use of membranes. In this case zeolite Mixed Matrix Membranes are used for CO_2 / CH_4 separation. The choice of membrane as a gas separation technology is not new. Two criteria for a separation technology will be chosen if technical and economic considerations are easy to do [3].

CO_2 gas in biogas needs to be eliminated because it can reduce the heating value of biogas combustion. In addition, the carbon dioxide (CO_2) gas content in biogas is quite large at around 30 - 45% so that the heating value of biogas combustion will be reduced considerably. The heating value of pure methane gas combustion at a pressure of 1 atm and a temperature of 15,5^{o}C is 9100 Kcal / m3 (12,740 Kcal / kg). While the heating value of biogas combustion is around 4,800 - 6,900 Kcal / m3 [1].

II. RESEARCH METHODS

The research method that will be used to achieve the research objectives is to test the concentration of CO_2 and CH_4 gas present in biogas before purification. Then proceed with testing the concentrations of CO_2 and CH_4 gas after purification with coconut shell ash adsorbent.

The method used in this study is a pure experiment with the research tool scheme as shown in Figure 1. All determined variables are searched and measured directly except the variables that must be calculated based on the measured variables. This is done to determine the ability of coconut shell ash in purifying biogas. The biogas flow rate that passes through the adsorber varies 2, 4, 6, 8 and 10 lt/min. The variables recorded are CO_2 and CH_4 gas levels produced.

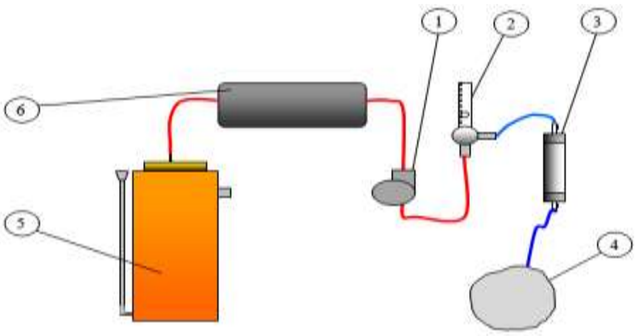

Figure 1. Composition of biogas testing equipment. 1. compressor, 2. flowmeter, 3. adsorber, 4. purified biogas plastic container, 5. digester, 6. biogas collection site

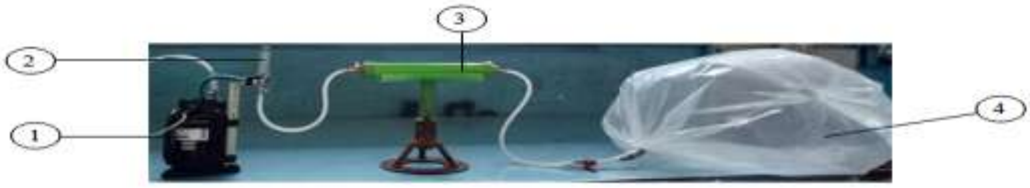

Figure 2. Composition of biogas purification equipment. 1. compressor, 2. Flowmeter, 3. adsorber, 4. purified biogas plastic container

The specifications of the tools used in this research can be seen in Table 1 as follows,

Name	Specification
digester	1400 lt
compressor	½ PK
Flowmeter	0 – 30 lt/min
Adsorber	Φ 3 cm , high 30 cm
adsorbent	coconut shell ash
gascromatography	GC7900

Table 1. (Tools and materials)

Testing Procedure

The main ingredient needed in this research is biomass waste from cow dung. Cow dung mixed with water with a volume ratio of 1 : 1, then stir until dissolved. The mixture is put in a storage tank (digester). Then all the channels and holes are closed tightly so that no air enters the digester, then allowed to stand for ± 1-2 weeks to produce biogas.

Phase I, analysis of the composition of biogas before purification. Analysis in the first stage is using gascromatography GC7900 so that the composition of CO_2 gas and CH_4 gas concentration in biogas can be known.

Phase II, biogas purification process from impurities. The research was continued by reducing CO_2 levels in biogas. Biogas purification method uses coconut shell ash adsorbent. CO_2 adsorption is done by feeding biogas into the adsorbent of coconut shell ash continuously with a certain flow rate (2, 4, 6, 8 and 10 lt/min), while biogas is flowed at the bottom of the column. Biogas and coconut shell ash will contact each other and chemical reactions occur. Furthermore, the biogas that comes out of the absorber is collected and then analyzed how much CO_2 is absorbed and the CH_4 produced using GC7900 gascromatography.

III. RESULTS AND DISCUSSION

The digester filling material for the biogas manufacturing process in this research came from biomass of cow dung. The comparison of the contents of the biomass digester filler material for cow dung and water is 1 : 1 in the sense that 500 kg of cow dung is mixed with 500 liters of water. For approximately 2-3 weeks the digester can produce biogas. The ambient temperature during fermentation is in the optimum range, which is between 27^oC - 31^oC. This temperature is in the range appropriate to the growth of microorganisms and digesters are placed in a room to avoid large temperature fluctuations, because methane bacteria are very sensitive to temperature changes.

CO_2 levels in biogas that have not been purified are still large at around 33,609% while the methane gas level is around 39,907%. This causes the resulting heat efficiency is still low so that the quality of the biogas flame is still not optimal. In this research, biogas purification from CO_2 impurities has been carried out using coconut shell ash as an adsorbent. The purification of biogas from CO_2 impurities by passing biogas into the adsorber tube with coconut shell ash as the adsorbent. Biogas flow rates that pass through the adsorber are varied as much as 5 variations of flow rates namely 2, 4, 6, 8 and 10 lt / min.

Biogas treatment	Biogas flow rate (lt/min)	Gas composition (%)	
		CH_4	CO_2
Without purification	-	39,907	33,609
Purification	2	38,719	33,651
	4	39,420	33,902
	6	39,789	34,106
	8	40,338	34,309
	10	40,954	34, 894

Table 2. (Data on the composition of carbondioxide in biogas)

The results showed that there was an increase in CO_2 gas as the rate of biogas flow increased through the adsorber (table 1). Changes in CO_2 gas levels for various variations in the flow rate of biogas when passing through the adsorber tube are more due to the nature of the coconut shell ash which has silica content, where silica has the ability to absorb moisture content. moisture content in biogas ranging from 1-5% can cause corrosion, the risk of freezing, on equipment, instruments, plants and piping systems [2]. The increase in CO_2 gas levels (figure 3) is more due to the reduced levels of water vapor in biogas so that the percentage of CO_2 volume changes by the percentage of the volume of water that can be absorbed by coconut shell ash.

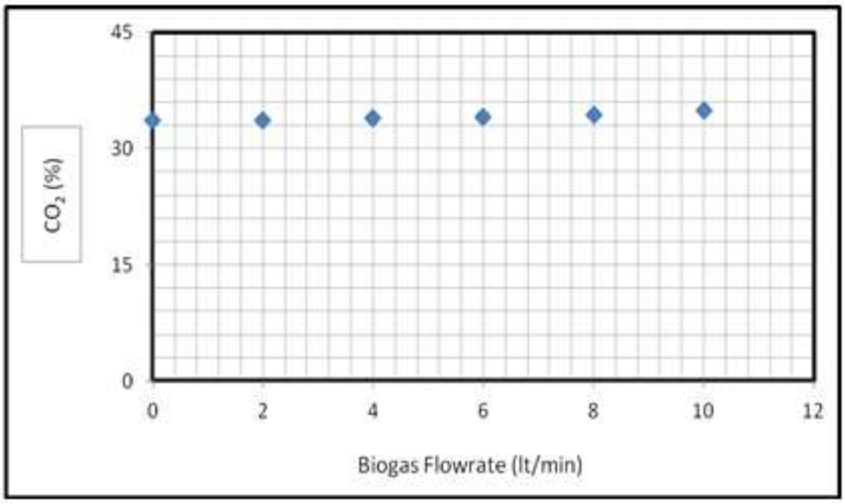

Figure 3. graph of the relationship of biogas flow rates to CO2 gas levels

In Figure 3 and Figure 4 it can be seen that with the increasing rate of biogas flow passing through the adsorbent, the carbon dioxide gas content increases, so does the methane gas level increases. This happens because the greater the flow rate of biogas that passes through the adsorber, the greater the water vapor that is able to be absorbed by the coconut shell ash. So the percentage of the volume of carbon dioxide and methane gas increases with the reduction in the percentage of the volume of water vapor contained in biogas.

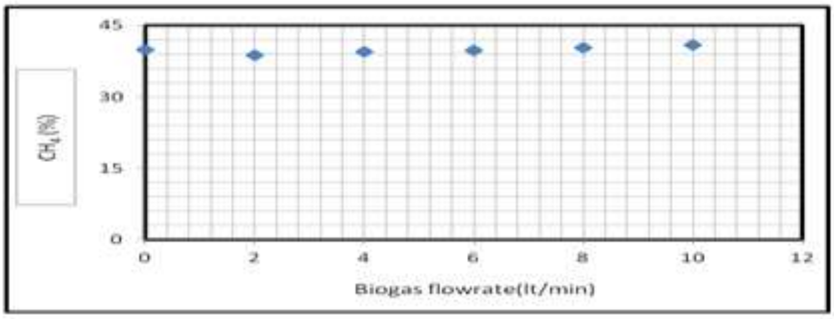

Figure 4. graph of the relationship of biogas flow rates to CH4 gas levels

IV. CONCLUSION

Coconut shell ash has silica content in it, so it can absorb water vapor contained in biogas. The increase in CO_2 gas levels and CH_4 gas levels is more due to the reduced water content in biogas so that the percentage of CO_2 and CH_4 volumes changes by the percentage of the volume of water that can be absorbed by coconut shell ash.

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