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EFFECT OF ABSORBENT CONCENTRATION ON PURIFICATION OF BIOGAS PRODUCED FROM BIOMASS FOR DOMESTIC USE

P. E. DIM and **A. S. ABDULKAREEM**
Chemical Engineering Department, Federal University of Technology, Minna, Nigeria

Abstract : The study of the effect of absorbent concentration on the purification ofbiogas by reducing the hydrogen sulphide and carbon dioxide content of the gas was carried out. This was done to determine the best absorbent concentration for the purification and to improve the combustion characteristics of the biogas produced to serve as an alternative to petroleum based products in used. In this study, five different absorbent concentrations were used for the removal of carbon dioxide and hydrogen sulphide impurities in the gas. The samples of gas produced were passed through a gas chromatography to determine the percentage composition (Mol % dry basis) of the biogas contents. The results obtained showed that the biogas sample before purification contained 54.09 mol % dry CH_4, 40.2 mol % dry CO_2, and 0.80 mol% dry H_2S. After purification, the composition of the biogas showed that at 40%, 45%, 50%, 55% and 60% concentration of the absorbent, 54.09, 54.09, 54.09, 54.09 and 54.09 of CH_4, 5.90, 5.00, 2.00, 4.58 and 5.45 of CO_2, 0.07, 0.04, 0.01, 0.05 and 0.08 of H_2S were left in the biogas respectively. The results show that the best absorbent concentration for purification is 50 percent concentration.

Introduction

Biogas otherwise referred to as "Bio fuels" as an alternative source of renewable energy. But petroleum is non-renewable; and it has been confirmed that non-renewable sources of energy could only last for about another 25 years or more (John and Twidell, 1987). The world attention is currently focused on biogas generation from abundant biomass materials because of their numerous potentials. The major components of a biogas is methane and carbon dioxide (Austin, 1984). Since ancient times, biogas is produced by the decay of vegetable and animal origin and was earlier identified as combustible swamp gas (Ronald, et al, 1982).This highly desirable fuel was obtained by fermentation of sewages as early as in 1934 and was used for heating an internal; combustion engine for pumping (White and Plaskette, 1981).Though the total amount produced may be small but of great significance locally in Nigeria and other parts of the world. It is on record that several large demonstration plants are already in operation and many other smaller units are installed daily (Malcom and Chris, 1979). This uncertainty has created a lot of anxiety for industrialized and developing nations like Nigeria. They are now looking back to the past and alternative methods of using biomass as one of the most

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viable solutions in the energy sector to avoid a complete breakdown should the fossil fuels be depleted suddenly. In this study, the production of biogas, from biomass materials, cow dung was allowed to decompose anaerobically at room temperature. This produced a gaseous product which on analysis contained methane, carbon dioxide and hydrogen sulphide in adequate proportions. Presently, countries like Brazil, India, United States, Pakistan and China have actualized this idea and are still thriving well. In Nigeria biogas can be produced from animal and human excreta, crop residue, poultry droppings, cow dung, pig dung, but in this work cow dung was used because there is no specific application for its use in Nigeria today.

METHODOLOGY

Preparation of Sample

A total solid concentration of five hundred grams in five litre solution was prepared using the sieved cow dung. The slurry was warmed using steam bath with constant stirring to remove air bubbles. The pH was measured and adjusted to 7.5 ± 1. The remaining air bubbles were removed by aspiration and subsequently by application of pressure to compress the plastic digester. The outlet was immediately closed tightly to prevent the entrance of air into the digester. Delivery tubes were connected from digester to the three 1000 ml conical flask containing 300 ml potassium hydroxide for carbon dioxide and potassium permanganate for absorbing the hydrogen sulphide. The gas collection bag was connected to the flask containing water for gas collection over water. The collection was done at five different absorbent concentrations of 40%, 45%, 50%, 55% and 60% respectively (Dim, 2002). After which five samples of 2000 cm_3 of biogas were collected in the collection bag. The digester was maintained at room temperature and the content was shaken daily and pH was monitored through a pH meter connected to a sampling point.

Analysis of Biogas

Each of the five samples of 2000cm^3 of biogas collected was passed through a gas analyzer of model P7450 to determine the percentage composition of the biogas.

Total Solid Analysis of Sample

The evaporating dish was washed clean with detergent solution and rinsed with distilled water. It was ignited for an hour in the oven at 100ºC. The content was allowed to cool at room temperature and the weight taken again using an electronic weighing balance. This was kept until is ready for use. 25g of the sieved cow dung was transferred to the pre-weighed evaporating dish, and weighed together and recorded. It was then dried at 105ºC in the oven for two hours. The dish and its contents were then cooled at room temperature and weighed again using the same electronic weighing balance.

Volatile Solid Analysis of Sample

The dried sample was put in a petri dish and was transferred to muffle furnace and heated at 500ºC for two hours. The loss in weight of sample represents the volatile solids.

Moisture Content Analysis of Sample

The test sample was weighed and dried in an oven at 100 ± 20ºC until approximately constant mass was attained. After drying, the sample was reweighed immediately and recorded. And the moisture content of the sample was calculated.

Results

Table-1.0 : Analysis of Cow dung Sample

Cow dung	Weight (g)	Weight (%)
Moisture Content	19.82	79.28
Total Solid Content	5.18	20.72
Volatile Solid	4.57	88.22

Table-2.0 : Biogas Analysis after Purification at Different Absorbent Concentrations

Biogas	Before Purification	After Purification				
		40%	**45%**	**50%**	**55%**	**60%**
CH_4	54.09	54.09	54.09	54.09	54.09	54.09
CO_2	40.2	5.90	5.00	2.00	4.58	5.45
H_2S	0.80	0.07	0.04	0.01	0.05	0.08
O_2	0.05	0.02	0.02	0.02	0.02	0.02
NH_3	0.98	0.06	0.06	0.05	0.06	0.07
H_2	0.50	0.50	0.50	0.50	0.50	0.50
N_2	3.29	3.12	3.01	2.54	2.67	3.15
Others	0.09	36.24	37.28	40.79	38.03	36.64

Table-3.0 : Percentage Removal of CO_2 and H_2S at Different Absorbent Concentrations

Absorbent Concentrations	Gas content	Before	After	Percentage Removal (%)
40%	CO_2	40.2	5.90	85.32
	H_2S	0.80	0.07	91.25
45%	CO_2	40.2	5.00	87.56
	H_2S	0.80	0.04	95.00
50%	CO_2	40.2	2.00	95.02
	H_2S	0.80	0.01	98.75
55%	CO_2	40.2	4.58	88.61
	H_2S	0.80	0.05	93.75
60%	CO_2	40.2	5.45	86.44
	H_2S	0.80	0.08	90.00

Discussion of Resuls

Table-1.0 present the result of the analysis of sample cow dung. From the Table it can be seen that the analyzed sample contained 5.18g, 4.57g and 19.82 g of total solid, volatile solid and moisture contents respectively. Table-2.0 shows the result of biogas analysis before and after purification at different absorbent concentrations. It can be observed from the results that the percentage composition of methane, carbon dioxide and hydrogen sulphide before purification were 54.09, 40.2 and 0.80 as against the literature values of 50-60, 30-50 and 0.1-.1.0. While the composition of the gases after purification at different absorbent concentration were, 54.09, 54.09, 54.09, 54.09, and 54.09, of CH4, 5.90, 5.00, 2.00, 4.58 and 5.45 of CO_2, 0.07, 0.04, 0.01, 0.05, and 0.08 of H_2S respectively. The result of biogas analysis after purification shows a great reduction in carbon dioxide and hydrogen sulphide content present in the gas sample. Basically biogas purification is all about the removal of CO_2 and H_2S present in the gas sample by using potassium hydroxide solution and acidified potassium permanganate solution (Dim, 2002).From Table-3.0, it can be seen that the results show that at 40%, 45%, 50% 55% and 60%concentrrations of $KMn0_4$ used in the purification were capable of removing, 91.25%, 95.00%, 98.75%, 93.75% and 90.00% of H_2S respectively. While at the same corresponding concentrations, KOH was capable of removing 85.32%, 87.56%, 95.02%, 88.61% and 86.44% of CO_2 respectively. From the findings, it was observed that 50% absorbent concentration was the best for the removal of H_2S and CO_2. While at 40%, 45%, 55%, and 60% concentration, less absorption of CO_2 and H_2S was recorded respectively. This may be due to effect of excess or limiting reactant in the absorbing medium.

Conclusion

From the result obtained it can be deduced that:

(1) The analyzed cow dung sample contained 5.18g, 4.57g, and 19.82g of total solids, volatile solid and moisture content respectively. This was also expressed in percentage as 20.72%, 88.22% and 79.28% respectively.

(2) The result of biogas analysis showed that at 50% concentration of KOH and $KMnO_4$, 95.02% and 98.75% of CO_2 and H_2S were removed respectively. At this concentration the highest amount of removal was recorded for both gases. Therefore 50% absorbent concentration is the best recorded for purification of the biogas in this work. (Dim, 2002).

(3) Finally, the quality of biogas produced can be assumed improved by reducing greatly CO_2 and H_2S contained in it. Therefore, it can now serve safely as a substitute for petroleum based cooking gas.

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