IOSR Journal of Engineering (IOSRJEN)
e-ISSN: 2250-3021, **p**-ISSN: 2278-8719
Vol. 3, Issue 7 (July. 2013), ||V3|| PP 04-07

Laboratory Scale Experiments for Biogas Production using Gas Chromatography Analysis

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Abstract: - A 2 m^3 floating dome anaerobic digester has been developed and its performance is compared with that of conventional mild steel dome biogas digester The overall objective of carrying the work is anlalyze the efficiency of biogas production for better performance of the digester tank and to optimize the biogas generation under normal operating conditions. The lab scale experiments are carried out in both the digesters in order to determine the composition of biogas and their efficiency. The gas samples which are collected through gas balloons from the biogas plant are taken to the laboratory for determination of composition of biogas by using gas chromatography. The results reviewed that methane composition is increased from 63.40% to 64.22% which holds good as of performance is considered .The greater methane yields results in better performance of the plant and proves to be more effective when compared to that of mild steel dome digester.

Keywords: *Anaerobic digester, transparent fibre dome, mild steel dome.methane yield.*

I. INTRODUCTION

The joint challenge of global pollution and depletion of fossil fuels is driving intense search into alternative renewable sources, among which is the biogas. It is a biofuel (60-70% methane),produced by an Anaerobic Digestion (AD) of organic waste through synergistic metabolic activities of consortia of hydrolytic, acetogenic and methanogenic bacteria on organic materials. Attempts have been made to increase the efficiency of biogas production by changing the dome of conventional biogas plant to transparent fibre dome and the rate of production of methane content is evaluated using gas chromatography analysis. The gas samples which are collected through gas balloons from the biogas plant are taken to the laboratory for determination of composition of biogas by using gas chromatography. The gas is collected from both the plants in order to analyze the performance of transparent dome type plant as compared to that of conventional floating dome type of digester plant. A gas chromatograph is a chemical analysis instrument for separating composition in a complex sample. The basic principle of GC is sample vaporized by injection into a heated system, eluted through a column by inert gaseous mobile phase and detected A gas chromatograph uses a flow-through narrow tube known as the column, through which biogas sample pass in a gas stream (carrier gas,) at different rates depending on their various chemical and physical properties and their interaction with a specific column filling, called the stationary phase. As the chemicals exit the end of the column, they are detected and identified electronically. The function of the stationary phase in the column is to separate different components, causing each one to exit the column at a different time (retention time). Other parameters that can be used to alter the order or time of retention are the carrier gas flow rate, column length and the temperature. The schematic diagram of gas chromatograph is shown in figure

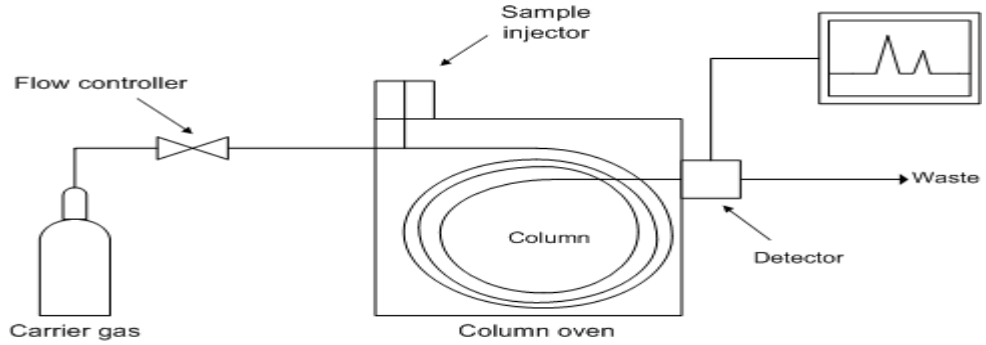


Figure1: Schematic diagram of gas chromatograph

In a GC analysis, a known volume of gaseous analyte is injected into the "entrance" (head) of the column, usually using a micro syringe. As the carrier gas sweeps the analyte molecules through the column, this motion is inhibited by the adsorption of the analyte molecules either onto the column walls or onto packing materials in the column. The rate at which the molecules progress along the column depends on the strength of adsorption, which in turn depends on the type of molecule and on the stationary phase materials. Since each type of molecule has a different rate of progression, the various components of the analyte mixture are separated as they progress along the column and reach the end of the column at different times (retention time).

II. EXPERIMENTAL PROCEDURE

A sample is introduced into a heated small chamber via a syringe through a septum -the heat facilitates volatilization of the sample and sample matrix. The carrier gas then either sweeps the entirety (split less mode) or a portion (split mode) of the sample into the column.In split mode, a part of the sample/carrier gas mixture in the injection chamber is exhausted through the split vent. Split injection is preferred when working with samples with high analyte concentrations (>0.1%) whereas splitless injection is best suited for trace analysis with low amounts of analytes (<0.01%). In splitless mode the split valve opens after a pre-set amount of time to purge heavier elements that would otherwise contaminate the system. This pre-set time can equal the total runtime to effectively keep the purge closed.

Figure 2: Gas chromatograph

The figure 2 shows gas chromatography in which a detector is used to monitor the outlet stream from the column; thus, the time at which each component reaches the outlet and the amount of that component can be determined.

2.1 Procedure followed

The procedure for the set up is as follows:

- Turn ON PA-2400 using red switch provided on front facial.
- PA-2400 will show following message for 10 seconds
- "ENDEE ENGG PVT LTD"
- Then after this it will display model no for 10 second "MODEL PA-2400"
- Finally PA-2400 will display

" READY "

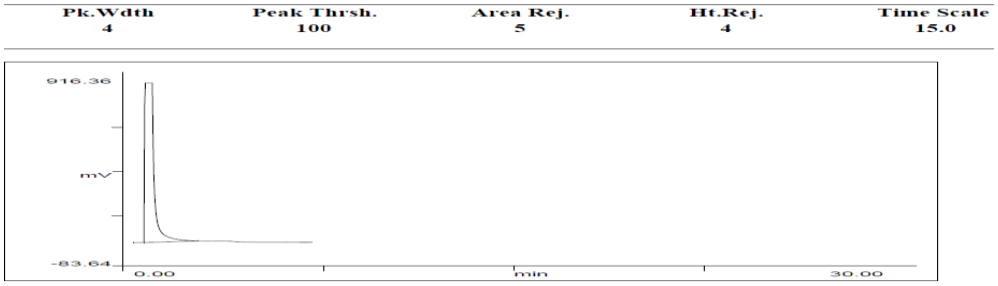
"PRESS FN\SAMPLE"

- If Fn key is pressed it will enter into function mode.
- If SAMPLE key is pressed it will enter into sampling mode. In this mode sample is collected along with data-logging.
- "SAMPLING PL…"
  - ….WAIT"
- "DATA LOGGING PL…"
  - ….WAIT"
  - NOW all parameter can be displayed one by one
  - After one scan it will go to Ready Mode as
  - O_2 : 20.9 %V/V

- CO : 000.0 PPM
- CO_2 : 00.0 %
- NOx : 0000 PPM
- HC : 000 PPM
- Temp. : 030 °c
- Eff. : 80.0
- In this mode the data gets stored.
- For ready mode press**" sample"**

III. RESULTS AND DISCUSSION

After the instrument is warm up for 30 minutes the sample button is pressed to determine the composition of methane. The instrument generated gas chromatography picture for the determination of methane composition of both the digesters is shown in the figure and the composition is tabulated.



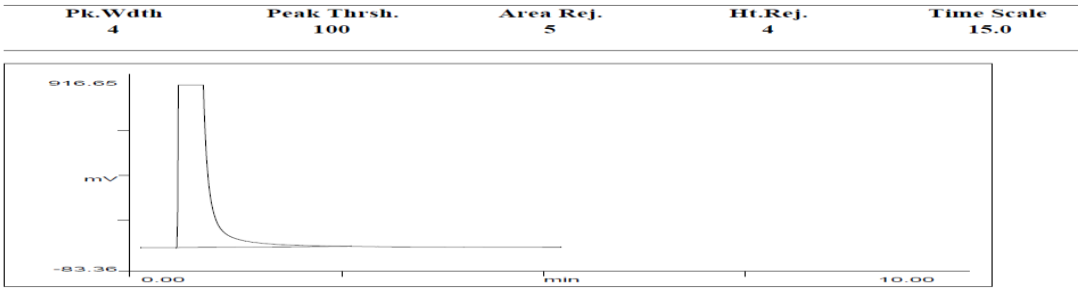
No.	R.T.	Area	Area %	Pk Ty	Comp Name
1	0.61	264614718	100.0000	BB	Methane
		264614718			

Summary :

TOTAL PEAKS :	1
MUL. FACTOR :	1.0000
SAMPLE AMT.	100.0000

Figure 3.1 Calibration curve of Mild steel dome digester

The graph represents the peak in which the sample is sent into the column and the display generates the graph, through which the retention time is noted. The area under the curve represents the amount of methane generated during the peak time is obtained. Similarly the gas chromatography analysis for the transparent fibre dome digester generated the graph as follows



No.	R.T.	Area	Area %	Pk Ty	Comp Name
1	0.63	268043896	100.0000	BB	Methane
		268043896			

Summary :

TOTAL PEAKS :	1
MUL. FACTOR :	1.0000
SAMPLE AMT.	100.0000

Figure 3.2: Calibration curve for transparent fibre dome digester

The results of the gas chromatography shown that the methane content in the transparent type of digester has been higher than that of mild steel dome digester type which yields to increases from 63.40 to 64.22.

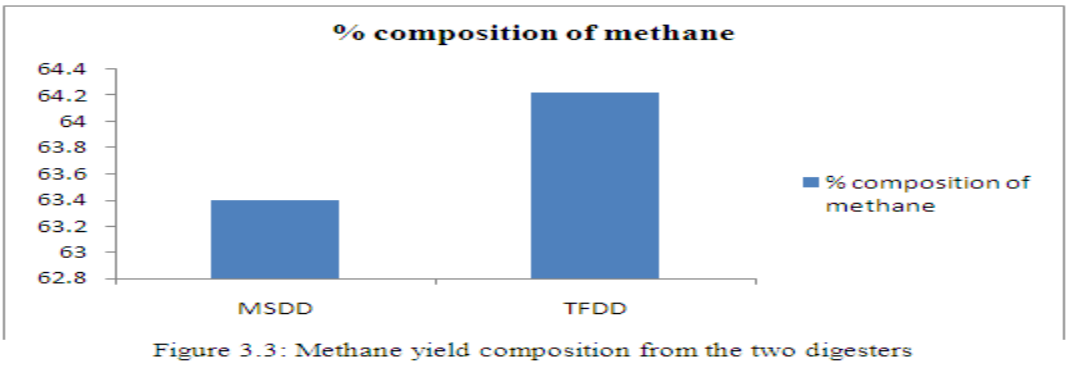


Figure 3.3: Methane yield composition from the two digesters

The results reviewed that the transparent type of digester has more methane yield than that of mild steel dome type of digester because of that the transparent fibre type of dome digester has maintained good digestion temperatures inside the digester tank as of methanogens inside the digester are actively formed by the anaerobic digestion process. The results reviewed that methane composition is increased from 63.40% to 64.22% which holds good as of performance is considered .The greater methane yields results in better performance of the plant and proves to be more effective when compared to that of mild steel dome digester.

IV. CONCLUSION

In the present study, the testing of transparent fibre dome as an alternate building material for biogas plant proves to be more effective than conventional biogas plant which is evident from the experimental results. The study mainly focuses on increase in temperature regimes of the biogas plant for the better anaerobic digestion process. The temperature plays a crucial role in fermentation of the slurry for the better formation of methanogens.An increased temperature in the digester tank facilitates faster reaction rates and hence faster gas yields are produced. The results reviewed that the temperature regimes are maintained moderately higher than that of mild steel dome digester which yields greater sterilization of the end digestate and faster gas yields. The experiments are conducted at laboratory level to determine the composition of the conventional and modified biogas plants to study the percentage variation of both the plants. The experimental results shown that the methane yield composition is increased from 63.40 % to 64.22 % in the transparent dome digester plant when compared to that of mild steel dome digester. Finally it concluded that the usage of transparent fibre dome type digester proves to be more effective than that of conventional mild steel dome digester in terms of performance and economical viability is considered.

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