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The Production of Biogas from Cow Dung for Powering a Motor Vehicle Tyre Tube

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Authors' contributions

This work was carried out in collaboration between all authors. Author AA designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author SA managed the analyses of the study. Authors ET and EO managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Biogas production from cow dung for powering a tyre tube was investigated, using a 20litre capacity prototype biogas digester, fabricated in the Lagos state university (LASU) research laboratory. The experiment was batch operated and daily gas yield from the digester was monitored for 21 days. The ambient and slurry temperatures, PH were also monitored. Two important aspects of the biogas itself is digester and starter. This Research aim to fabricate a digester that can be used to convert a cow dung into methane for powering a tyre tube and the objective to determine whether cow dung from ranch can produce methane. In this study a mini biogas digester fabricated and tested for organic waste, thirty-five (35) kg of the cow dung, water and starter was used. (The starter that used in this study is silica gel). The cow dung inserted into the digester through the inlet pipe, and kept for

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three weeks. The ratio of cow dung water is 1:2. The result obtained from the biogas production showed that methane has 67.9%. This result show that these waste could be a source of a renewable gas if managed properly since the waste sluggishly continued gas production after 21 days retention time.

Keywords: Digester; methane; silica gel; cow dung and water.

1. INTRODUCTION

Biogas is a renewable source of energy; in general biogas consists of methane, carbon Dioxide, as well as little amounts of other gases such as nitrogen, hydrogen, hydrogen sulfide and oxygen [1,2]. Biogas is suitable in Nigeria because there are a lot of organic wastes that can be used as source of energy. This energy release allows biogas to be used as fuel [3]. Biogas can be used as a fuel in other country for the purpose of heating, cooking and a lot more, biogas can be more compressed like a natural gas and can also be used to power motor vehicle tyre tube. Biogas can be derived from the following such as agriculture waste, animal manure, sewage, green waste, poultry, cow dung, human excrement, expired food and in addition to factory organic liquid [4]. The process of biogas formation is divided into four stages which are hydrolysis, acidification, methanogenesis and acetogenesis. In the hydrolysis step, complex organic materials decomposed into a smaller form, the result obtained from the hydrolysis stage are then fermented in acetogenesis stage, Mathanogenesis stage, methanogenic bacteria will consume acetate, hydrogen, and carbon dioxide to produce methane gas [5]. Biogas formation process must take place in a place that is free of oxygen, called a digester. The shape and the size of the digester vary depend on the available materials to make the digester [6]. The advantage of making this mini biogas digester are relatively low manufacture cost, this mini-biogas digester can be an alternative solution for energy shortage [7]. The digester slurry is a good fertilizer, it is claimed that its value as fertilizer could double crop yield [8]. Biogas is a clean renewable energy produced from organic waste using digestion as a method [9]. biogas consists of methane (50-75%), carbon dioxide (25-50 %), as well as small amounts of other gases such as nitrogen (0-10%), hydrogen (0-1%), hydrogen sulfide (0-3%), and oxygen (0-2%) [10]. the biofuel is renewable and environmentally clean which significantly decreases the fossil fuel consumption [11]. Anaerobic digestion is a useful energy production technique.

2. MATERIALS AND METHODS

The materials used for fabricating mini biogas digester is a 20Litre capacity prototype biogas digester (Fig. 1). Some other equipment such as ¾ pvc pipe, pvc caps, t- connector, gas hose, funnel, tyre tube, air flow valve and pvc gum. The study was carried out between July and August 2018 at Lagos state university. Cow dung, water and starter were the substances used for this study. Fresh cow dung was collected from the slaughter house, in Agumajayi area along Badagry express way Okoafor, Lagos State. The water was collected from Lagos State University and the silica get was collected from department of biochemistry in Lagos state University. Other materials such as top loading balance and thermometer were used. A minimum and maximum ambient temperature of 20ºC and 32ºC respectively and a minimum and maximum slurry temperature of 23ºC and 36ºC respectively.

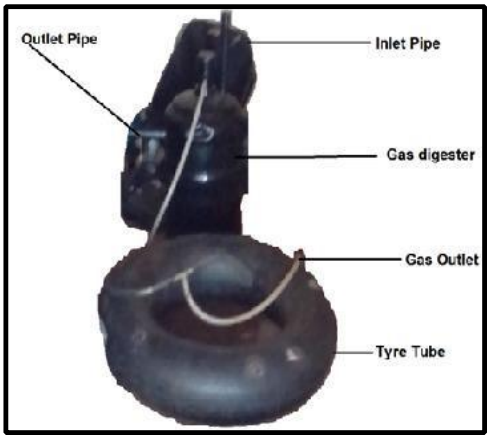

Fig. 1. Prototype of mini biogas digester

In the experiment we tested the mini size biogas plant using slurry derived from cow dung with the addition of starter. The digester is placed at a room temperature of 30ºC. Also, we use silica gel as starter for producing biogas.

Experiment procedure

i. The 20L of water bottle is air tight container.

ii. Two holes was drilled, one hole was by the side of the container and the other hole was at the top of the container.
iii. One pipe was fixed at the top hole of the container (inlet pipe) and the second pipe was fixed by the side of the container (outlet pipe).
iv. The holes that were drilled between the top and the side of the container was sealed up with pvc gum and the inlet and outlet pipes were covered with the pvc caps.
v. Another hole was drilled at the upper top of the container, the gas hose was fixed and the hole was sealed up with pvc gum and connected with the t-connector and the off and on valve called the test point.

35kg of a cow dung was charge into the digester through the inlet pipe with 70kg of water in the ratio of 1:2 of waste to water and slurry was properly stirred. The ambient and slurry temperature were measured using thermometer, and the pH values were monitored on the 3days interval, after the third days there was emission of gas from the digester into the motor vehicle tyre tubes. A top loading balance was used in the measurement of water and organic waste. The mini biogas plant consists of the fermentation chamber, inlet pipe, outlet pipe, gas hose and off and on valve. The main functions of this mini biogas plant are

i. To provide a means to discharge the spent slurry
ii. To keep the charge at operating temperature
iii. To accept new quantities of charge
iv. To collect the gas for processing and storage.

3. RESULTS AND DISCUSSION

Table 1 shows the mixed mass of charge stock and water ratio for the cow dung. A close examination of table 2(biogas composition by $^0/_0$ volume) shows that cow dung has 27.2$^0/_0$ content of carbon dioxide, hydrogen Sulphide 0.1 $^0/_0$, carbon monoxide 4.7$^0/_0$ and total methane content of 67.9 $^0/_0$.

Table 3 shows the summary of the result for the 21days retention period. From the table cow dung, generated the total amount of the gas volume of 280m^3.

Table 4 shows the 21 days daily and volume of biogas production for the cow dung. A close observation shows that cow dung started daily production on the second day, reaching peak on the 10th day and yield 8.2litre of biogas. A cumulative of 280litre of a biogas was produced at the end of 21days retention period from cow dung waste.

From the graph, we observed that using a starter, the emission of gas started from the day three (3) when fermentation had taken place. This process continued for three (3) weeks. From

Table 1. Mix mass of charge stock and water

Waste	Mass of waste (kg)	Mass of water (kg)	Mix ratio
Cow dung	35	70	1:2

Table 2.

Waste stock	Carbon dioxide	Hydrogen Sulphide	Carbon Monoxide	Methane
Cow dung	27.2	0.1	4.7	67.9

Table 3. Summary of the results for cow dung

Items	Cow dung
Mass of waste used (kg)	35
Mass of Water used (kg)	70
Total mass of Slurry (kg)	82
No. of days of Digestion	21
Volume of Gas Generated (L)	280
Maximum Ambient Temp. (^{o}C)	32
Maximum Slurry Temp. (^{o}C)	36

Table 4. 21 days of daily\ volume of biogas produced (litre) for the cow dung waste

Waste	Cow dung	
No of Days	**Daily Volume of the gas (L)**	**Cumulative volume of the gas (L)**
1	0.0	0.0
2	4.5	4.5
3	6.1	10.6
4	7.5	18.1
5	3.2	21.3
6	3.8	25.1
7	4.5	29.6
8	2.9	32.5
9	2.9	35.4
10	8.2	43.6
11	7.6	51.2
12	7.2	58.4
13	5.3	63.7
14	4.4	68.1
15	2.4	72.3
16	2.9	75.2
17	5.2	80.4
18	5.5	85.6
19	4.2	89.8
20	3.9	93.7
21	3.0	96.7

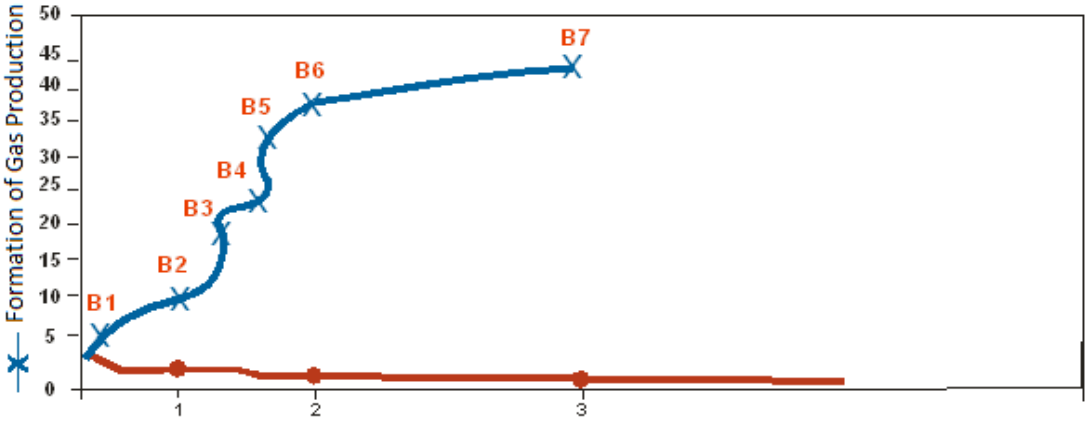

Figure 2. The time require for biogas formation

the first bar B1, corresponding to three days, the total volume of gas produced was 40m³. This is the same with B2, B3, B4, B5, B6 and B7 which shows that the total volume of gas to power the motor vehicle tyre tubes for the twenty (21) days 280m³.

4. CONCLUSION

The result of this research on the production of biogas from cow dung has shown that flammable biogas can be produced from these waste through anaerobic digestion for biogas

generation. These revealed further that cow dung as animal waste has great potential for generation of biogas and its used should be encourage due to its early retention time and high volume of biogas yields.

To calculate the methane flow rate by using the Kinetic Energy equation which can express as $k.e = ½MV^2$. Where $M$the mass of the organic waste and V is the output velocity of the gas. To determine the output velocity of the gas is difficult because methane consist of organic waste which moves at a different speed in a random direction. The root mean square velocity (RMS) is a way to find the single velocity value of the gas.

$$V_{rms} = (3RT/m)^{\frac{1}{2}}$$

V_{rms} = root mean square velocity in m/s
R = ideal gas constant with value of 8.3145
T= room temperature in ºC
M= mass of the organic waste in kg

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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