Biogas Production Using Cow Dung From Abakaliki Abattoir In South-Eastern Nigeria

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Abstract— The demand, high costs and health implications of using energy derived from hydrocarbon compound have necessitated the continuous search for alternative source of energy. Cow dung as a renewable source of energy supply has been proven to be very efficient. This study investigated the production of biogas using cow dung from Abakaliki abattoir located in Abakaliki, Ebonyi State, Nigeria. A 2ml/g of the cow dung was used in this study. The digestion was carried out in a 10 L anaerobic digester at a temperature of 25^0C to 30^0C and uncontrolled pH for a period of 3 weeks. About 23 cm^3 of biogas was produced on the 22^{nd} day. Thus biogas production from cow dung is a good and cheap alternative source of energy. The use of biogas will not only serve as a source of fuel but will also help in the management of waste. The biomass generated after digestion can be used both as animal feed and to improve soil fertility. It is therefore recommended that large scale production of biogas from wastes should be undertaken by all as the wastes around you today can become your wealth tomorrow.

Index Terms— Abakaliki, Biogas, Bioreactor, Cow dung, Wastes

1 INTRODUCTION

The use of fossil fuels as primary energy source has led to global climate change, environmental degradation and human health problems [1]. Also, improper waste management is one of the major problems confronting every development. This is because increase in industrial, commercial, agricultural and environmental activities has resulted in the generation of large quantities of wastes [1]. These wastes, when not properly managed contribute to unhygienic environmental conditions that breed pathogenic microorganisms. Apart from the health implications, wastes make an environment unpleasant and unattractive. However, these wastes can be managed properly by conversion into useful and more environment-friendly forms called biogases. Biogas typically refers to a gas produced by the breakdown of organic matter in the absence of oxygen [2]. It is a renewable energy source, like solar and wind energy. Furthermore, biogas can be produced from regionally available raw materials and recycled waste and it is environment friendly and carbon IV oxide (CO_2) neutral. Biogas is produced by the anaerobic digestion or fermentation of biodegradable materials such as manure, sewage, municipal waste, green waste, plant material, and crops [3].

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Renewable energy resources appear to be one of the efficient solutions to the problems resulting from the use of fossil fuels [4]. Livestock waste management in many parts of the world is a big challenge which if not properly taken care of can cause a lot of health/environmental problems [5]. Large volumes of cow dung generated from feed lot farming is on the increase, most of which are disposed into landfills or applied to the land without treatment [3]. Animal wastes are abundant all over the world with Nigeria producing about 227,500 tons of fresh waste each day, that 1kg of fresh animal waste produce about 0.03 m^3 of gas per day[6]. This shows theoretically that Nigeria can produce 6.8 million M^3 of biogas daily, which in terms of energy is equivalent to about 3.9 million liters of petroleum. The use of biogas is capable of providing a special impetus in both rural and urban areas. Biogas plant can be built by using materials which are locally available in most developing countries like Nigeria [7]. Nigeria is tremendously blessed with a variety of energy resources (both conventional and non-conventional). The reserves for animal waste alone which is a viable source for biogas production as at 2005 was estimated to be 61.00 million tonnes/yr and crop residue was put at 83.00 million tonnes/yr. However, 50 and 400 MW of electricity is targeted to be generated from biomass by 2015 and 2025 respectively [8]. Biogas is a renewable, alternative and sustainable form of energy [9]. Not only does biogas technology help to produce an alternative energy source, but it also helps in maintaining the environment and improving health conditions. The energy in plant vegetation, animals, industrial and domestic waste matter can be released in terms of a useful gas when fermented anaerobically, that is, in the absence of oxygen. The biogas formed after the decomposition of organic wastes is channeled or transported to homes for use for cooking, running engines, electrical power generation and heating, with virtually little or no pollution at all. This gas is now used in large scale in many countries [10]. The use of anaerobic digestion as waste-to-energy technology has been employed in the treatment of different organic wastes [11]. This method when used on organic material produces compound like methane, CO_2, ammonia, traces of gases, and organic acid of low molecular weight [12]. Ignorance about this technology has made majority of people in the developing countries mainly depend on solid fuel like wood, to meet their cooking and light needs [13]. Nowadays fossils-based fuel is becoming scarce and more expensive, thus the need to resort to the use of biogas

as a more efficient supplement. In this study, biogas production was investigated using cow dung from Abakaliki Abattoir in Ebonyi State, Nigeria. There was a significant yield of biogas observed in this study.

2 MATERIALS AND METHODS

2.1 Sample Collection

Fresh dung was collected from Ebonyi state University farm, Abakaliki and also from Abakaliki Abattoir.

2.2 Procedure

A 10 L jacketed fermenter equipped with pH probe, stirrer, sampling ports and temperature controller was used in this study. The working volume of the bioreactor was maintained at 6 litres and ran under uncontrolled pH, without acid or base addition. Experiment was carried out at temperature of 35^0C by circulating water from a thermostat through a water jacket surrounding the bioreactor, and mixing was aided by a mechanical stirrer set. The outlet was immediately closed tightly to prevent re-entry of air into the digesters. The gas collection bag was connected to the flask containing water for gas collection over water. The digester was maintained at room temperature, the contents shaken daily and pH monitored using pH meter connected to a sampling point. About 600 ml of distilled water was added to 300 g of the organic waste material to form slurry (water and cow dung) making a water to dung ratio of 2:1. The organic wastes were added into the tank and properly sealed to prevent air from entering the tank. The digestion was carried out for 3 weeks.

2.3 Gas Collection

The gas was collected by downward displacement of water in the gas holder and the volume of displaced water was recorded as the volume of gas produced.

2.4 Test for the Presence of Methane in Biogas Produced

The presence of methane was tested by lighting flame on a Bunsen burner connected to the digester. The gas that came out from digester was checked whether it burns; the color of the flame and the odor were also checked.

3 RESULTS

The anaerobic digestion of cow dung from Abakaliki abattoir generated some volume of biogas over the three-week digestion period. There was no biogas production in the first two days of anaerobic digestion. The highest biogas yield of 23.0 cm^3 was observed in the 22^{nd} day while the least was observed in the 4^{th} day. The biogas yield increased as the day increased. Details of the result are shown in **Table 1**.

Table 1: Temperature Readings through Duration of Digestion

Days	Initial volume of water (ml)	Final volume of water (ml)	Temperature (^{O}C)	Volume (cm^3)
0	37.0	36.4	10	-
2	36.5	36.8	25	-
4	36.0	37.1	25	1.5
6	35.5	37.3	25	2.0
8	34.8	37.4	25	3.3
10	33.8	37.5	25	3.5
12	32.8	37.7	27	4.5
14	32.0	37.8	25	5.2
16	21.0	38.0	25	16.2
18	18.0	38.1	25	19.0
20	15.0	38.5	25	22.0
22	14.0	38.0	25	23.0

4 DISCUSSION

This investigation reveals that biogas production was delayed till the fourth day. This can be traced to the fact that most cows feed on fibrous materials and microorganisms require a longer time to degrade fibrous materials. This finding is in conformity to that, from the works of Babatola [14] in Akure, and Ukpai and Nnabuchi [15] in Abakaliki, both in Nigeria. The absence of biogas production in the first three days could be as a result of multiple carbon sources in the cow dung (substrate) as one carbon source is exhausted due to the change to anaerobic condition, the microbial cells divert their source of energy for growth to a new carbon supply [16]. A close examination of the findings of this study show that biogas production was less and gradual in the first week of the investigation. This suggests that the biogas producing microorganisms are in the lag phase of growth where acclimatization or adaptations of the cells take place. This report is in consonance to that of Abubakar and Ismail [17]. It can also be deduced from this that biogas production rate is equivalent or dependent on the growth of methanogenes. From the second week of the study, results indicated a progressive increase in biogas production, this continued to the third week of the study. This indicates that the methanogenes are in their exponential stage of growth. However this differs from the findings from the findings from the works of Rabah *et al* [18] in Sokoto and that of Abubakar and Ismail [17] in Malaysia where biogas production experienced a decline in the third week. These differences observed may be due to the different breeds of cows found in the different locations. Also climatic factors, the nature or quality of feed or pasture that the cows were exposed to, are factors that could contribute to the differences in the rate of biogas production [10]. When biogas is used, many advantages arise. In North America, utilization of biogas would generate enough electricity to meet up to three percent of the continent's electricity expenditure [19]. In addition, biogas could potentially help reduce global climate change. Normally,

manure that is left to decompose releases two main gases that cause global climate change: nitrogen dioxide and methane. Nitrogen dioxide (NO_2) warms the atmosphere 310 times more than carbon dioxide and methane 21 times more than carbon dioxide. By converting cow manure into methane biogas via anaerobic digestion, the millions of cows in Nigeria, United States, etc, would be able to produce one hundred billion kilowatt of electricity, enough to power millions of homes across the United States. In fact, one cow can produce enough manure in one day to generate three kilowatt hours of electricity; only 2.4 kilowatt hours of electricity are needed to power a single one hundred watt light bulb for one day [19]. Furt\hermore, by converting cow manure into methane biogas instead of letting it decompose, global warming gases could be reduced by ninety-nine million metric tons or four percent [20].

5 CONCLUSION

This study shows that abattoir wastes (cow dung) hold a good promise in the cost-effective production of biogas. It is also important to note that biogas also can help to potentially reduce climate change as it is environmentally friendly. Therefore, Nigeria needs to harness this medium to boost its energy production.

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