International Digital Organization for Scientific Research
IDOSR JOURNAL OF COMPUTER AND APPLIED SCIENCES 3(1):25-29, 2018. ISSN: 2579-0803

Biogas Generation from Poultry Manure

[1]S. M. Ngaram, [2]M.Sulyman, [3]I. U. Zungum and [4]M. Tijjani, [5]D.I. Malgwi

[1]Department of Physics, Federal University Gashua, Yobe State, Nigeria.

[2, 3,4]Department of Biological Science, Federal University Gashua, Yobe State, Nigeria.

[*]Department of Physics, University of Maiduguri, Borno State, Nigeria
Corresponding Author Email: ngaramsuleiman@fugashua.edu.ng

ABSTRACT

This study was carried out to investigate the generation of biogas from poultry manure. Biogas is a mixture of colourless, flammable gases obtained by the anaerobic digestion of animal-based organic waste materials. Biogas is typically made up of methane (50-70%) carbon dioxide (30-40%) and other gases. The plastics digesters were labeled A, B and C. Each digester contains equal volumes of the slurry. Equal volumes of slurry (750 g manure, 20cm^3 water) in the digesters were subjected to anaerobic digestion over a four- week retention period and weekly measurements of gas. The biogas was collected by the water displacement method. Flask A was kept at room temperature (25^{0}C) and gas was collected over water. The flask B was also collected over lime water at ambient temperature. The digester B had the highest gas yield (16.30 cm^3). Gas production increased with increase in retention time. Week 4 had the highest percentage gas (63.75%) for the B digester. For the A digester, week 3 had the highest percentage gas yields of (42.08%) respectively. The content of the C digester which was exposed to the sun dried up and no gas was produced. In digesters A and B gas yield increased as retention time increased.

Keywords: Poultry manure, Biogas and Generation.

INTRODUCTION

A biogas production is a technology that depends on microorganism that convert fermentable organic matter into a combustible gas and matured organic manure [1, 2 ,3]. It works in the absence of air, yielding finally, methane, carbon dioxide and water, this process is called anaerobic decomposition. Biogas obtained through this process could be from several matters (animal or agricultural waste) that are available in surrounding environment. Biogas can be used directly for heating and lighting process, and the effluent released from the biogas digester could be an excellent fertilizer [4, 5]. Therefore, suitable management of poultry manure is required to mitigate these quantities of manure by anaerobic digestion and biogas technology. Not only can anaerobic digestion of poultry manure produce renewable energy in terms of biogas, but it can reduce waste from manure use and production. Worldwide, various biogas plant propagation programmes have been launched in over 50 countries, with those in China and India being of the largest scale [6, 7]. In Western Europe there is political pressure for developing renewable energy. Therefore, farmers seek developing units for the production of energy using animal dung to produce biogas and earn money with it (Krieg *et al.,* 2014). In Arab countries, biogas plants started in 1970s in Egypt, Morocco, Sudan and Algeria while it began in 1980s in other Asian Arab countries.

Recently, poultry industry has become a fast growing business with an average of 3 percent per year [8, 9]. The reason may be attributed to population increase and rising demand for poultry meat and egg. However, one of the problems confronting this industry is the accumulation of waste near farms causing many environmental problems such as fly breeding, odor, nuisance and greenhouse gas emission if not disposed of or managed appropriately [10].

The two enormous problems that are increasingly threatening the good life of many nations include the task of waste management and inadequacy of energy supply. A nation's inability to dispose waste and to find enough energy greatly affects living conditions. The problem of fuel scarcity and sewage disposal in Nigeria and many developing countries is alarming. Energy generated from waste is therefore needful as it will serve the dual purpose of cleaning the environment and providing a cheaper source of energy [11]. The aim of this research was to investigate the possibility of generating biogas from a cheap raw material (Poultry manure) using a laboratory scale digester [12].

MATERIALS AND METHODS

Sample collection

Poultry manure was collected from the farm of the Department of Agricultural Technology, Federal Polytechnic Mubi, Adamawa State. A clean container with cover was used for collection of the waste. The poultry litter was dried under the sun for three days and then pulverized using a pestle and mortar.

Slurry preparation

Seven hundred and fifty grams each of the fine powdered poultry litter was weighed and mixed with water in a 20 liters plastics digester to give a ratio of 1:2 as recommended by Mattocks (1984) [8]. The mixture was thoroughly stirred with a glass rod to achieved homogeneity.

Anaerobic digestion

The plastics digesters were labeled A, B and C. Each digester containing equal volumes of the slurry was connected by a rubber delivery tube, which conveys the gas, to a burette filled with water and placed in an inverted position in glass trough containing water such that gas released from the digestion process was collected in the burette by water displacement method. The plastic-end digester of each delivery tube was inserted into the mouth of the conical flask and held in place by cotton wool stuffed at the mouth of the flask. The connecting point of tube and flask was sealed with adhesive tape to prevent leakage of gas from the flask. Each of the three sets of digesters was subjected to a different treatment.Plastic digester A was kept in the laboratory at ambient temperature (25^0C) with gas collection carried out over water. The digester B was also left at ambient temperature but there water trough contained lime water instead. Digester C was exposed to the sun outdoors all through the period of the experiment. The contents of the digesters were allowed to undergo digestion for a retention period of four weeks with weekly measurements of gas yields.

Regression analysis

A computerized numerical analysis of the data resulting from the biogas test was made using the MATLAB, select regression software. The analysis produces the statistically optimum regressions on subsets of the independent variables of size 1 to n< 90. The result is a linear equation of biogas as a function of poultry litter. The resulting regression equation was

$Ҡ(t) = P_1 t + P_2$ . . . (1)

Where,

Ҡ = Biogas (Methane)

t = Poultry manure

P_1 and P_2 = Constant

RESULTS

The mean weekly biogas yields for different sets of digesters are presented in Table 1. The highest total gas yield (16.30 cm^3) was observed in the B digester which was left at ambient temperature and in which gas was collected over lime water. The least total gas yield (5.04 cm^3) was observed in the A digester which was also left at ambient temperature but with gas collection carried out over water. The content of the C digester which was exposed to the sun dried up and no gas was produced. In digesters A and B gas yield increased as retention time increased. Weekly monitoring of gas yields showed that for the B digester, week 4 had the highest percentage gas yield (63.75%). For the A digester, week 3 had the highest gas production (42.08%). The observed differences in the total gas yields for the different treatments were significant ($P < 0.04$). The microorganisms isolated from different digesters were similar.

Table 1: Mean weekly biogas yields from anaerobic digestion of poultry manure

Retention Time (Weeks)	Mean Gas Yields from Digesters (±SD) (cm^3)		
	A	B	C
1	2.20 ± 0.04^a	0.00 ± 0.00^b	0.00 ± 0.00^c
2	3.00 ± 0.04^a	3.02 ± 0.07^b	0.00 ± 0.00^c
3	3.93 ± 0.03^a	8.05 ± 0.20^b	0.00 ± 0.00^c
4	5.04 ± 0.08^a	16.30 ± 0.21^b	0.00 ± 0.00^c

DISCUSSION

The highest total volume of biogas produced (16.30 cm^3) was in the digester B which was left at ambient temperature and in which gas was collected over lime water (Table 1). The differences in total biogas production for the different treatments were significant ($P < 0.04$). The gas volume yields from this study are lower than the 2500 $cm^3$of biogas generated from the anaerobic digestion of the contents of sheep colon reported by [7] and [9] reported a biogas volume of 8772 cm^3 from cow dung. The observed higher gas yields recorded in these two studies were probably because of the use of larger digesters, higher volumes of slurry and larger gas collection apparatus in their experiments. Exposure of the C digester to the sun led to the drying up of their contents and to non-production of gas. The moisture content of the substrates in these digesters was probably too low for any significant microbial activity that could have brought about biogas production. It is not clear why the gas yield of the digester A (5.04 cm^3) was much lower than that of the digester B (16.30 cm^3) and considering that the digestion in both cases were carried out under the same temperature conditions. Since the bacterial isolates were mostly mesophilic organisms, it is possible that the temperatures as high as 40^0C could have limited their activities. The highest percentage weekly biogas productions of 63.75% and 42.08% were observed in digesters B and A respectively. These periods of higher gas production were periods of higher microbial activity following the period of acclimatization for the microorganisms. A retention time of four weeks brought about better biogas yields in the present study.

CONCLUSION

The findings of the study show that poultry manure could be used as a suitable substrate for biogas production. Biogas production, if carried out at commercial scale, would not only provide an alternative source of energy but would also be a means of waste disposal for Nigeria.

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