Anaerobic Plan for Waste Treatment.

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ABSTRACT

The need for proper hygiene and good waste management is on the increase in recent years. Poor or inadequate waste management systems in homes and public places have been attributed to various outbreaks of diseases. The aim of this work is to manage waste generated from Ibagwa municipality and generate biogas. The anaerobic plant used in this study is a concrete type with capacity of 1000 liters constructed at Igbo Eze, South Local Government Secretariat.

The waste, Inoculum and water were charged into the anaerobic plant at a volume ratio of 1:2:1. The experiment was monitored for 20 days; volume of biogas produced and atmospheric temperature were recorded. The maximum biogas volume produced was 100 liters and maximum atmospheric temperature recorded was 34°C.

(Keywords: waste management, disease, anaerobic digestion, temperature, biogas)

INTRODUCTION

Biogas technology was originally used as a means of reducing the amount of organic matter which must be treated, while little emphasis was made on the gas so produced. Recently, the anaerobic process has moved from mere waste stabilization to the level of gas production. The quantity of waste generated every day in the world is increasing due to geometric population increase [1]. Many scholars have worked so hard in devising a means of the waste disposal to reduce both air pollution and land pollution [1]. The various ways of waste disposal are burning in the air, incinerator burning and disposal in water. Some of these methods are not safe due to air pollution and destruction of aquatic life.

One of the better ways of home waste disposal is degradation by anaerobic bacteria otherwise called anaerobic digestion. In recent years anaerobic technology has been well established and satisfied performance in organic waste stabilization [2]. Due to the coupling of pollution reduction and energy production, various types of anaerobic digester have been installed [2] Anaerobic digestion (AD) has become an increasingly important industrial process [3].

AD is a green technology involving the generation of methane-rich biogas via the biological degradation of regionally available biomass like agricultural and municipal solid wastes and Wastewaters [3]. AD processes have for many years been used to treat and sanitize sewage sludge waste from aerobic wastewater and animal manure, reduce its odor and volume, and produce useful biogas [3]. Biogas in turn is a first generation, renewable biofuel that offers the prospect of replacing fossil fuels in the transportation sector and limiting the net greenhouse gas emissions implicated in climate change [4].

Between 1950-1980, high production-rate systems were developed and used to process effluents from agricultural and industrial sectors [3]. Processing of effluents that contained toxic and recalcitrant compounds from the pulp/paper, petrochemical, and other chemical industries was later possible as both technology and knowledge pertaining to toxicity and biodegradability were enhanced [5]. AD technology has been widely adopted by Germany and Denmark, which have implemented rigorous waste disposal legislation.

Since 2000, annual electricity generation from digester projects in the USA has increased almost 25-fold from 14 million kilowatt-hours (kWh) to an estimated 331 million kWh per year [6]. By the end of the 19th century the development and utilization of anaerobic digestion received great impacts when it was discovered that it can be used for wastewater treatment [7]. It is reported that the first digestion plant was built at a leper colony in Bombay, India in 1897[7].

The produced gas was used for lightning and beginning from 1907 it powered an engine for electricity generation (Eladawy, 2005) [7]. It was also in 1907 when the German engineer and inventor Karl Imhoff - a pioneer and a driving force for major advancements in wastewater engineering in the early 20th century - developed the so called Imhoff tank which was the first anaerobic digester in wastewater treatment (Eder and Schulz, 2006) [7]. Biogas production is divided into four stages. These stages are shown the Figure 1 [8].

MATERIALS AND METHODS

Collection of Waste Materials

The waste used was a mixture of domestic yam peelings, cassava peelings, decay food, leaves of plants and grasses around the surroundings. The waste was accumulated domestic waste left for a very long time in an enclosure. These wastes were collected from different homes and even in public places where restaurant, eateries are found. These homes are located at Igbo Eze South Local Government Area of Enugu, Nigeria.

Experimental Method

The wastes were measured and appropriate weight of the waste from these places was recorded. The inoculums used was also measured and recorded. 1000 liters anaerobic plants digester was set up. The waste to water to inoculums ratio used was 1:2:1. The digester was charged with the waste and was monitored daily, biogas yield, atmospheric temperature were recorded.

Figure 1: States of Biogas Production.

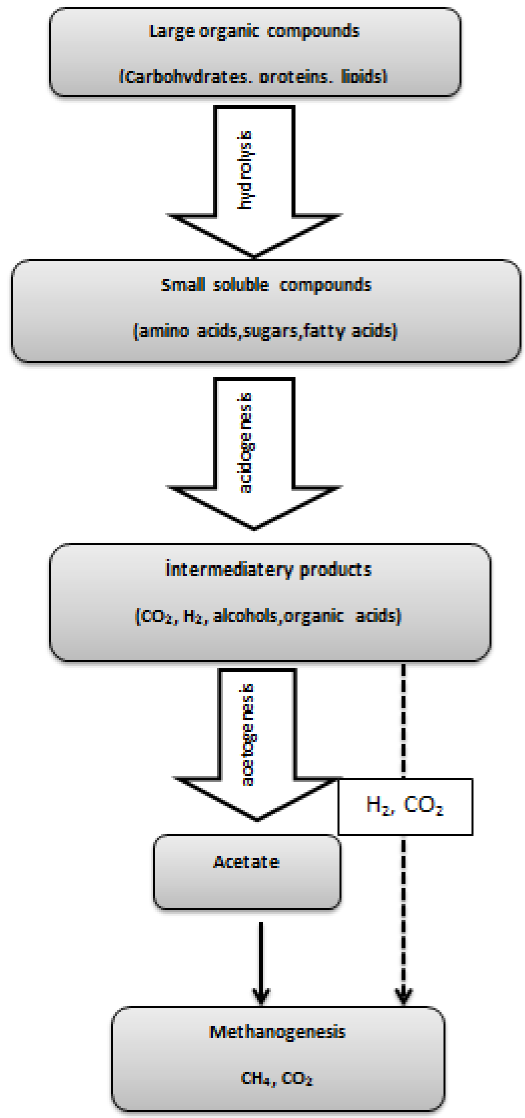

Table 1: Feedstock Characterization.

Total solid (%)	8.9
Volatile solid (%)	74
Moisture content (%)	12
pH	6.8
COD (mg/L)	90,000
PH of Innoculum	7.4

Determination of the Total Solid and Volatile Solid

The total solid and volatile solid concentrations were determined by taking a 100g sample every two days to the laboratory. The weight of a crucible was measured empty, the weight was also measured with the sample. The both value of the crucible were recorded. The sample inside the oven was heated at 105°C for 24 hours to evaporate all the water content so as to calculate the total solid concentration. The oven with the sample was measured after heating at 105°C for 24 hours to ascertain the loss in weight. The heated sample then was poured into a furnace at 550°C for 3 hours to obtain the volatile solid. The weight after heating was also measured and recorded. The total and volatile solid were calculated mathematically with the formula below.

A = weight of dried sample after 24 hours at 105 ^{o}C,
B = weight of container,
C = weight of wet sample,
D = weight of burnt sample after 3 hours at 550 ^{o}C;

$$TS = \frac{A - B}{C - B,}$$

$$VS = \frac{(B + A) - (B + D)}{(B + A)} - B$$

Determination of Moisture Content

The A.O.A.C method (1990) was used. Porcelain crucibles were washed and dried in an oven at 100^{o}C for 30 minutes and allowed to cool in a desiccator. One gram of the raw waste was placed into weighed crucibles and then put inside the oven set at 105^{o}C for 4 hours. The samples were removed from the oven after this period and then cooled and weighed. The drying was continued and all the samples with the crucibles weighed until a constant weight was obtained.

$$\% \text{ moisture} = \frac{A - B}{A} \times \frac{100}{1}$$

A = Original weight of sample
B = Weight of dried sample.

Energy Content Determination

AOAC (1975) method was used. This was done with bomb calorimeter (model XRY-1A, make: Shanghai Changji, China). It involves igniting the waste sample in oxygen bomb calorimeter (under a high pressure of oxygen gas). The heat energy that was released was absorbed by the surrounding water inside the bomb calorimeter. This gave rise to a temperature increase of the surrounding water and this was used to estimate the energy value of the sample. 1g of the sample was pelleted and turned in the oxygen bomb calorimeter. The heat of combustion was calculated as the gross energy.

$$\text{Energy content} = \frac{E\Delta T - 2.3L - V}{g} \text{ (KJ/Kg)}$$

Where,

E = energy equivalent of the calorimeter
ΔT = temperature rise
L = length of burnt wire
V = titration volume
g = weight of sample

RESULTS AND DISCUSION

The result showed that biogas could be generated from waste in homes. The biogas yield from Figure 2 indicated that biogas yield increased as the anaerobic digestion progressed. That was as a result of lignocelluloses breakdown by anaerobic bacteria. As the anaerobic digestion progresses and get to a certain stage the biogas yield decreased due to decrease in the activity of anaerobic bacteria. Ugwuoke, et al., reported that more disintegration of lignocelluloses gives higher biogas yield [8].

The maximum biogas yield from the experiment was 100 liters and the maximum atmospheric temperature recorded was 34°C. Experiments conducted by Funda Cansu (2011) with red, green and a mixture of red and brown algae at 25 day retention times gave high biogas yield. An increase in the mixture ratio caused an increase in the biogas production in all three experiments. Pretreatment of sludge by Eskicioglu and Kennedy at Robert O. Pickard Environmental Centre ROPEC – TWAS at temperatures above and below boiling point (at 50, 75, 96, 120, 150 and 175^{o}C, temperature ramp of 1.2-1.4^{o}C/min) by MARS-5 disintegrated the complex floc structure which helped in more biogas production.

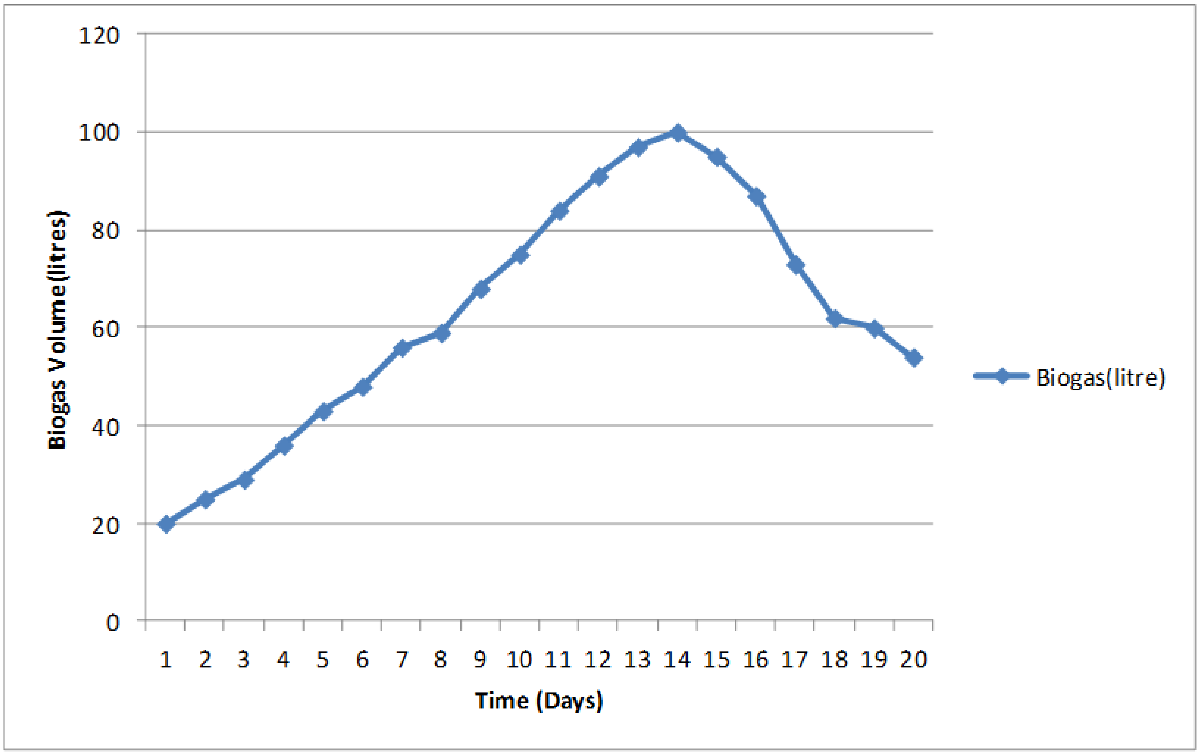

Figure 2: A Graph of Biogas Yield (liters) versus Time (days).

Table 2: Biogas Production.

S/N	Time (days)	Biogas yield (liters)
1	1	20
2	2	25
3	3	29
4	4	36
5	5	43
6	6	48
7	7	56
8	8	59
9	9	68
10	10	75
11	11	84
12	12	91
13	13	97
14	14	100
15	15	95
16	16	87
17	17	73
18	18	62
19	19	60
20	20	54

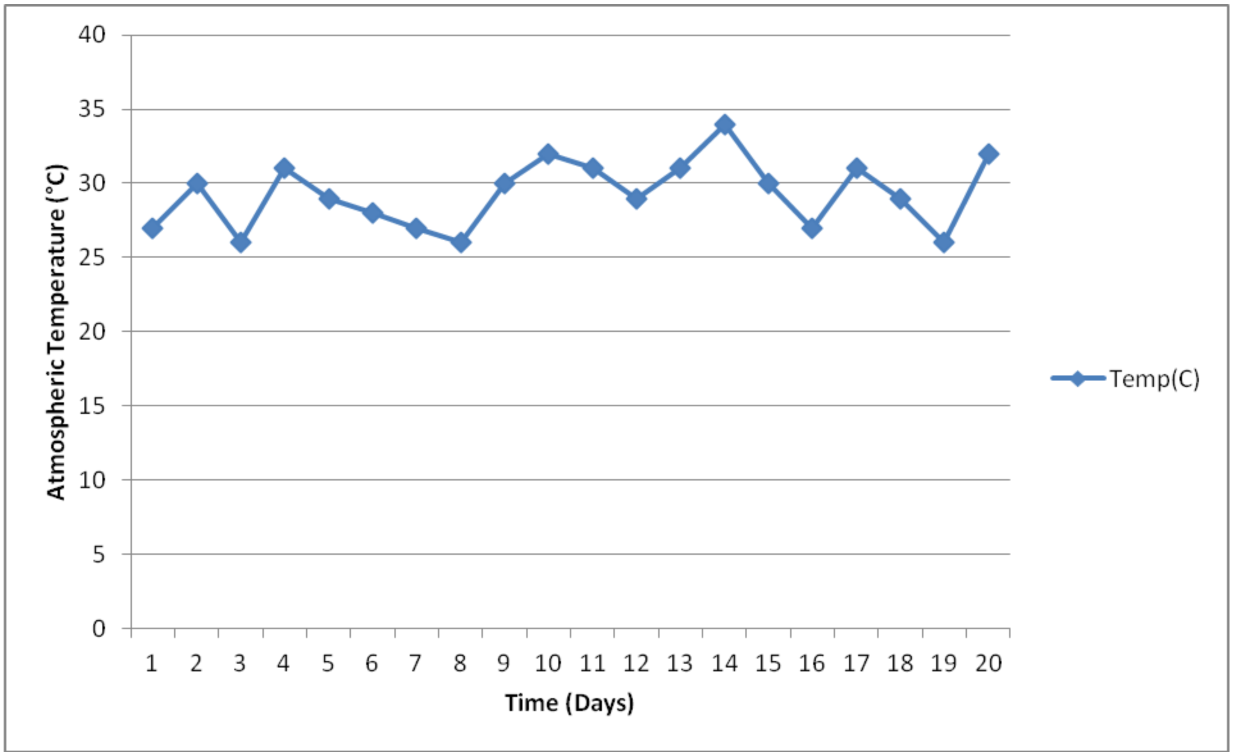

Figure 3: A Graph of Atmospheric Temperature versus Time (days).

Table 3: Atmospheric Temperature.

S/N	Time (Days)	Atmospheric Temperature (°C)
1	1	27
2	2	30
3	3	26
4	4	31
5	5	29
6	6	28
7	7	27
8	8	26
9	9	30
10	10	32
11	11	31
12	12	29
13	13	31
14	14	34
15	15	30
16	16	27
17	17	31
18	18	29
19	19	26
20	20	32

CONCLUSION

The waste from home and public places could be used to generate biogas which is very essential energy for cooking, power generation and powering of vehicle. Anaerobic degradation is very important in waste treatment and environmental control which in turn generates biogas.

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