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PRODUCTION AND UTILITY OF COW DUNG AS AN ALTERNATIVE ENERGY FOR DOMESTIC COOKING

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ABSTRACT

Energy is a key factor for the growth and development of a country. Almost all the energy used by the households resulted in forest depletion thus creating serious loss of biodiversity, land degradation and loss of soil fertility. This study was conducted with the objective of determining the possibility of biogas production from cow dung as an alternative source of energy for domestic cooking. A total of fifty-one questionnaire was administered on the household heads of Iyana Emirin community in Ado Ekiti. The questionnaire survey of the cow dung site was done to obtain information on the number of cattle, energy consumption that is times of cooking per day, availability of cooking material, effect of cooking material on their monthly income, knowledge about biogas production. Laboratory and field experiment were done on biogas from cow dung to determine the possibilities of its production and utilization as an alternative energy for domestic cooking for the people at Iyana Emirin in Ado-Ekiti. A Focus Group Discussion (FGD) was conducted to bring the people into awareness of the utilization of cow dung as a potent biogas element. The result showed that 86.3% of the people considered biogas as an alternative energy source for domestic cooking, 90.2% supports production of biogas and 49.0% desire to invest in biogas production, also, 41.2% of the people use firewood as an alternative means of cooking. This shows biogas has significant contribution by providing multiple benefits particularly to the people in the study area. It serves as an alternative source of energy, so also using biogas reduces the rate of deforestation by saving firewood, trees and forest, more also, it is waste management, reduction and conversion of waste to wealth or poverty alleviation and a employment opportunity if biogas is commercialized. The study therefore recommended biogas production from cow dung as a domestic cooking resource. It also solicited for the awareness of the public through private agencies so that the mass production of the product could be realized. The study also advocated that government at the local level should invest in the product.

Key Words: Biogas, Energy, Biodiversity, Cow dung, Anaerobic, Digestion, Degradation and Utilization

INTRODUCTION

Production of biogas through anaerobic digestion of organic materials provides a versatile carrier of renewable energy. Biogas can be used in replacement of fossil fuels in generation of heat and power, thus contributing to cutting down emissions of greenhouse gasses and slowing down climate change. Biogas is a flammable gas produced by microbes when organic materials are formulated in certain range of temperature, moisture content, acidified and under air tight condition (Potivichayanon et al., 2011). The gas has wide range of applications including its use for lighting, driving automobiles, powering farm machinery, heating and cooking (Eze, 2010). Anaerobic bio-digestion is a process through which organic materials are decomposed by bacteria in the absence of air to produce biogas (Adelekan and Bamigboye, 2009). The most important reason for the choice of anaerobic digestion as a treatment method are the feasibility to treat waste with a high organic load (Saev *et al.*, 2009; Kara *et al,. 2009 and Karellas* eta al., 2010). The aerobic treatment of such waste require biological purification system with high construction and operational costs (energy consumption), besides which stabilization of the biological reactions is not assured (activated-sludge tanks), or the waste(s) causes clogging of installations such as aerobic biological filters and biodiscs. The organic substance such as food wastes, oil, or fat, animal manure, chicken swine or cow manure can be digested and used to produce useful energy for the world (Potivichayanon *et al.*, 2011*;* Widodo and Hendriadi, 2005)

The country's economy mainly depends on the energy resources available and utilized energy has been exploited since the prehistoric times. With the advent of industrial revolution, use of fossil fuels began growing and increasing till date. The dependence on revolution, use of fossils fuel as primary energy source has led to global climate change, environmental degradation and human health problems. With increasing prices of oil and gas the world looks towards alternative and green energy resources. In 21 sub-Saharan SAfrican countries, less than 10% of the population have access to electricity (Mshandete and Parawira, 2008). The need for alternative renewable energy sources from locally available resources cannot be over-emphasized. This need has forced the search for other alternative sources of energy. But unfortunately the new alternative energy sources like solar, hydro and wind require huge financial outlay and technical power to operate, which seem to be very difficult for the developing countries like Nigeria. In the present moment, biogas energy can be the reliable, easily available sources and economically source of alternative and renewable energy. This is due to its locally available sources and its simple technology for rural villages.

Sources of renewable energy are wind, hydro, ocean waves, geothermal energy resources and solar energy, which can be applied as solar thermal and solar electricity (photovoltaic). Heat-based technologies developed for the utilization of heat energy from the sun (solar thermals). They are applied in water heaters, drying, chick-brooding, cooking, manure dryers, biogas and thermal refrigerators. With the advent of industrialization and energy based intensive agriculture, chemical pathways for raw materials conversion became predominant with extensive use of petrochemical based feedstock. The damaging long term environmental impacts and resources indicate unsustainability of the current method. (Ravi Prakash Mahor *et al,* 2011). Biogas is another source of renewable energy; it is produced when biomass is subjected to biological gasification and a methane-rich gas is produced from the anaerobic digestion of organic materials. Achieving solutions to possible shortage in fossil fuels and environmental problems that the world is facing today requires long-term potential actions for sustainable development. In this regard, renewable energy resources appear to be one of the most efficient and effective solution (Ofoefule et. al,2010). Biomass is the biological organic materials that are renewable and can be recycled to produce biogas. A huge amount of waste is generated daily from the various processing industries in Nigeria. The wastes that are usually disposed off either into the sea, river, on the land as a solid amendment materials, which causes support for breeding of flies and constitute health hazards to people living around the area are converted into biogas by anaerobic fermentation (Ezeonu, 2002). What is considered as waste many years ago have in recent time become useful that it can be inferred that in life, nothing is a 'waste'. They are only waste when they lack the useful technology for their transformation and application.

Significance of the Study

In evaluating national development and the standard of living of any nation, the supply and consumption of energy are very important. Human energy consumption was moderate before the industrial revolution in the 1890s. Man has mostly relied on the energy from brute animal's strength to do work. Recently, man acquired control over coal, electricity, crude oil, natural gas, etc. Sustainable resource management of waste and the development of alternative energy source are the present challenges due to economic growth. The history of waste utilization shows independent developments in various developing and industrialized countries. Anaerobic digesters can convert energy stored in organic matter present in manure into biogas. Energy supplied from fossil fuels is not easily recycled and takes a long time to form, hence is exhaustible and not renewable.

LITERATURE REVIEW

History of Biogas Production

Although biogas was first discovered by Alessandro Volta in 1776 and the presence of combustible gas methane in the farmyard manure was pronounced by the Humphery Davy in the early 1800s, yet it was only the oil crisis of 1973 which led to the active promotion of biogas technology. While international interest in these uses have been most noticeable in the technical and developing communities in the last 15-20 years, serious development efforts in this field began about 50 years ago in Asia (Bond and Templeton, 2011).

Nigeria is an energy resources country in terms of both fossil fuels such as crude oil, natural gas, coal, and renewable energy resources like solar, wind and biomass. The urban poor and rural households however, still depend on biomass for their energy needs. In Nigeria, identified feedstock substrate for an economically feasible biogas production includes water lettuce, water hyacinth, dung, cassava leaves, and processing waste, urban refuse, solid (including industrial), waste agricultural residues and sewage (Ubalua, 2008). It has been estimated that Nigeria produces about 277,500 tons of fresh animal waste daily. Since 1 kg of fresh animal waste produces about 0.03 m^3 of biogas, then Nigeria can potentially produce about 6.8 million m^3 of biogas everyday from animal waste only (Mshandete and Parawira, 2008). In addition, 20 kg of municipal solid waste (MSW) per capital has been estimated to be generated in the country annually. By the 1991 census figure of 88.5 inhabitants, the total generated MSW will be at least 1.77 million tones every year. With increasing urbanization and industrialization, the annual MSW generated will continue to increase. Biogas production may therefore be a profitable means of reducing or even eliminating the means and nuisance of urban waste in many cities in Nigeria (Akinbami *et al.*, 2001).

Although biogas technology is not common in Nigeria, various research works on the science, technology and policy aspects of biogas production has been carried but by various scientists in the country. Some significant research has been done on reactor design by some Nigerian scientists that would lead to process optimization in the development of anaerobic digesters. Biogas technology in which biogas is derived through anaerobic digestion of biomass, such as agricultural wastes, municipal and industry waste (water), is one of such appropriate technology Africa should adopt to ease its energy and environment problem. Adelekan and Bamigboye (2009) reported that several researchers have reported biogas production from various materials including pigeon droppings (Aliyu et al.,); water hyacinth, Eichhornia species (Bamigboye and Abayomi, 2000); manure from the major farm animals (Adelekan, 2002); camel and donkey dung (Dangoggo et al., 2004); onion bulbs (Abubakar et al., 2004) and other bulk organic waste (Kovacs et al., 1995). The gas is principally composed of methane (CH_4), carbondioxide and some other gasses in small proportion. (Suyog, 2011). We have had it good for many years, using and misusing fuels supplies at will for countless decades. In the United States, the average consumption of oil equates to three gallons per day. That is for every man, woman and child of the population! This makes an annual consumption of over 2 billion gallons. This is probably the most wasteful of the developed nations, but still not extremely far ahead of the others. The Gobar Gas Research Station (Gobar is Hindi for cow dung) was founded in 1960 as the newest of a long series of Indian research efforts started some time in the1930s as one might guess from the name, the Gobar Gas Research Station has concentrated on studying the production of biogas from cow manure. Ram Bux singh and his colleagues have biogas plants in operation ranging in size from about 8 cubic metres per day to 500 cubic metres per day.

They have plants using heating coils, filters as and mechanical agitators to test the change in efficiency, and have also tried various mixes of manure and vegetable waste. There is an immense amount of documentation of all their projects since every detail has been recorded for analysis and future reference. Biogas can be practically produced using as landfill gas (LFG) or digested gas. A bio gas plant is the name often given to an anaerobic digester that treats farm wastes or energy crops. Bio gas can be produced using anaerobic digesters. These plants can be fed with energy crops such as maize silage or biodegradable wastes including sewage sludge and food waste. During the process, as an air-tight tank transforms biomass waste into methane producing renewable energy that can be used for heating, electricity, and many other operations that use any variation of an internal combustion engine, such as GE jenbacher gas engines. There are two key processes: Mesophilic and Thermophilic digestion.[www. Clarke-energy. com] In experimental work at university of Alaska Fairbanks, a 1000-litres digester using psychrophiles harvested from "mud from a frozen lake in Alaska" has produced 200-300 liters of methane per day, about 20-30% of the output from digesters in warmer climates. Landfill gas is produced by wet organic waste decomposing under anaerobic conditions in a landfill. The waste is covered and mechanically compressed by the weight of the material that is deposited from above. This material prevents oxygen exposure thus allowing anaerobic microbes to thrive. This gas builds up and is slowly released into the atmosphere if the landfill site has not been engineered to capture the gas. Landfill gas is hazardous for three key reasons. Landfill gas becomes explosive when it escapes from the landfill and mixes with oxygen. The lower explosive limit is 5% methane and the upper explosive is 15% methane[Gupta et al, 2010]. The methane contained within biogas is 20 times more potent as a greenhouse gas than is carbon dioxide. Therefore, uncontained landfill gas, which escapes into the atmosphere, may significantly contribute to the effects of global warming.

Biogas Composition

The composition of biogas varies depending upon the origin of the anaerobic digestion process. Landfill gas typically has methane concentration around 50%. Advanced waste treatment technologies can produce biogas with 55-75% methane, which for reactors with free liquids can be increased to 80-90% methane using in-situ gas purification techniques [www.adelaide.edu.au/biogas] As-produced, biogas also contains water vapor. The fractional volume for water vapor is a function of biogas temperature; correction of measured gas volume for both water content and thermal expansion is easily done via a simple mathematic algorithm [www.kolumbus.fi] which yields the standardized volume of dry biogas.

In some cases, biogas contains siloxanes. These siloxanes are formed from the anaerobic decomposition of materials commonly found in soaps and detergents. During combustion of biogas containing siloxanes, silicon is released and can combine with free oxygen or various other elements in the combustion gas. Deposits are formed containing mostly silica (SiO_2) or silicates (Si_xO_y) and can also contains calcium, sulfur, zinc, phosphorus. Such white mineral deposits accumulate to a surface thickness of several millimeters and must be removed by chemical or mechanical means. Practical and cost-effective technologies to removed siloxanes and other biogas contaminants are currently available.

Processes involved in Purification of Biogas using Cow Dung

Cow dung gas is 55-65% methane, 30-35% carbon dioxide, with some hydrogen, nitrogen and other traces. Its heating value is around 600 B.T.U. per cubic foot. Natural gas consists or around 80% methane, yielding a B.T.U. value of about 1000. Biogas may be improved by filtering it through limewater to remove carbon dioxide, iron fillings to absorb corrosive hydrogen sulphide and calcium chloride to extract water vapour after the other two processes. Cow dung slurry is composed of 1.8-2.4% nitrogen (N_2), 1.0-1.2% phosphorous (P_0O_5), 0.6-0.8% potassium (K_2O) and 50-75% organic humus. About one cubic foot of gas may be generated from one pound of cow manure at around 28^0C. This is enough gas to cook a day's meals for people in India. About 1.7 cubic metres of biogas equals one litre of gasoline.

Characteristics of Biogas

Composition of biogas depends upon feed material. Biogas which has about 20% lighter than air has an ignition temperature range of 650^0 to 750^0c(Suyog. 2011). It burns with smokeless clear blue flame and is not toxic (Anushiya, 2010). It is caloric value is 20MJ/m^3 and usually burn with 60% efficiency in a convectionalbiogas stove (Suyog, 2011).

Properties of Biogas and Its Benefits

Change in volume as a function of temperature and pressure, change in calorific value as function temperature and water vapour content and change in water vapour as a function temperature and pressure. Biogas, a sustainable renewable energy, has positive environmental impacts at local national and global levels. Below are some environmental benefits associated with the use

Replacing biomass energy with biogas could help to solve lot problems that are typically found with biomass fuels. The indoor air quality of homes will be dramatically improved as a result of employing biogas stoves instead of burning firewood, straw and dung cakes. This would mean that a lot of the problems associated with hazardous smoke particles would be avoided (Li *et al., 2005*). In addition, installation of biogas system has resulted in better management and disposal of animal dung and night soil. The slurry that has been digested is a high grade fertilizer. From a national perspective, biogas system have helped the pressure on forest (Anushiya, 2010). This in turn has important implications for watershed management and soil erosion. In addition, use of bio-slurry will reduce the depletion of soil nutrients by providing organically rich nutrients which will increase crop yield and hence reduce the pressure to expand cropland the principal cause of deforestation. Biogas fuel help to reduce greenhouse gas emissions by displacing the consumption of fuel wood, agricultural residue and kerosene (Budiyono *et al.,* 2010). The biogas used in a sustainable basis, the $\mathbf{CO_2}$ associated with biogas combustion will be reabsorbed in the process of the growth of fodder and food for animals. All the $\mathbf{CH_4}$ and $\mathbf{CO_2}$ emission that are associated with the combustion of firewood can be considered as being replaced by a biogas system.

MATERIALS AND METHOD

Materials collection and preparation

Cow dung was collected freshly from the kraal (i.e. Fulani Settlement) in Iyana Emurin, Ado Ekiti.

Plate1 shows the researcher introducing the issue to discussants during focus group discussion at the study area. The next plate shows FGD sessions in progress.

The digester will be connected through its gas outlet to a Bunsen burner.

Plate3 shows the researcher mixing the cow dung for the discussant to see during FGD, while plate4 show the researcher weighing the cow dung during practical demonstration, also, plate5 show the testing of biogas.

Plate1: Introduction Process

Source: Fieldwork,2017

Plate2: FGD Session

Source: Fieldwork,2017

Design Methodology

The biogas digesters were designed and constructed using a drum with a slurry capacity of 88 liters at Obasanjo Renovation Centre, Federal Polytechnic, Ado-Ekiti. The drum has a cylindrical shape with a diameter of 0.4m and height of 0.7m, having a thickness of 0.002m. The drum is made up of mild steel. The pressure gauge (calibrated in millimeters of mercury) and thermometer (in degree Celsius) were installed at the top of the digester to measure the pressure and temperature of the gas produced inside the digester respectively. A 1cm diameter rubber hose served as the biogas conveying system from the digester to the burner.Epoxy steel material was used for the digester to prevent leakages. There is a control valve on the digester to regulate the flow of the biogas to the burner. The control valve is located at the top of the daughter. At the bottom of the digester, a circular slurry outlet which is closed with a thread plug for discharging off the slurry is incorporated while the inlet for feeding the substrate is located at the top of the digester. This slurry outlet also serves as the sampling part of the digesting waste for intermittent analysis.

Plate3: Weighing process

Source:Fieldwork, 2017

Plate4: Mixing Process

Source:Fieldwork, 2017

EXPERIMENTAL

Production of Biogas from Cow Dung

The following will be taken to achieve the production of biogas cow dung.

1. 18kg of the substrate (cow dung) will be weighed and then mixed thoroughly with about 36kg of water for optimum gas production.
2. This mixture will then pour to the digester to make for ¾ volume of the digester.
3. The digester will be subjected to periodic shaking to ensure intimate contact between the microorganism and substrate, in order to enhance complete digestion of the substrate.
4. The pressure and temperature of the biogas yielded will be measured on a daily basis, using pressure gauge and thermometer respectively.
5. The volume of the biogas yielded will also be determined on a daily basis, using the values of the pressure and temperature reading respectively.
6. The experiment will be monitored for about 7 weeks.
7. During this period, daily ambient temperature will be measured
8. During this period also, combustion time for the reaction will be observed.

Plate5: **Testing Of Biogas**

Source: Fieldwork, 2017

Precautions Taken During The Experiment

(i) A proper sealing of the digesters were ensured, in order to avoid leakage of slurry and gas.

(ii) The digesters were positioned properly and rigid, in order to withstand the load.

(iii) The amount of water added to the substrate was appropriate, so that the slurry will not be too diluted.

(iv) The digester outlet value was closed before loading. Indigestible materials that can impede the generation of biogas were removed while loading the digester.

(v) After loading, the inlet value was tightly sealed to avoid air into the digester.

(vi) Before testing for combustion of the gas, any inflammable materials or objects was removed from the surrounding.

(vii) The pressure gauge and thermometer were tightly fixed on the digester to avoid any leakage.

(viii) To prevent any health hazard due to the offensive odour of the substrates, nose muff was used taken to protect our nose while loading the digester.

(ix) Restriction notice was pasted at the location of the digesters, to prevent any damages.

RESULTS AND DISCUSSION

The result of pressure, temperature and estimated volume observed per day in the production of biogas from cattle dung were shown in Table 4. At day 2 the pressure observed was 13,996.5Nm^{-2}, there was steady increase in pressure from 13,996.5 to 27,833.04Nm^{-2} from day 3 to 40. The range of temperature of gas produced by cattle dung and ambient temperature is closely related as shown in fig 4. The temperature of the gas and the ambient temperature were decrease from 303 to 297K from day 1 to 9. The temperature increase from 297 to 303k from day 9 to 17 and the lowest temperature was observed on day 9 and day 26 to be 297k while the temperature was fluctuating within 298 and 300K from day 30 to day 40.

The estimated yield of biogas from dung was fluctuating as shown in Figure 5. The yield was low in the first 8 days of the loading. Figure 6 shows the relationship between pressure difference and change in volume per day in cattle dung. The total volume and maximum pressure observed in cattle dung digester was 17.16m^3 and 27,833N/m^2 respectively as it is shown in Figure 7.

Determination of Volume of Gas Produced

Using Ideal Gas Equation

$P_T V_{T=n} RT$

Where,

$P_{T=}$ total pressure of biogas inside the digester (Pa)

$V_{T=}$ total volume of the digester (m^3)

T= maximum temperature of the digester (Kelvin)

R= universal gas constant = 8.314KJ/kgK

n= number of moles

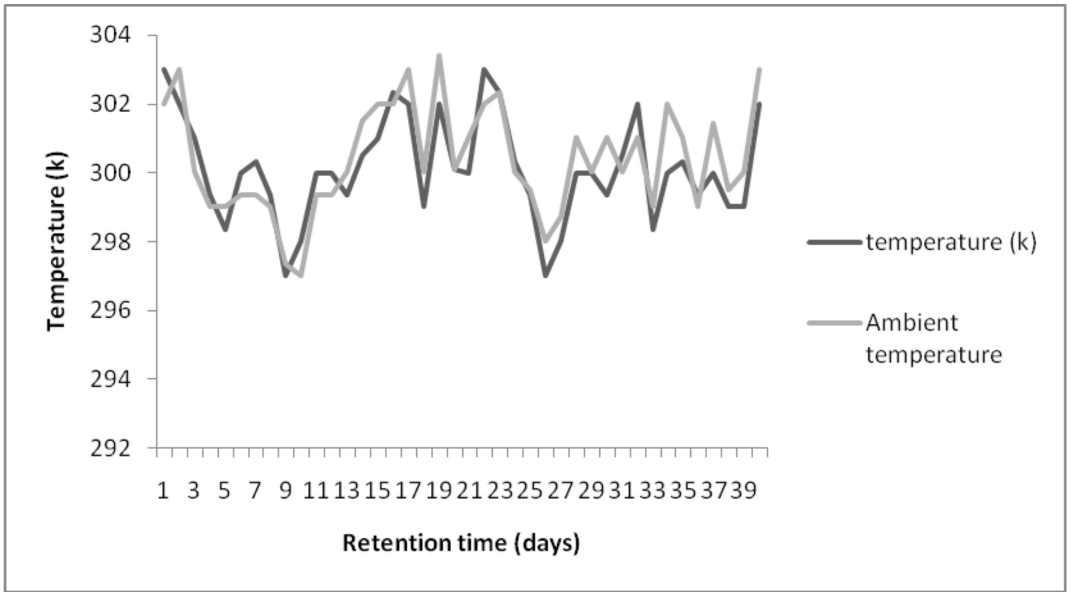
Table 3.1: **The Pressure, temperature and volume of biogas produced per day**

Days	temperature (k)	Ambient temperature (K)	Pressure (mmHg)	Pressure (N/m2)	pressure Difference (N/m2)	Estimated volume per day (m3)	Cumulative estimated Volume (m3)
1	304	303	0	0	0	0	0
2	303	301	105	13,997	13,997	0.008	0.008
3	301	300	120.5	16,063	2,066	0.056	0.064
4	299.33	299	139.33	18,577	2,510	0.046	0.111
5	298.33	299	147.47	19,658	1,085	0.106	0.217
6	300	299.33	160	21,328	1,670	0.069	0.287
7	300.33	299.33	170.33	22,705	1,376	0.084	0.371
8	299.33	299	175.33	23,372	667	0.174	0.545
9	297	297.33	176.03	23,465	93	1.233	1.778
10	298	297	177.3	23,634	169	0.681	2.460
11	300	299.33	179.67	23,950	316	0.367	2.828
12	300	299.33	179	23,861	89	1.305	4.126
13	299.33	300	181	24,127	266	0.334	4.468
14	300.5	301.5	183.3	24,434	307	0.792	4.847
15	301	302	185.4	24,714	280	0.416	5.263
16	302.33	302	186.2	24,820	106	1.104	6.368
17	302	303	188.6	25,140	320	0.395	6.734
18	299	300	190	25,327	187	0.619	7.353
19	302	303.4	194	25,860	533	0.219	7.573
20	300.1	300.1	196	26,126	277	0.419	7.992

21	300	301	197.6	26,340	213	0.545	8.538
22	303	302	199.8	26,633	293	0.398	8.936
23	302.33	302.33	201	26,793	160	0.730	9.666
24	300.33	300	202.4	26,980	187	0.623	10.289
25	299.33	299.5	204.5	27,260	280	0.414	10.703
26	297	298	199.8	26,633	627	0.183	10.887
27	298	298.7	200.9	26,780	147	0.785	11.672
28	300	301	202.8	27,033	253	0.459	12.132
29	300	300	203.9	27,180	147	0.790	12.922
30	299.33	301	204.7	27,287	107	1.083	14.006
31	300.5	300	205.8	27,433	149	0.781	14.787
32	302	301	205.8	27,433	0	0.000	14.787
33	298.33	299	208.9	27,846	413	0.279	15.067
34	300	302	190.7	25,420	2,426	0.047	15.115
35	300.33	301	195.6	26,074	653	0.178	15.293
36	299.33	299	197	26,260	187	0.620	15.913
37	300	301.44	199	26,527	267	0.435	16.349
38	299	299.5	202.8	27,033	506	0.228	16.577
39	299	300	205.9	27,446	413	0.280	16.858
40	302	303	208.8	27,833	387	0.302	17.160

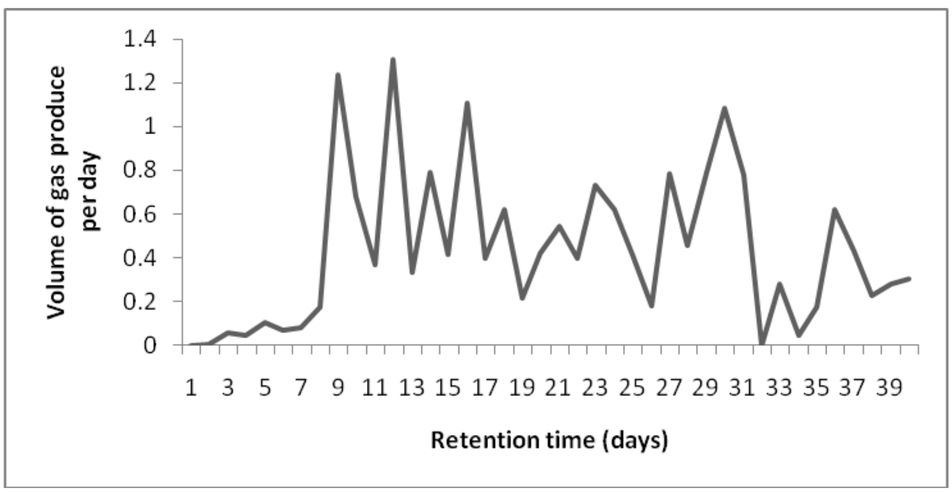
Source: Author’s Fieldwork, 2017.

Fig 3.3: Digester and Ambient Temperature Per Day .



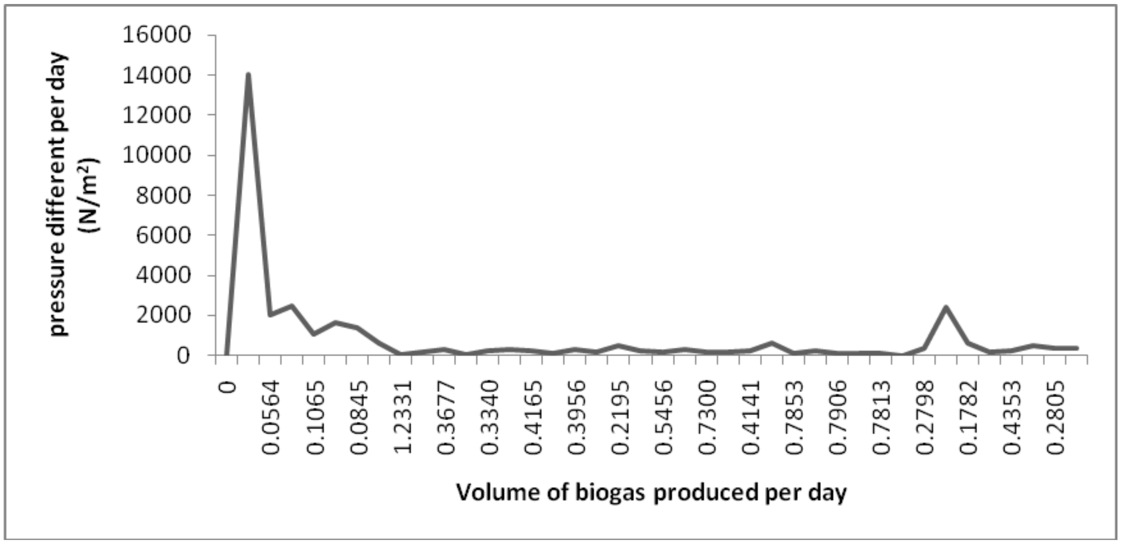
Source: Author's Fieldwork, 2017.

Fig 3.4: Biogas Produced Per Day.



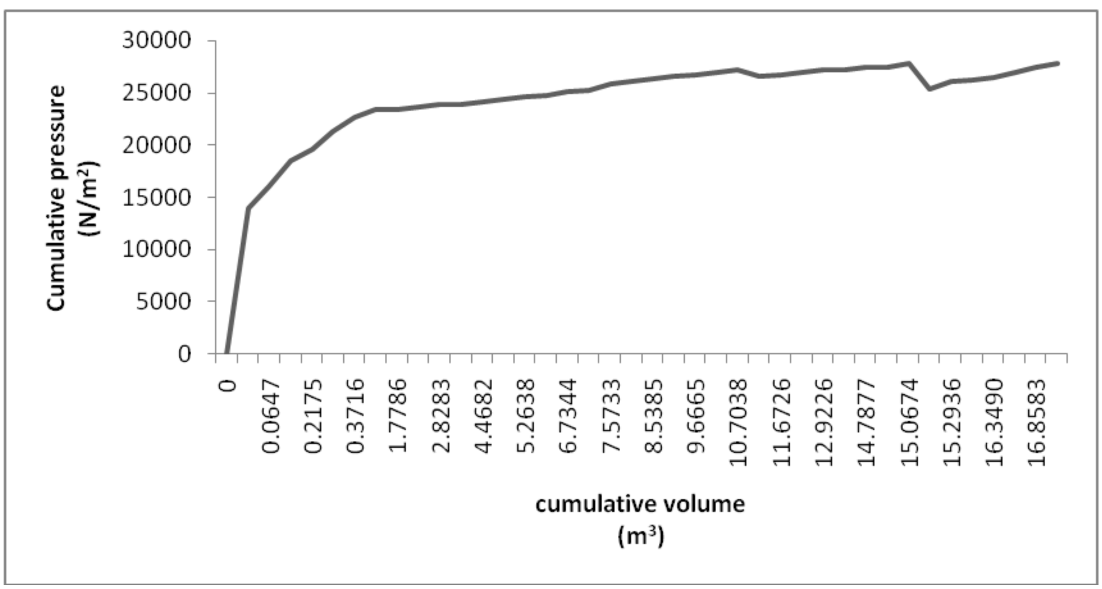
Source: Author's Fieldwork, 2017.

Fig 3.5: Change in Pressure against Change in Volume of Gas Produced Per Day.



Source: Author's Fieldwork, 2017.

Fig 3.6: Cumulative Pressures against Cumulative Volume Of Gas Produced.



Source: Author's Fieldwork, 2017.

SUMMARY AND CONCLUSION

The result of this research on the potentialities of production of biogas from cow dung, shown that flammable biogas can be produced from this waste through anaerobic digestion for biogas can be used as a source of fuel if managed properly. The study revealed further that cow dung as animal waste has great potentials for generation of biogas and its use should be encouraged as an alternative cooking resource. Also in this study, it has been found that cow dung might be one of feedstock for efficient biogas production and waste treatment and depletion of forest wood as fuel wood which is against the principles of forest conservation and sustainable ecology will be reduced.

Local GHG emissions will be reduced (by sustainable treatment of bio-waste by reduced reliance on energy intensive inorganic fertilizers, and by displacement of fossils fuels for cooking). Benefits will be realized to industry to taxpayers and to the nation as a whole when top-level decision maker get the message and put in place incentives that will enable local authorities and other stakeholders to make the significant capital investment that will be required and give a wider publicity on production of biogas from animal waste (cow dung).

This study revealed that biogas is not significantly embraced as an alternative cooking resource among the people in the study area because of their lack of knowledge about it and their level of illiteracy. Majority of the people have no knowledge about biogas but after various interactions discussion, teaching and interview this developed their interest in biogas production and enlighten them and making them to support production of biogas as an alternative means of cooking.

RECOMMENDATIONS

As a result of the study conducted so far, the following recommendations were made:

(i) The waste from biogas production can be used as manure for planting and the digester could serve as a model for building larger digester that is capable of producing large amount of biogas for industrial and domestic use. Public and politicians must invest and made people aware of the potentialities of biogas production from cow dung and its benefits as an alternative cooking resource also, the industry must embrace production of biogas and do more to engage the media to get this message across, knowing the long term sustainability, environmental and economic gains of utilizing biogas as a cooking gas, Government should stimulate investment in it and the industry must do more to publicize the benefit and potentialities of production of biogas from cow dung and biogas as a cooking gas.

(ii) Government should subsidize the equipment needed for the production of biogas from cow dung.

(iii) Private sector should embrace the production of biogas from cow dung as an alternative energy for domestic cooking because it is cheaper than other energy use for cooking and the raw material (cow dung) is readily available in some places.

(iv) Government should set up an agency to control or standardize the quality of gas produced from cow dung in order to erase any hazardous effect of it.

(v) There should be wide publicity by government about production of biogas from cow dung, which will embrace good patronage of people.

(vi) Government should also constitute an agency that will go into production of biogas using both domestic and animal waste, because it can be also produced from other waste.

(vii)

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