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Research Paper

Utilization of Domestic Waste for Production of Biogas: Effort in Providing Energy For Heating/Lightening in Rural Communites in Nigeria

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ABSTRACT: *Demand for energy in rural and suburban sociesties in Nigeria has became an issue, these occurred as the vast rural settlements and poor availability of grid connection. In which has virtually affected many communities's well-being and social benefits. Although, abundance of huge degraded wastes, from domestics,aniamls and agriculture that can be renewable into clean energy source are wastage untilised. Therefore, to bridge gab of such wastes for supporting human living, this has measured the availability of waste taking Polytechnic domestic waste/Animal dung the production of CH4 to provide heating and lightening low loads. In the study, two cylindril drum of 32-litres were used to contain the combined waste from animal dune and domestic waste of equivalent of 125Kg. The workable system was demonstated by availing its importance to the populace of rural area in particularly in North-Eastern region, Nigeria that inevitably that need such technology for sustainable life change. The technology was found cost effective, eco-friendly and above all does not technical difficulties compared with natural gas and fossil fuel.*
KEY WORDS*: Biogas, animal dung, retention period, digester, anaerobic digestion,.*

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I. INTRODUCTION

In Modern days, Eenergy demand for sustainable development keep increasing as the population tend to exponentially increases year-in year-out in rural areas. In such, an effort to maintain social benefit of the dwellers has become an issue despite the daily need on energy for domestic ulitisation. Nigeria has been blessed with with an abundances energy source in various form that include; convensional and renewable energy that enhances energy demand. Thus for decades, societal utilisation on woods and fossil fuel have been resulting in environmental pollutions and rapid deforestation that had contributed alots to climatic changes and global warming. Therefore,to protect societal deforestration and reduces environmental land degradation and pollution, utilisation waste for the production of biogas or bio-fuel has became imperative. Hence, the bio-fuel would be merely achieved by waste undergoes anerobic digestion for methane , carbondioxide,sulphur oxide and othe gases element. If any arganic substances kept in a closure in an absence of air circulation is term as anerobic digestion. This process virtually yield a production of biogas and bio-fertilizer for sustainable energy demand and agricultural enhancement and also add value to sanitation condition despite any abstraction by environmental factors. Therefore regarding vast low income citizens of Nigeria in particularly are dwelling rural areas where both animal and agricultural waste and some percentage of domestic garbage are available in tonnes. It has been asserted that anaerobic digestion can convert energy stored in organic matter of manures into biogas. Anaerobic digestion is a biological process whereby micro-organisms convert complex organic matter to biogas[1]. significant studies have been conducted issues on production of biogas from degraded food and aminal waste and dung. [2], described biogas remains a friendly source of bioenergy that can be produced by undergoing waste through anerobic fermentation or phenoma through digestion chamber. In addition, a versatile subsestance that include, wet and solid waste from animal dung, left-over food, agricultural residues, sewage for required bio-fuel production. On similar content [3] clarifies that importance of such gas is beyong expression despite an utilisation for domestic energy need on cooking/heating and energising power generators and thermal machines as well. Typically, bio-fuel consists methane and carbon-dioxide with inevitable gases in about 50-75% and 25-50% respectively. In addition methane to carbon-dioxide proportion in biogas mixted is around 65% and 35% [4]. These clearly verifies that percentage proportion of CH4 (Methane) and CO_2

(Carbondioxide) found to much abundance to provide enough bio-fuel for consumers' demand in the aspect of cooking, heating and powering power generator depending the waste mixture Kg and the plan size. It is also an efficient way of waste water treatment and renewable energy production. In this research, a design and implementation of biogas utilisation that supplement traditional cooking/heating needs and energising electric generator is proposed. Hence aimed to replace use of fossil fuel, decreases rate of deforestation for cooking and transform from conventional and renewable source for energy to meets the consumer demand. Primarily, energy utilisation within human ecosystem remain considerable despite the fact that almost all entities across the populace particularly in suburban and rural societies. The societies are either directly or indirectly depend on the product harvested from renewable or conventional source of energy to supports human existence. Moreover, the immediate needs for people to maintain its livelihood depend on energy sources for cooking, heating and energising low power devices to solve various demand. Though, carter for these demands requires availability of fossil fuel and natural gas to operate such devices that include cooking burners, heaters, small power electric generators and the likes. Thus, the prices of fossil fuel and natural gas tend to hike and increasing as the human population increases. Therefore to meets such demand, there is need to embark on affordable, clean and eco-friendly source of energy to solve such requirement. Hence this research proposed to design a simple digester capable of extracting biogas from degraded waste product accumulated from remains of kitchen, farm and animals dung and construct to provide biogas to energised cooking burners, heaters and low power generator to the dwellers of rural and suburban communities where the waste lacks proper utilisation.

A. Availability of Waste

For decades, utilisation of biogas extracted from degraded waste from various sectors have been amplified to energised or drive different operation on different demand. In the study of [5] biogas results from metamorphosed of waste product from kitchen, farm, abattoir that undergoes organic material based on anaerobic fermentation**.** Although, recording the available waste in form of wet and solid states from animals and agricultural degradation are well abundance in both rural and subrural areas in Nigeria.The significant biogas components are carbon dioxide (CO_2) methane (CH4) and hydrogen sulphide components (H_2S). In which the percentag**e** composition of these components as: methane 65-70%, carbon dioxide 30-35%, sulfuric components 1-2%. The bio gas can be purified for its use in various applications. However, viability of biogas source in modern society remains available due to the geometrically multiplying human population particularly in an area where waste products lacks proper utilisation. In addition, Nigeria is situated in relative high temperature area in west African state that easier for the production of bio gas favourably throughout the year and the arability of the bio degradable waste is in bulk. Moreover, study reveals that in Nigeria recording it population and settlements which outputs about 227,500 tons of immediate animal dung every day, and in which if utilised millions of metercubes of bio-fuel would be produced daily[7]. Production of biogas need technical sepation of unwanted gas from the substrate in order obtaine right proportion of methane (CH4) that make it high in purity. The biogas possess multiple of gases depending upon fermentation or the anerobic process. digestion process.Study of [11] reveals some sort of gases percentage in the biogas composition.

Table. 1 Gases Composition og Biogas[11]

Compound	Symbol	Proportion (%)
Methane	CH_4	50-70
Carbon dioxide	CO_2	30-40
Hydrogen	H_2	5-10
Nitrogen	N_2	1-2
Vapour	H2O	0.3
Oxygen	O_2	0-2
Hydrogen Sulphide	H_2S	Traces

Therefore, abundance of such waste would help on utilisation of biogas for electricity generation and heating burners remain imperative if persisted considering the availability of degraded waste virtually in almost all communities, but this trend is accelerating. In some rural areas across Nigeria, sewage and organic waste were used under cover or anaerobic digesters to generate fertilizers locally. Some of the industries that generate significant amounts of solid or liquid organic waste also have installed digesters to convert it into green manure instead of gas engines for electricity production. Many of these require sizable investments, but it is estimated that they have a good return on investment as the main feedstock that they use is essentially free . Thus, simple principle of biogas digester is illusted in Fig 1.0

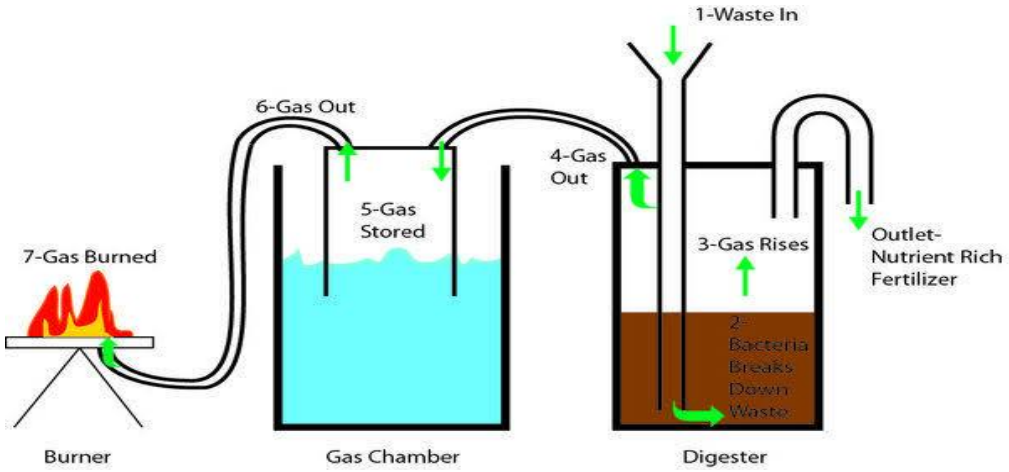

Fig.1.0 biogas digester [6]

Moreover, cost of energy for domestic, commercial and industrial uses in Nigeria has risen beyond the reach of average Nigerians and most importantly the energy meant for domestic and commercial use is not readily available . A according to NERC, 2015 various efforts have put in place to increase power demand above the maximum power generation capacity (5.96GW) in Nigeria has confirmed abortive.

1.2 Potential of Biogas

Referencing the degraded waste products from farm and animal, the significant benefit to certify the energy demand is beyong explanation as international communities have practices for decades and yielding positive output[7]. In Study [8] of gas produced as a result of decomposed and degraded waste through fermentation contains a high calorific value and can be used for energising gas-based machine, cooking and lighting purpose. This signifies that efforts have been made that cooking with biogas will help to reduce the amount of unwanted gases emission into our ecosystem. Biogas burns in a clean way, which has less harmful eco-friendly and emits free during combustion. However, a biogas burner and stove are situated in an enclosed area unlike in natural gas or fossil fuel. However, waste abundance defined tremendous importance in the production of biogas for supplementing natural gas and uses the sluge for bio-fertizer with huge composition of nutrients and organic mater. Thus these composition rate is a perfect fertilizer that increases crop yield in about 12.5% for wheat, 27.5% cotton, 20.6% spinach, 35.7% for maize ,5.9% rice as well as 14.9% carrot[9]. Moreover present that harmful organic substances from waste virtually magane by production of bio-fuel for domestic energy demand for cooking. [10], added that biogas from such organic waste is free from smook that make it ideal domestic uses and also reduces rate of cut down thick woods for ulilisation. Thus, uses the digested slurry for chemical fertilzsers and soil conditioners. In which, positive production from biogas plants were recording with uptimum output from abour 5 millions masonries in India, 45 million in china, 400,000 in Nepal and Cambodia, bangaldesh and Vietnam with 400,000 mansories biogas plants.

II. METHOD/MATERIALS

A. Sample Set-up

In this study, various materials were used for the perfection of the design according to biogas production principles. Although some of the materials were adjusted from initial design into required sharpe that suitable for this worked. The selection of the material has to do with the availability, cost, heat withstand capacity, adaptable engineering usage. In addition, the material used in the construction of the digester and its periparials possess strength and toughness similar to [12] material specification. However, the basic material used were three barrel (or pvc drum) of 2- 200litres and 1-125litre. In addition, connection huses, pressure nozzles and the gas burner, steal-cylinder as a scrowber.

i- *Feedstock*: In this study, an available biowaste used were remain of kitchen waste combined fat,carbonhydrate, protein and other decomposed substrate and animal dung in ration 2:3 were used for formulation of the slurry in 40% and 60% of waste + water respectively. The combined waste were later stored at 30°C before transferred to the biodisgester **B1** for anerobic process for the period of 15 days, after which various parameter were recorded as in table 1.

ii- *Experimental setup:* After plant materials were set-up, An equivalent composition of animal and domestic waste of 150Kg in a ratio of 1:2 mixed with 60-litres of water to formed a semi-liquid slurry for the production.With this ratio, it has observed that biogas production increases as the substrate of mixture is added. This verifies that volume of biogas production is directly proportional to the weight equivalent of slurry added.

In this design, waste digestion was kept ally for the period of 13days for the realisation of biogas production. Henceforth, an amount of 5Kg waste have been added after every 5days by recording other parameters accordingly for 15days.

iii- *Pressure Measure:* As gas production expiriences, an appropropriate measurement of the pressure were observed after every added substrate of 5kg of the mixture using Barometer. In addition, it was recorded that at every change of state or anerobic process taken place, the volume of measurement tube is increasing and this means digester B1 was in air-tight state.

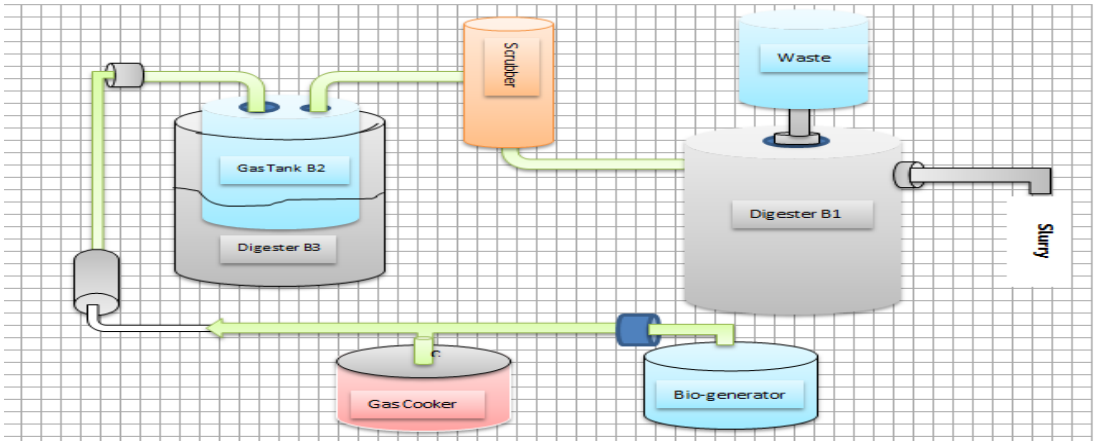

Fig.2.0 Plant Architecture

III. BIOGAS PRODUCTION

The research design is based on the methodology adopted as in the Fig.2.0 that reveals the skeletal framework of the plant. In which the design comprised of some fundamental components to be adhered for the perfection of the plant. However, two storage barrels were tag B1, B2 for biogas container and subsidiary tank, then scrubber which is a cylindrical drum of steel with dimension100mm diameter and high of 900mm was also used to suppress the hydron sulphide (H_2S) mixed with methane (CH_4) by passing through the steel wool inside the cylinder, Thereby iron-oxide react with H_2S and enabled CH_4 to passé to the gas barrel B3. The barrel B1 and B2 were connected using 20mm pvc hose, in which slurry pipe as an outlet and Waste funnel as an intel pipe were designed on B1. The bio-digester B1 was designed in according with fundamentals parameters that includes; gas pressure, bio-fuel production rates, digester volume, waste ratio, the pH level and the digester tempreture. Fig.2.0(a)

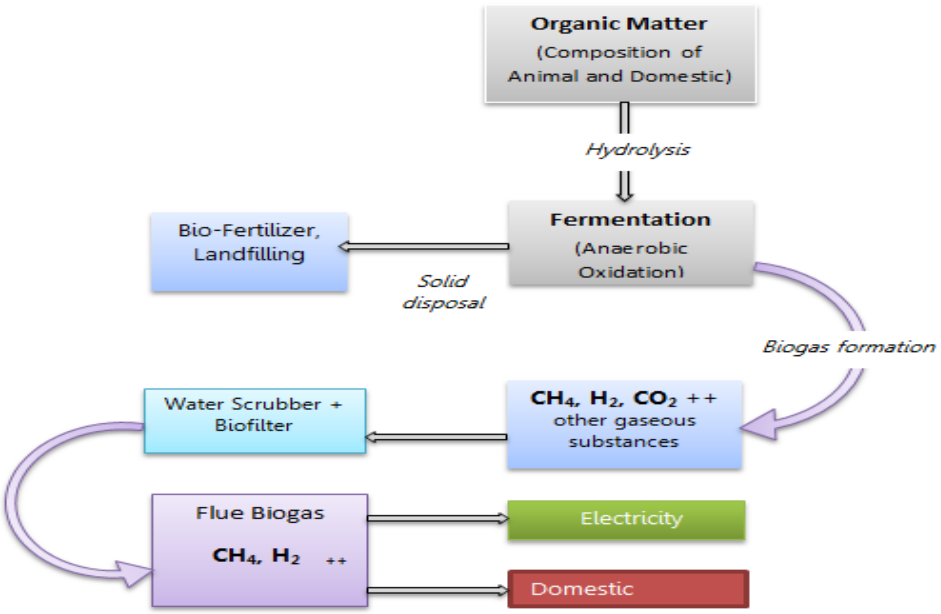

Fig2.0(b)

A. System Construction

A technical and academic oriented project has been commenced on project title "Utilisation of Domestic Waste for Production of Biogas Issue for Enhancing Cooking and Heating in Rural/Suburban Society". In this research, appropriate works such as design, measurement and constructions haves been performed base on the following;

***i- Location*::** As far as this research is concerned, site to positioning the project digesters remain the essential aspect. Following the it essentiality, an open space of 16 meter-square behind the mechanical workshop was selected to perfect the proper site for this project. The site is selected to provide gas point to mechanical students for gas featured practical and at the same time for heating light consumables.

ii. Digester design and reformation: It has mentioned in method/material section reformation of the digester to the required 4mm thick plastic containers of two- 200 litres capacity and one- 175-litres capacity where used for the digester, dehydration and gas storage containers as in fig. 2a and 2b respectively. The digester tank was measured and drilled to house slurry inlet and gas outlet to the dehydration tank, while the gas (CH_4, H_2S) storage container was designed and drilled to house the inlet and outlet valves to capacitates the gas input/output to the Methane (CH4) storage tube before filtration.

iii. ***Coupling/Reformation of the digester container*:** The digester is finally designed and reformed according to the required measurement as in performance design parameters as in design of [13] that offers substantial CH4 productions which will certify the objectives. Thus, a hose of $8mm^2$ were fixed for the conveyance of the CH4 to the tube storage for further exchange to provide blue flame for heating and cooking using burners.

Fig 3.0(b)

Fig 3.0(c)

Fig. 3.0(d)

iv. Containers Assembly :After the storage, digester and hydration tanks were designed and reconstructed, An assembly of all the 3-tanks with designated B1,B2 and B3 were realised using stop-valves, hose and clipping kits as part of the process

Table 2.a

Table 2.0 *a*Biogas Production Percentage per- 2days

Observation Period (days)	Slurry Ratio Manure(M) Water(w)	Digester Temperature(Celsius)
	M:W = 2:3, Biogas in %	
0	2.1	29
2	4.5	32
4	6.0	30
6	21	30
8	28	31.5
10	34	34
12	35	36
15	52	35
16	57	38.3

IV. RESULT and DISCUSSION

With reference to the sample preparation and the activities performed verifies that the characteristics of slurry used signifies high impact production of biogas that seem so impressive. The Table 2.0a contains the

biogas parameter and the effect of inoculum of food-waste per day to increase the rate of gas production. In addition, the performance of characteristic of the of the gas formation per day for 15-days retention period by adding an amount of volatile slurry.Hence, the amount of gas produces from day 2 to day 16 were recorded using (CH4), Model PG100 digital with range 0.00 – 100.00% v/v respectively. However, different pH reading of the digestrate were equally monitored from day 1- day 15 of the retention period. This certify that increases in retention and fermentation process has an effect on pH as cleary verified in the study of [14][15].However, it has observed that CH4 production tend to increases as inoculum of certain amount of slurry in kilogram were added as depicted in Table 2(a)

V. CONCLUSION

In modern days, Population in rural areas is exponentially increases year-in year–out and due to such reason domestic wastes are also realised in thousands of kilogram. In which, it s very necessary to transform such wastes into realible energy for sustainable development. In this research, a domestic waste in combination of cow dung were used to formed a slurry of 40% and 60% . Thus, the data were recorded for just 15-days to write the results as depicted in table.2.0a. In which the results verifies that temperature add more digestion rate for the production of CH4 and at the time the number days that covers an aerobic dynamic. The results were observed using CH4-meter, digital type and Model:PG100 respectively

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