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Original Research Paper

Sustainability of Biogas Generated from Cow Dung as Household Fuel for Cooking

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Cow dung is a spongy degradable biomass containing digested and partially digested plant (cellulose) material found in the rumen of ruminants like Cow. When excreted, they lie as a waste in the environment with messy look and acrid smell causing pollution and rarely recycled into any useful end due to ignorance. In some instances farmers collect the dung and dump them to decompose on farmland as fertilizer. The environmentalist in their effort to sanitize the environment has given a second thought to the waste material by investigating the solid biofuel to be converted to gaseous biofuel. About 39kg of Cow dung was fed and allowed to digest by passing through fermentation, hydrolysis and methenation before a gas is generated. A period of 6 days at a temperature of 3 25-30oc soaked in 172 liters of water and 4 liters of dissolved chicken dropping as an inoculant. After 6 days the gas was generated to a volume of 1.2m3 which was tried for sustainability by cooking 477kg of rice with ingredients. The volume was sustained throughout the three cooking periods of breakfast, lunch and dinner and 24hrs after then until after 6 days when the volume subsided. The slurry left was removed through displacement and served as bio fertilizer. Considering the result, it indicates that biogas can serve as an alternative to fuel wood or any biomass in terms of combustion and sustainability. However storage and transportation remain as a major challenge-Biogas generation was part of an effort to reduce the pressure on firewood extraction especially in rural areas where alternative is not forthcoming.

Keywords: Biogas, Fuel wood, Cow dung, Rice, Digester, Burner.

INTRODUCTION

Before biogas, fuel wood and combustible organic materials have been mans first and most frequently used domestic fuel for cooking, primarily because fuel wood and such materials are cheaper and accessible to mankind. Recently, due to increasing human number, desertification, increasing cost of petroleum energy resources, government regulated laws and in some cases, it is completely not available, especially in dry land community's fuel wood has been scarce and expensive. NAP (2000) observed that nearly three quarter (3/4) of Kano city (the second largest city in Nigeria) fuel wood fuel wood requirement is about 75000 tons, similarly, Mende and Ahmed (1991) identified fuel wood as the staple energy source of three quarters (3/4) of the developing country's population, especially in the tropical regions. Therefore, due to the increasing demand for fuel wood which caused deforestation resulting in to desertification, erosion and land degradation, considering this a number of measures were taken to cut down the use of fuel wood or look for alternatives.

In an attempt, therefore, to reduce and divert the rural domestic fuel demand from fuel wood to alternative, biogas (methane) was chosen due to the abundance of the raw material such as organic waste material which are not in use for any purpose, but constituting an eye sore in the environment, such materials include cow dung, household waste, industrial sewage, plant, plants, leaf litter and flowers (Maishanu and Sani 1991). Biogas or methane (CH4) is an alternative source of energy for domestic cooking, especially in rural areas,www.beg.utexas.edu (2003) indicated that natural gas has an energy content higher than methane because of added gas liquids while include other hydrocarbons other than methane, such as ethane, propane and butane. As a result, natural gas has a higher caloric value than pure methane. Biogas can be used in all energy consuming applications designed for natural gas. It is burned in an internal combustion engine to generate electricity, running fuel engines, cooking light and pumping water, it was reported using biogas can save about610g/ day of fuel wood at the rate N50.00 (Abbasi *et al.,*

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1991). The gas is trusted and popular, produced by the use of local resources, like cow dung, sugar cane waste (peels and bites), chicken droppings (guano), grasses, decomposed vegetable, large and small animal waste, bedding materials, rice straw, rice hull, water hyacinth, banana peels and other organic materials of low lignin content.

The technology and yield of biogas depend on the composition and biodegradability of the organic feedstock, microbial growth, pH and temperature conditions. The feedstock in decomposed anaerobically by methagenic bacteria in an airtight digester, where the substance is subjected to the process of fermentation, acidification and methenation under a given range of temperature usually 250c and a moisture content of 20% 40% and 1 atm pressure (Letcher and Kolbe 1994). Depending on the digestion process, the methane content of biogas is generally between 55% - 80% (Anon 2004b), the remaining composition is primarily C02 with trace quantities (015000 ppm) of corrosive hydrogen sulphide and water (Anon 2004a). Meynell (2004) indicated that the energy content of pure methane is 8961069 btu /ft3, to obtain useful methane to biogas is scrubbed of C02, hydrogen sulfide and water. There are several factors, affecting biogas production, which include temperature, retention time, air, bacteria, C:N ratio, pH, water ratio and solid contents required. There are various designs of biogas such as floating steel drum design, fixed dome design and tunnel design, plastic bag bio digester, brick mortar, dome designed by various engineers. On production the gas is collected in a floating collector which is connected directly to the kitchen for use in a gas burner. The spent or slurry of digestion is collected as a nitrogen fertilizer or bio fertilizer, based on a number of trails to generate the biogas or methane (CH4) in the Department of Biological Sciences, University of Maiduguri where waste materials, like cow dung and sugar cane waste with chicken waste or guano as seeding material (inoculant) were used. This research therefore intends to assess the rate of biogas production from cow dung per unit time of cooking in a home. A similar effort was used by numerous authors to determine biogas production from organic material as indicated by Letcher and Kolbe1994) that the maximum possible volume of gas from a ton (1000kg) of dry organic plant material in 416m3 at 250c with 20-40 moisture content. The maximum heat energy that can be obtained from burning 25 liters of methane (CH4) gas 1mole is 890 kj/mol. It is estimated that 1kg of cow dung can generate 600 liter of methane gas. As part of effort to probe this ascertain effort were made to generate biogas from cow dung.

2.0 MATERIALS AND METHOD

There are various designs of biogas digesters used and suggested by researchers, end users and engineers respectively. This includes the floating steel drum, fixed dome, tunnel and plastic bag bio digester design. In this research, the floating steel drum design was used, where the digester mainly consists of a gasholder made of drum with central guide pipe. The drum gasholder is of welded steel construction with a steel frame at the opened end. The top of the drum is slightly coned with a mixing arm. An inlet for feeding fresh substance and simultaneously flushing out digested materials Nagamani, and Ramasamy (1990) reported that the performance of floating dome biogas plant was better than the fixed dome gas plant.

Measurement of the gas was made easy by displacement of water by the gas. The gas displaces water, being insoluble, where the height of the cone was measured as the amount of gas collected. The amount of gas produced was assessed on the basis of three meals for a family in a day. A meal of rice was prepared with ingredients to determine sustainability. Where 477g of rice was cooked.The digester was fed with 40kg of waste organic material (cow dung) with the crumbs, broken into fine pieces and thoroughly mixed and stirred into 80 liters of water and 10 liters of seeding material (chicken waste) as source of methagenic bacteria. In the second trial using the same digester, about 39kg of waste material mixed and stirred properly in 172 liters of water with only 4 liters of seeding material.

3.0 RESULTS AND DISCUSSION

The decision to increase water and reduce inoculant by 50% in the second trial was arbitrary and partly because hydrolysis require more water and microorganism multiply very fast. In the two trials carried out, the second trial (B) produced gas vigorously within the expected period of six days, producing about 1.12cm3 of gas in 24hrs as indicated in table 1. The rate and volume of gas production was maintained throughout the period of the three meals (breakfast, lunch and dinner) for two consecutive days. Then volume was regardless of the excess which was wasted through the world spillage of water whenever the gas was not in use and was not accounted for. The volume of gas utilized for cooking for the three periods of cooking ranges from 0.28m3 to 0.44m3. Gas production and accumulation in the collector continued after the third cooking trial (dinner) and 21hrs of usage. This phenomenon was indicated by continuous and excessive spillage of water from the gas collector.

If this trial experiment is to be compared with the work of Letcher and Kolbe (1994), it means the 40kg of Cow dung that generated 1.12 m3 within 24hrs was estimated to be equivalent to producing 28m3 (0.7m3/kg) or 24000 liters of methane gas or 21360000 kj/mol of energy. Yerima and Ngulde (2015) obtained about 0.99417m3/kg of methane generated from sugar cane bites which was sufficient enough for the amount of gas required to cook the three meals in this trial. Therefore one consider that using the floating drum design type of digester is the best adequate enough to produce a gas that can sustain a family size of 6-8 for 3-4 days, whenever the burner is turned between1/2-3/4 on, producing short blue and hot flame against the cooking surface Gas Turbines (2013) suggested that temperature is another factor that affect gas flow from the digester because the outlet is in the air influenced by atmospheric temperature. Therefore biogas (methane) generated from Cow-dung is a good and alternative source of domestic fuel, particularly in rural and dry land areas where poverty thrives. Yahaya and Ibrahim(2012) using an agricultural waste (rice hull) as an alternative to firewood, observed that the rice hull blended with gum Arabic took 15 minutes to boil compared to that of firewood that took 21 minutes to boil the same quantity of water.

Table 1: Table showing quantity of substrate and volume of gas generated.

A	Weight of cow dung	Volume of water	Volume of seeding material	Calculated volume of gas generated	M3/hr
A	40kg	80 liter	1.10M3	1.12m3	

4.0 CONCLUSION

It can be concluded that biogas is a reliable alternative source of domestic fuel, particularly in the rural arid zone of the desert environment anywhere on the globe. Peasant farmers who are faced with the challenge of expensive inorganic fertilizer can resort to using the slurry as a bio fertilizer .It is also noteworthy when using biogas generated from cow dung factors like temperature, water, particle size, and inoculant, pH and burner usage must be put into consideration. Considering the volume of gas generated per unit time one can be recommended that more than one digestion can be attached to the gas collectors. The burner in use can be partially open about ½ - ¾ tuned on. The gas can be collected into another container due to excessive pressure and rate of generation..

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