EVALUATION OF BIOGAS PRODUCTION POTENTIAL FROM ELEPHANT DUNG

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Abstract - *The huge amount of elephant dung generated at elephant camps and the disposal of elephant dung are the serious problems faced today. Normally, it is left over to dried and burned causing air pollution in the surrounding area. Moreover, during the rainy season, the waste from the camp will be washed into the main river resulting in a wide spread water pollution. It might cause the long-term ecological problem since more elephant dung is dumped into the river. So, there is a need to propose a proper way to manage the elephant dung in order to prevent further damage to the surrounding environment. Therefore, this project aims to investigate the feasibility of using elephant dung as a raw material for biogas production. Not only for biogas production but this project also offers the sustainable solution to manage the biological waste from the elephant camp and helps establishing the use of renewable energy.*

Keywords:elephant dung, co-digestion, biogas

1. Introduction

The need for energy to carry out our day to day activities both at our homes and in the industries cannot be overlooked. The demand for energy is increasing with increasing growth in technology and urbanization. Our main sources of energy (i.e. oil, natural gas and coal) are threatened by fear of depletion if new reserves are not found within the next thirty years. As a result, it is important to research into other sources of energy preferably from renewable sources to compliment those of fossil fuels. Energy are needed for cooking, lighting, heating and power our electronics and machines at home, schools, industries and other varieties of applications to better our standard of living on earth. In addition, the use of fossil fuels and biomass (such as fuel wood and agricultural wastes) as means of energy are accompanied by environmental pollution and a shift to the environmentally friendly energy sources will curtail the rate of depletion of the Oxon layer. Fossil fuels are the main energy source used for supplying the actual mankind needs. Vast majority of energy gained from renewable sources relates to the water energy. Since in the future we will be forced to satisfy our energy needs from renewable sources, we have to think of the way to transform renewable sources to a usable energy. The main problems are expensive and long researches, with most transformation relating just to the production of electrical energy. Factors that contribute to higher research costs are also variety of renewable energy sources. Renewable energy sources do not pollute environment in the same amount as non-renewable do, but they are also not completely clean. This primarily affects to the energy gained from biomass which has the same effect as fossil fuels, and that is CO_2 emissions when combusting, but carbon circle is at least closed in that case. Biggest problems of renewable energy sources (water energy excluded) are price and small amount of gained energy. Renewable energy sources have huge potential, but at this moment our current technology development does not allow us to rely strictly upon them. In present world demand for renewable energy resources is increasing day by day, so the world's view of waste has changed dramatically recent years and it is now seen as resource to feed the ever-growing demand of energy. Waste to energy is the process of generating energy in the form of electricity, heat or fuel through a variety of processes, including combustion, gasification, anaerobic digestion, pyrolysis etc. An increase of the current CO_2 concentration in the atmosphere causes global warming as carbon dioxide is a greenhouse gas (GHG). The combustion of biogas also releases CO_2. However, the main difference when compared to fossil fuels is that the carbon in biogas was recently up taken from the atmosphere, by photosynthetic activity of the plants. The carbon cycle of biogas is thus closed within a very short time. Biogas production by anaerobic digestion reduces also emissions of methane and nitrous oxide from storage and utilization of untreated animal manure as fertiliser.

2. BIOGAS GENERATION

Biogas is produced by extracting chemical energy from organic materials in a sealed container called anaerobic digester by the biological process in the absence of oxygen. Biogas plants can be fed with organic waste such as dead plants, biodegradable wastes including sewage sludge, kitchen waste and cattle dung. It is a naturally occurring microbiological process that converts the organic matter to methane and carbon dioxide producing renewable energy.

The anaerobic biological conversion of organic matter occurs in three steps. The first step involves hydrolysis where transformation of insoluble organic material and higher molecular mass compounds such as lipids, polysaccharides, proteins, fats, nucleic acids, etc. into soluble organic materials, i.e. to compounds suitable for the use as source of energy and cell carbon such as monosaccharide, amino acids and other simple organic compounds. Next step involves acid formation were group of microorganisms ferments the break-down products to acetic acid, hydrogen, carbon dioxide and other lower weight simple volatile organic acids like propionic acid and butyric acid which are in turn converted to acetic acid. Third step were the anaerobic bacteria called as methane formers converts the organic acids formed in second stage into biogas having its main constituents as methane and carbon dioxide with other small trace of H_2S, H_2 and N_2.

The performance of biogas plant can be controlled by studying and monitoring the variation in parameters like pH, temperature, loading rate, agitation, etc. Any drastic change in these can adversely affect the biogas production. So these parameters should be varied within a desirable range to operate the biogas plant efficiently. Various factors such as biogas potential of feedstock, design of digester, inoculums, nature of substrate, pH, temperature, total solid contents, loading rate, hydraulic retention time (HRT), C:N ratio, uniform feeding, volatile fatty acids (VFA) etc. influence the biogas production.

3. TYPES OF BIOGAS PLANTS

Biogas plant design of the digesters is varied based on the geographical location, availability of substrate, and climatic conditions. For instance, a digester used in mountainous regions is designed to have less gas volume in order to avoid gas loss. For tropical countries, it is preferred to have digesters underground due to the geothermal energy. Out of all the different digesters developed, the fixed dome model developed by China and the floating drum model developed by India have continued to perform until today. Recently, plug flow digesters are gaining attention due to its portability and easy operation. This is a composite unit of a digester and gas holder wherein the gas is collected and delivered at a constant pressure to gas appliances through a distribution system. Depending on the amount of raw material to be handled the digester may be of either a single chamber or a double chamber type. There are two types of processes for anaerobic fermentation. They are continuous and batch process. The continuous process is suitable for free flowing suspended materials while the batch process is applicable to light materials.

3.1 FLOATING GAS HOLDER TYPE BIOGAS PLANT

Khadi and Village Industries Commission (KVIC) is the name of a floating drum digester model developed in 1962. Even though the model is pretty old, it is one of the most widely accepted and used designs for household purposes in India. In floating gas holder digester the gas holder is separated from the digester. The digester may be vertical or horizontal. The design includes a movable inverted drum placed on a well shaped digester. An inverted steel drum that acts as a storage tank is placed on the digester which can move up and down depending on the amount of accumulated gas at the top of the digester. The gas holder has an outlet at the top which could be connected to gas stoves. It has less scum troubles because solids are constantly submerged. No separate pressure equalizing device needed when fresh waste is added to the tank or digested slurry is withdrawn. No problem of gas leakage

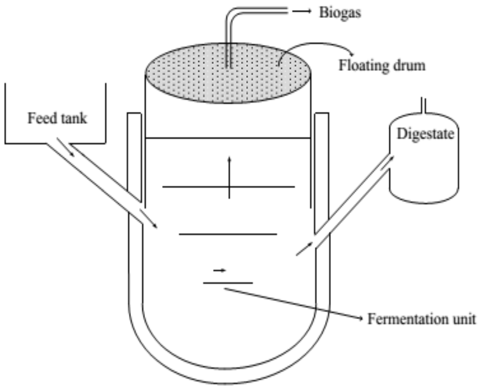

Fig -1: Schematic Diagram of a Floating Drum Digester

3.2 FIXED DOME TYPE BIOGAS PLANT

In fixed dome digester the gas holder and the digester are combined. The fixed dome is best suited for batch process especially when daily feeding is adopted in small quantities. The fixed dome digester is usually built below ground level. The slurry is fed into the digester through the inlet chamber. When the digester is partially filled with the slurry the introduction of slurry is stopped and the plant is left unused for about two months. During these two months an anaerobic bacteria present in the slurry decomposes or ferments the biomass in the presence of water. As a result of anaerobic decomposition biogas is formed which starts collecting in the dome of the digester. From the outlet chamber the spent slurry overflows into the overflow tank. The spent slurry is manually removed from the over flow tank and used as manure for plants. The gas valve connected to a system of pipelines is opened when a supply of biogas is required. It has no corrosion troubles. In this type heat insulation is better as construction is beneath the ground.

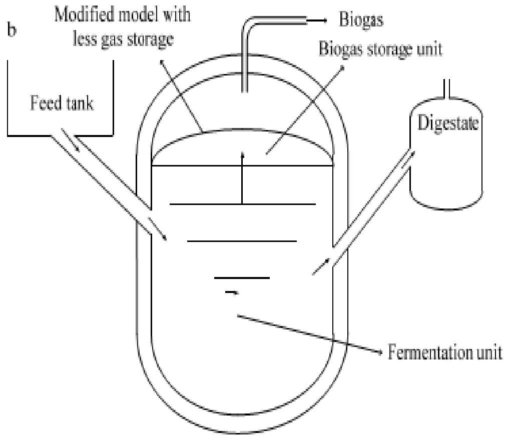

Fig -2: Schematic Diagram of Fixed Dome Digester

3.3 BALLOON TYPE BIOGAS PLANT

A balloon plant consists of a heat sealed plastic or rubber bag (balloon), combining digester and gasholder. The gas is stored in the upper part of the balloon. The inlet and outlet are attached directly to the skin of the balloon. When the gas space is full the plant works like a fixed dome plant i.e., the balloon is not inflated or it is not very elastic. The fermentation slurry is agitated slightly by the movement of the balloon skin. This is favorable to the digestion process. The useful life span does usually not exceed 2-5 years.

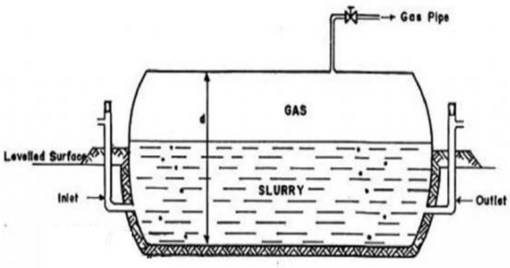

Fig -3: Flexible Bag Type Digester

4. BIOGAS POTENTIAL OF ELEPHANT DUNG

Biogas production is mainly by the fermentation of cellulose found in the cell components of plants by certain groups of bacteria and protozoa. Cattle being ruminants, their dung has very little plant fibre content and various plant materials can be added to cow dung to increase biogas production. By contrast, elephant being a non-ruminant its dung has considerably more fibres. The cow is a fore-gut feeder while the elephant is a hind-gut feeder. In the cow, the digestion and absorption of cellulose is almost complete and the excreta contains very little plant fibres, whereas in elephants, the process being incomplete, the dung contains a high percentage of undigested plant materials. As a result, comparatively more biogas can be produced from elephant dung than from cowpats without additional plant materials and also handling dry elephant dung is much easier as it is not as pasty and smelly as cow dung. Therefore people would like to make use of elephant dung rather than cow dung to produce biogas as a fuel for cooking.

Cooking with biogas offers many benefits in comparison to cooking with firewood. It is easy as biogas gives off a pure blue smokeless flame when it burns. This in itself would help keep the pots and pans and the kitchen free of soot. Furthermore, to create the blue fame with biogas, there is no need for sophisticated burners as in the case with LP gas. Cooking with firewood is a health hazard and causes problems in the respiratory tract and eye ailments as a result of the smoke. These characteristics of biogas give an advantage over the use of firewood as fuel for cooking, which is the major source of fuel for the majority of people living in areas frequented by elephants. The hotels, which have invested on ecotourism in areas frequented by elephants can also use biogas produced from elephant dung to cook food and keep food warm during the buffet meals. The profit return can also be used to feeding and caring for the elephant. The residue of biogas production is a high quality fertilizer and it comes free. Today, there is a great demand for organically grown vegetables. Crops grown using the residue will not only yield bigger harvests, they will also fetch higher prices and thus bring greater profits to the villagers. Farmers will therefore be assured of a high return for their investment. The hotels in particular which attract the wealthy foreign tourists may purchase such organically grown vegetables at a higher price thereby wean the farmers from suing harmful chemical fertilizers which are also very expensive. The byproducts of biogas production may in some small way help compensate the farmers for the damage caused by wild elephants to their crops.

5. MATERIALS AND METHOD.

5.1 Materials

Elephant dung was collected from Mangalamkunnu elephant camp and it is mixed with water in the pre digester tank and the tank is kept in aerobic condition for one day. The fibrous material is raked off the surface after the slurry is admitted to the digester. The kitchen wastes used as raw material for co digestion are collected from IRTC mess hall. Non- biodegradable components such as plastics, metal foils, and pebbles etc, contained in the biodegradable portion of kitchen wastes were sorted out. Some larger vegetables are cut into smaller ones to allow faster bio degradation.

5.2 Work Plan

Experiment was conducted at laboratory scale and at large scale. In lab scale experiment study was done in a 20 lit plastic container to check the gas production. The gas production occurs and burned with blue flame. In large scale experiment three portable type biogas digester of $1m^3$ capacity were used.

5.3 Experimental Design

Three identical biogas digesters of floating dome type is used as experimental units. These digesters are of KVIC model biogas plant with $1m^3$ capacity and in this type of plant the biogas is stored in a drum, which moves up and down on a guide, according to quantity of gas stored in it. The gas holder rests on a guide, according to quantity of gas stored in it. The gas holder rests on a guide frame which is fixed in a digester walls. The compositions of the three samples used in these experiments were presented in Table1.

Table -1: Compositions of samples

Sample	Composition	Ratio
A	Elephant dung and water	1:1.5
B	Elephant dung and water	1:3
C	Elephant dung and kitchen waste	1:1

5.4 EXPERIMENTAL SET UP

In first phase three biogas digesters are filled with 120kg cow dung and mixed it with water for inoculum preparation. The inoculation digester was kept for some days and gas production was checked by burning in a stove. After the checking of gas production the different samples were placed in the biogas digesters to test the biogas production. Elephant dung is mixed with water in different ratios and poured it in to the pre digester and kept for one day. Elephant dung is predigested in a pre-digester tank so that it undergoes aerobic digestion before fed in to the gas digesters and in digesters it undergoes anaerobic digestion .After pre-digestion, fibres are separated from elephant dung wash water and it is fed in to the biogas digesters. In co digestion, kitchen waste is added to the elephant dung wash water before placed in to the biogas digester. The contents of three bio digesters were mixed daily. The mixing facilitated homogenization of the contents and thus enhanced the rate of bio digestion. At the end of every day's operation, the gas from gas outlet was tested for flammability by burning in a biogas stove and methane and CO_2 proportions were calculated using water displacement method.

6. RESULTS AND DISCUSSIONS

The temperature, ph, methane and CO_2 proportions were noted every day. The temperatures within the digester ranged between 27 and 32°C. This was due to constant rain which reduced the proportion of methane since the optimum temperature 35°C was not reached. Since the ph of the initial slurry varied between 7.38 to 7.53, the final ranged between 7.4to 7.6.Thus the experiment was conducted within the range for the optimum methane production as the recommended ph of digester mainly from 7.0 to 7.6 which is the healthy environment for methane forming bacteria, in order to minimize the toxicity of both free ammonia and free-volatile fatty acids.

Sample C which is a co digestion of elephant dung and kitchen waste in the ratio of 1:1 produced more methane than the rest of the treatments and its highest methane yield by volume was 86.3% and it occurred on 28th day of digestion due to the difference in retention time period of elephant dung and kitchen waste. This was followed by sample B obtained from mixture of elephant dung and water in the proportion of 1:3 with methane yield of 85.2 % and it occurred on 22nd day. The lowest methane rate was 82.1% obtained from sample A which is a mixture of elephant dung an d water in the proportion of 1:1.5.This values show that methane production increased with time.

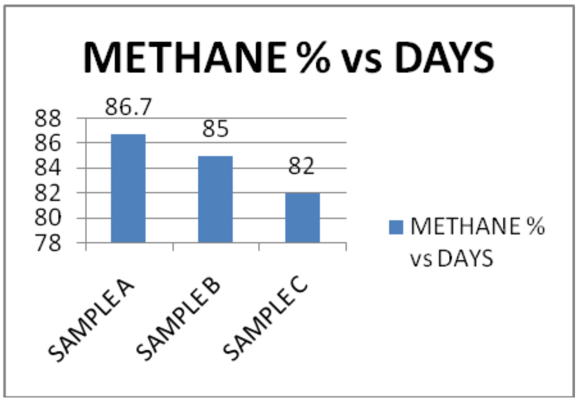

Chart -1: Graph Showing Methane Production from Different Treatments

CO_2 production increased for the first days of digestion and observed to be at its peak on the 9th day of digestion, there after it reduced significantly. Sample C produced the highest emission of CO_2 with 22% by volume and it occurred on the 9th day of digestion. It was followed by sample A with 20.7% which was noticed on the 10th day of digestion and least was sample B with 19% which happened on the 9th day.

7. CONCLUSION

The evaluation of biogas produced from elephant dung was carried out with different ratios including co digestion of elephant dung and kitchen waste. The co-digestion of elephant dung wastewater and kitchen waste has high methane yield of 86.3 % on the 28nd day of digestion. It is evident that biogas from elephant dung can give hand to an extremely great extent in substitution of fossil fuels and a thorough investigation in many angles, the generation and utilization are to be explored. In addition to this high NPK value of biogas slurry shows that it can be used as a high quality organic fertiliser for soil conditioning and as a growing medium, with the environmental advantages of replacing petrochemical based fertilizers. . The fibre separated from elephant dung waste water has high economic value and can be used for various purposes such as it can be used as solid fuel, for the production of paper, can be used in several handicraft materials etc. Thus by product of anaerobic digestion can be used to create source of income. Therefore ban should be made in burning elephant dung cakes. With such a potential energy source, elephant camp can establish a hygienic and pathogen free environment through protection of soil, water and air if these potentials are properly trapped and used.

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