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STUDY ON PRODUCTION OF BIOGAS FROM MIXTURE OF COWDUNG AND CHICKEN EXCRETA USING SILICA GEL AS A CATALYTIC

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Abstract- *This research evaluates and estimates biogas (methane) production potential from mixture of cow dung and chicken excretaat laboratory scale through anaerobic digestion processes. The gas can be used to produce electricity, to cook, to heat water for farm use, or for other business ventures that use energy.There is an increasing need to replace conventional energy with the renewable energy to save our natural resources and our environment. Bio-energy seems to be the most probable solution to this crisis. In this study, the biogas production potential of the mixture of cow dung and chicken excreta in the ratio of 1:1 has been discussed.The conical flask (700 ml) is used as digester and container is used as gas holder and water collector. The gas is collected by displacement method. The main content is chicken excreta and cow dung using 5 gm silica gel as catalyst. For first set-up (without using silica gel), Total solid of "8%" is used. The amount of chicken excreta and cow dung is 289.78 gm and amount of water is 410.22 gm used. The total gas produced is 10070 ml/kg and maximum gas production rate per day is 1111 ml/kg. For second set-up (with using silica gel), Total solid of "8%" is used. The amount of chicken excreta and cow dung is 289.78 gm and amount of water is 410.22 gm used. The total gas produced is 10964 ml/kg and maximum gas production rate per day is 1841 ml/kg. By using silica gel or cupric nitrate as additive, total gas yield time dramatically reduced. For couple of day's production of gas approximately double than without using additive.*

Keywords: Biogas, Cow dung, Chicken excreta, Anaerobic digestion, Renewable

1. INTRODUCTION

Biomass is well known as a renewable fuel energy resource and ranks fourth providing about "14%" of the world's energy needs [1].

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 context, renewable energy resources appear to be one of the most efficient and effective solutions [2]. Bio-energy is now accepted as having the potential to provide a major part of the projected renewable energy provisions of the future [3-4]. Biogas, which is one of the byproducts of anaerobic digestion, comprises about "60%"methane and "40%" carbon dioxide [5]. It has been used as a source of fuel in several countries such as India, China, Sweden, Bangladesh etc. for lighting and cooking purposes. The content of biogas varies with the material being decomposed and the environmental conditions involved [6].

Biogas production comprises of three stages namely hydrolysis, acidogenesis and methanogenesis.

$(C_6H_{10}O_5)n + nH_2O \rightarrow n\ (C_6H_{12}O_5)$ - Hydrolysis
$n(C_6H_{12}O_5) \rightarrow nCH_3COOH$-Acidogenesis
$3nCH_3COOH \rightarrow n\ CH_4 + CO_2$- Methanogenesis

Various wastes have been utilized for biogas production and they include amongst others; animal wastes [7-9], industrial wastes [10] and food processing wastes [11]. Cowdung and chicken excreta are such biomass being considered as a potential feed stock [12-14]. A biogas system becomes flammable when its methane content is at least "45%". Methane has a heating value of 15.6 MJ/kg [15]. Consequently, biogas can be utilized in all energy consuming applications designed for natural gas [16].

Biogas is about "20 %" lighter than air and has an ignition temperature in the range of 650 °C to 750 °C. It is odorless and colorless gas that burns with clear blue flame similar to that of LPG gas. Its caloric value is 20 Mega Joules (MJ) /m^3 and burns with "60 %" efficiency in a conventional biogas stove. Biogas refers to a gas made from anaerobic digestion of agricultural and animal waste. The gas is a mixture of methane (CH4) "50-70 %", carbon dioxide "30-40 %", hydrogen "5-10%", nitrogen "1-2 %", hydrogen sulphide (trace), water vapor "0.3 %". The gas is useful as a fuel substitute for firewood, dung, agricultural residues, petrol, diesel, and electricity, depending on the nature of the task, and local supply conditions and constraints [17-22].

Table1:Biogas compositions

Substances	Symbol	Percentage
Methane	CH_4	50-70
Carbon Dioxide	CO_2	30-40
Hydrogen	H_2	5-10
Nitrogen	N_2	1-2
Water vapor	H_2O	0.3

Hanif investigate biogas production from fish residue and author found that total gas produced 118 ml for the composition of 800 gmand produced gas per gm of total mass is 0.07375 ml [23].

Ahmed investigate production of biogas from cow dung and poultry waste using Couric nitrate as catalyst and author found that total gas yield 6462.6 ml/g and maximum gas yield 253.7 ml per day[24].

2. METHODOLOGY

The following methods were used for the feasibility study of biogas production**:**

- Data collection and assessment of resource base(sight visits)
- Sample collection
- Sample analysis for total solids
- Sample analysis for volatile solids
- Anaerobic digestion for experimental procedure
- Potential gas yield calculations and digester sizing
- Economic analysis

Different step of biogas production is summarized in the given flowchart Fig. 1.

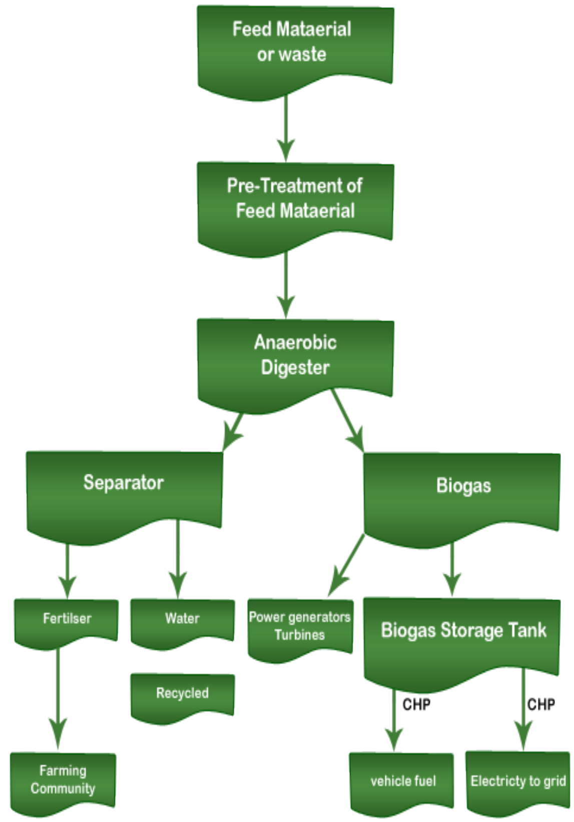

Fig. 1: Flowchart of Biogas

2.1 Design method

The study was conducted by varying the proportion of biomass to be co-digested while the amount of total solid and detention time were kept constant. Also, the ratio of amount of total solid to water in each of the fermentation digester was the same.

2.2 Sample collection

Cow dung and chicken excreta are available anywherein Bangladesh. Approximately 289 gm of cow dung, chicken excreta and also 5 gm silica gelwere collected for the purpose of this research. Cow dung and chicken excretacollected were sun dried and thereafter crushed mechanically using a mortar and pestle to ensure homogeneity.

2.3 Materials/instruments

The following materials/instruments were used for the purpose of this research: Buckner flask (5000 ml), conical flask (7000 ml), a mercury-in-glass thermometer (range -10°C – 100°C, accuracy ± 0.1, tap water, mortar and pestle, corks and connecting tubes.

2.4 Water content

The water content for each sample was determined using the recommendation for better biogas production as reported by Ituen et*al*. (2007), that is, a total solid (TS) of "8%" in the fermentation slurry. This was the basis for the determination of the amount of water to be added for any given mass of total solid. Hence the proportion of total solid to water was the same in all the fermentation slurry samples.

2.5 Total solid content

For the purpose of this research, there were three x: y proportions aimed at investigating the efficiency of cow dung and chicken excreta in biogas production. The proportion was as follow: 50:50cow dung and chicken excreta on a weight percent basis.

2.6 Model Biogas Plant

Including measuring arrangements Fig.2 shows a schematic view of set-up for biogas production. In this set up there are three sections. First section is digester will use for processing of slurry. Second and third sections are gas: "measuring section. In this setup gas production will be calculated by using the water displacement method. Many experiment proved that this method is more effective to measure the volume of the produced gas. The first container contains the waste, which will go through anaerobic digestion process, and second container contains water, which will be displaced by the gas pressure. Thus these two containers are connected by a plastic tube just connecting the upper portion of two containers. There is also a pipe connects third container with second one by a plastic tube from the bottom of water filled container to upper portion of the third empty container. The total system is completely gas sealed.

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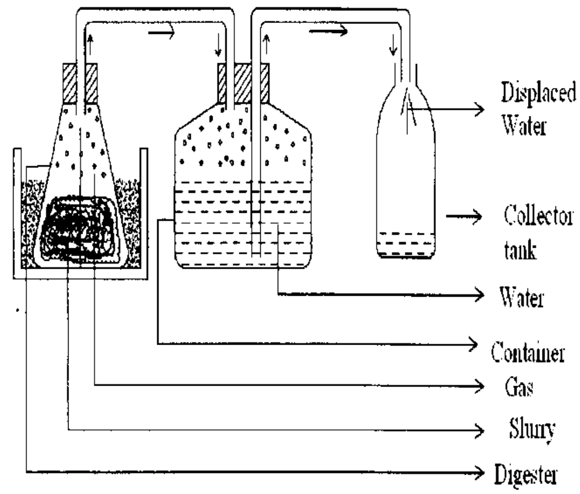

Fig. 2: Schemetic view of the experimental set-Up

2.7 Experimental set-up

The bio-digester was made from a 700 ml conical flask as shown in Fig. 3.Any biogas plant consists of mainly digestion chamber or digester and gas chamber. For producing gas continuously the construction must have a process for continuous feed of raw slurry. Raw material that is the mixture of cow dung and chicken excreta feed into conical flask in 1:1 ratio. The set-up is needed to standardize.The conical flask contains the waste, which will go through anaerobic digestion process, and the first container contains salt water, which will be displaced by the gas pressure. Here we applied Archimedes law. Thus the conical flask and the container are connected by a pipe just connecting the upper portion of two containers. There is also a pipe connects the second container with the first one from the bottom of salt water filled container to upper portion of the second container.The neck of the can was closed with a cork. By using M-seal the neck was made air-tight so as to prevent any escape of biogas. The cork was drilled and plastic T valve was inserted. The bio-digester was placed in the open lab where optimum sunlight is available throughout the day. The study was performed during May to June 2013.

Fig. 3: Experimental set up (Mesophilic)

3. RESULTS AND DISCUSSION

For the production of biogas from mixing of cow dung and chicken excreta with silica gel two experimental set-ups were constructed for mesophilic condition in laboratory. One construction for mixing of cow dung and chicken excreta and another is mixing of cow dung and chicken excreta with silica gel. Then several data have been collected and the collected data have been analyzed to find the total amount gas produced.

In Chittagong cow dung produces per day approximately 4500 ton. That means 1642500 ton per year. By using this huge amount of biogas can be produced. And after production, slurry can use as a fertilizer of agriculture.

The experiment was carried out under ambient temperature range of 26° to 36°C and within a retention period of 22 days.Total gas yield production andthe daily biogas production are graphically presented in Figure 4 and Figure 5 respectively. The digester commenced biogas production within 24hr of its charging. The output gas obtained became flammable within 24hr of charging the digester.

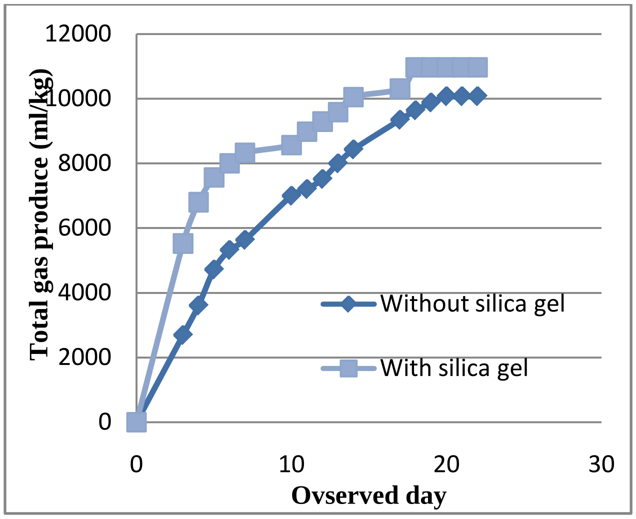

Fig. 4: Total gas produced Vs. Observed day for mesophilic digestion of chicken excreta and cow dung.

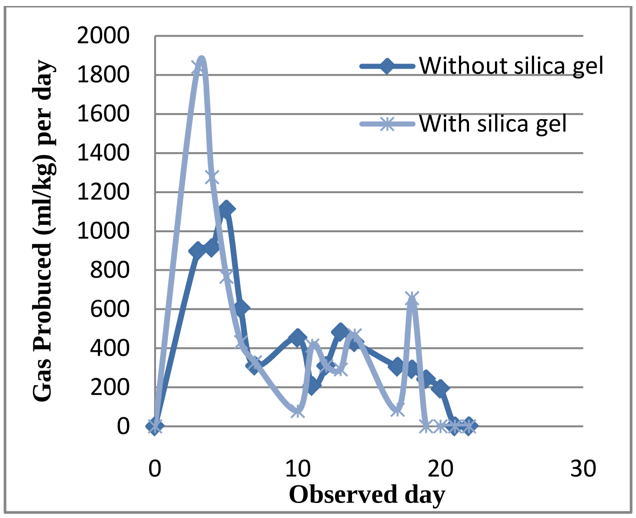

Fig. 5: Gas produced per day Vs. Observed day for mesophilic digestion.

From Figure 4, it is clear that the rate of production of biogas with silica gel is much higher than without silica gel. For rapid production of Biogas within short time silica gel must use. And consequently it is also shown inFigure 5. The rate of production reached a peak in 3 day (with silica gel) and 5 day (without silica gel). It seems almost twice times greater than without silica gel. The average per day production of biogas was 320.1 ml/day (without silica gel) and 407.3 ml/day (with silica gel). However when the flammable biogas production resumed, it was observed that the gas production was quite high and continued long after the blend had nearly stopped production. Overall 11.41L of biogas was accumulated by the end of the retention period. The general accepted mean calorific value of biogas is 20MJ/m3. The energy that can obtain by 11.41L of biogas would be 228KJ. Mentioning above amount of raw material can be used in proper way then a significant amount biogas will be produced. And by utilizing those gas will be produced a large amount of energy. But ambient temperature must be kept within range 25°C to 35°C. For that reason, in winter season biogas production rate is slower than summer season.

A competitive studies of work performed at CUET with present work is presented in Table 2. Amount of raw material approximately are same into Ahamed and present work. But main difference is Ahmed was used cupric nitrate and we used silica gel. Ahamed found that total gas yield 6462.6ml/kg, maximum gas yield per day 253.7 ml and production period was 4th to 45th day. But it took too long time by using cupric nitrate 2 gm and also production amount was quite low. We use silica gel 5 gmand we get total gas yield 10964 ml/kg, avarage gas yield per day 407.3 ml and observation period only 22 days. We measure pH of this raw material and it is 6.9. From our observation we can say that if amount of silica gel increase, required time of production will reduce.

Table 2: Comparison of studies

Reference	Raw materials	Amount of raw material (gm)	Additives	Total production (ml/g)
Hanif [23]	Fish Residue	320	No	90.5
Ahmed [24]	cow dung , poultry waste	280	Cupric nitrate	6462.6
Biswas [25]	Cow dung	320	No	20575
Present work	cow dung and chicken excreta	289	Silica gel	10964

4. CONCLUSION

In developing countries like Bangladesh, more than "80%" of the population lives in the rural areas where more than" 90%" of the energy being consumed comes from non-commercial sources, the major one being fuel wood. The increasing cost of conventional fuel in urban areas necessitates the exploration of other energy sources. Animal and plant wastes are abundant especially in rural areas. Biogas can be produced from cow dung and chicken excreta and peelings as a substitute for fossil fuels.

The result of this research on the production of biogas from cow dung waste has shown that flammable biogas can be produced from these wastes through anaerobic digestion for biogas generation. These wastes are always available in our environment and can be used as a source of fuel if managed properly. The study revealed further that cow dung and chicken excreta waste as animal waste has great potentials for generation of biogas and its use should be encouraged due to its early retention time and found that temperature variation and concentration of total solid etc. are some of the factors that affected the volume yield of biogas production. Biogas technology can be a viable development option for developing countries for energy production and substitution if properly managed and marketed.

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