Production of Biogas from Food Waste

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Abstract – *Biogas is a renewable resource which can be used to meet today's energy needs. Biogas is a mixture of gases produced from different sources during anaerobic digestion. Simple batch digesters were used for testing biogas production from different feeds. Each digester was fabricated to maintain the anaerobic conditions. Tire tubes were used for collecting the gas. Cow dung, cooked food, Fruit waste and Rice husk were used to study the biogas production for 30 days. No optimization was done in order to check the gas production under purely natural conditions. The gas obtained was subjected to Gas Chromatography to analyze the composition of gas.*

***Key Words*: Sustainable Environment, Food Waste, Biogas.**

1. Introduction *:*

Energy has always played a vital role for providing the essential needs and substance to fuel he growth and development of the civilization. The need of energy has continued to rise throughout the time which has led to a drastic impact on the sources which have provide the same. The sources which include petroleum, LPG, coal etc. are at a risk of getting exhausted due to which there is a pressure regarding the demand and supply on the above. This has led to an increase in cost of the said sources, thereby putting pressure on the economics of the middle class people. In India, it is evident that 80% of the 1.35 billion people rely on LPG for their daily household chores and the rest 20% rely on different sources such as coal, fire wood, dung cakes etc. This not only contributes to the economics but also causes pollution in the environment leading to disastrous changes.

To reduce the frequency of such changes, a different perspective has to be adopted and that comes from the renewable sources of energy. These sources are available in infinite proportions ad do not cause any harm to the environment. There are number of renewable energy sources which include Hydro- electric energy, Solar energy, Wind energy etc. These sources are no doubt very effective in maintaining the atmosphere but, have not been exploited owing to their initial cost of setup. The maintenance and the cost of setup is comparably very high. In order to compensate for the same, a long and obsolete method named Biogas come into limelight, which promised better fuel recovery along with cheaper setup and operating cost to benefit the concerned people.

2. Mechanism of Biogas Production

The process of production of Biogas occurs through the degradation of any possible organic source by anaerobic digestion i.e. in the absence of the air or oxygen. Degradation of such organic source leads to the formation of biogas is a mixture of different gas including Methane and other nonessential gases including Hydrogen Sulphide, Carbon Dioxide and few other gases. Almost every organic waste is the eminent source of energy. Anaerobic digestion is a bio-physio chemical process that depends on various physical parameters like Temperature, pH etc. Chemically it is a multi-step process and more appropriately, it is a four stage process which is catalyzed by different kinds of bacteria at the various stages.

The stages are-

Hydrolysis: It is the process of breaking down of complex and large organic molecules into the soluble monomer and oligomer units. It is one of the important steps for the quantity production of biogas as all the molecules are not easily absorbed. This process is carried out by enzymes derived from various fermentative bacteria that cleaves the complex molecules into the simpler ones. Hydrolysis is carried out by the class of hydrolytic bacteria such as Bacteroides, Clostridium and Acetivibrio. The end products of this reaction are soluble sugar, hydrocarbon, amino acids, glycerol and a long chain of carboxylic acids. It finally results in the breakdown of complex organic substance into the monomeric units of Glucose and Hydrogen. you begin to format your paper, first write and save the content as a separate text file. Keep your text and graphic files separate until after the text has been formatted and styled. Do not use hard tabs, and limit use of hard returns to only one return at the end of a paragraph. Do not add any kind of pagination anywhere in the paper. Do not number text heads-the template will do that for you.

Acid Formation steps: It is comprises of two steps which is Acidogenesis and Acetogenesis.

Acidogenesis: It is the process where the products of hydrolysis further convert into organic acids like acetic acids, butyric acids, propionic acids etc. The reaction of acidogenesis is fascinated by the activity of bacterium belonging to class Acetobacterium and Eubacterium.

Acetogenesis: In this, the product of acidogenesis is further oxidized into the simpler forms. This stage shows a symbiotic association of the two different phases that is the oxidation and methanogenesis. This is the stage where some microbes in the mixture of all the different microbial consortium start catalyzing the production of methane or at this stage, we start getting methane by the activity of methanogenesis. Alcohols, Amino acids, various fatty acids act as substrates for the essential conversion. The general bacterial involved in the activity of acetogenesis are Clostridium and Syntrobacter.

3. Feeding Digester

After the digesters were filled with the substrate, valves connecting them to storage tubes were opened. All these digesters were checked for the leakage from time to time. As these tanks were left in the open sun, the leakage was inevitable. But the leakage was sealed efficiently with m-seal, fevicol and PVC glue. Practically, leakage was found in every digester and tube which affected the amount of gas production. It was found that there was 10%-15% loss of gas when compared the practical valves with theoretical values.

The following table shows the values of feed in each digester:

Table-1

Substrate	Startup Culture in Kg	Amount of Substrate in Kg	Amount of Water in Kg	Total	Ratio (Substrate : Water)
Cow Dung	5	6	6	17	1:1
Cooked Food Waste	5	6	6	17	1:1
Fruit Waste	5	6	6	17	1:1
Rice Husk	5	4	8	17	1:2

4. Gas Produced :

From the table it is clearly evident that the gas production from the cooked food is greater than all the other substrates.

Table-2

Time in Days	Cow Dung	Cooked Food	Fruit Waste	Rice Husk
0-15	No Biogas (co2)	No Biogas (co2)	No Biogas (co2)	No Biogas (co2)
15- 20	54g	155g	88g	15g
20- 25	31g	94g	62g	12g
25-30	23g	71g	60g	10g
Total	171g	440g	257g	37g

The gas production in rice husk is very low which might be because of the lingo cellulosic material.

The following table gives the information of an amount of gas produced with respect to days.

5. Simulation

It was done in order to represent the relation between values for the sole purpose of making an effective study of the biogas production obtained. The relation between μmax and Xf/Xo were defined with μmax representing the maximum growth rate of the biomass per day for efficient batch process.

For theoretical Biomass concentration: $Tb = 1/\mu max. \ln(Xf/Xo)$

Where, Xf= Final biomass concentration, Xo= Intial biomass concentration.

Table-3 : Simulation of cooked food

Serial Number	Days (Tb)	Xf (g/l)	Gas Production (g/l)
1	1	1.25	0.13
2	5	3.03	0.32
3	10	9.21	0.97
4	15	27.94	2.95
5	20	84.77	8.96
6	25	257.24	27.19
7	30	780.55	82.50

Results:

Table-4: Simulation of Fruit Waste

Serial Number	Days (Tb)	Xf (g/l)	Gas Production (g/l)
1	1	1.25	0.07
2	5	3.03	0.19
3	10	9.21	0.58
4	15	27.94	1.78
5	20	84.77	5.37
6	25	257.24	16.31
7	30	780.55	49.5

After giving a retention time of 30 days, and getting enough gas in the storage tanks, we took our samples at Sardar Swaran Singh National Institute of Renewable Energy (SSS-NIRE) for having gas chromatography.

We got results for GC which are:

S.No.	Substrate	Methane (CH_4) %	Carbon Dioxide (CO_2) %	Nitrogen (N_2) %	Oxygen (O_2) %	Trace Gases %
1	Cow Dung	55.4	34	8.4	0.5	1.7
2	Cooked Food	50.21	29.05	15.64	1.22	3.88
3	Fruit Waste	41.21	28.64	26.02	2.24	1.89

7. Conclusions

As the substrates vary in terms of amount and type of materials present. Cooked food produced moderate amount of methane owing to the presence of starch in the feed, which contributed to the production of non-essential gases. Fruit waste and Rice husk produced the least amount of methane largely because of the presence of lingo cellulosic material. The presence of moisture also lead to the decrease in quantity of biogas which again could have been controlled by using activated charcoal leading to increased cost.

This project was indeed performed keeping in mind the economics of the people and the results have shown that gas production is indeed possible and achievable using simplest of techniques with the only requirements being the HRT of 30 days along with the collection and proper utilization of the feed of interest.

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