Sustainable Method Of Solid Waste Management: Anaerobic Digestion For Canteen Waste

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Abstract *-Considering a present scenario there is a peak demand for energy in our country.Energy from the waste is one of the best methods to overcome this demand. Biogascan be obtain from the waste by "Anaerobic Digestion Process" .The anaerobicdigestion process is the biological oxidation of organic matter by the action ofmicroorganisms in the absence of atmospheric oxygen. Organic matter is convertedinto stable end products at the same time; the process generates biogas (mainlymethane and carbon dioxide).*

Conventionally cow dung is used for production of biogas .We are using food wastein addition to cow dung to generate biogas efficiently. As food waste is organicmaterial having the high calorific value and nutritive value to microbes, it increasesefficiency of methane production. The waste has been taken from the collegecanteen. The Pilot Model work has been done in anaerobic digestion tank havingcapacity 400 liter. The potential of biogas generation is expected to be increased and cost is also expected to be reduced based on the replacement of LPG.

IndexTerms- Anaerobic digestion, Food Waste, Biogas, LPG.

I. INTRODUCTION

Now a day's whole world is facing huge problem of solid waste, it is estimated that the total solid waste generated by 300 million people living in urban India is 38 million tonnes per year[Manual on MSW IST Edition May 2000]. The collection and disposal municipal solid waste is one of the pressing problems of city life, which has assumed great importance in the recent past. The proper disposal of urban waste is not only absolutely necessary for the preservation and improvement of public health but it has an immense potential for resource recovery.

It is now well recognized that sustainable development to overcome on the problems of waste disposal can only be achieved if society in general and industry produces 'more with less' i.e. more goods and services with less use of world's resource and less pollution and waste.

Food waste generated from residences, canteens, hotels also need to be manage cause everyday this waste can be generates in large quantity and also the problem of disposal in environment therefore, sustainable development of biogas technology is the vital in need.

II. IDENTIFY RESEARCH AND COLLECTION

According to Taleghani and Kia (2005) observed, In today's world there is limited resources like fossil fuels, coal, minerals etc. and the excess use of it creates the problem of pollution and ozone depletion Therefore there is a need of renewable sources utilization such as biogas, tidal, wind, solar etc. Biogas is very economical and cheap resources which decrease the greenhouse gases like Methane, carbon dioxide also the waste from it can be used as manure for various plants and increasing fertility capacity of the land.

Jantsch and Mattiasson (2004) discuss 'Anaerobic Digestion' is a biological process that occurs in the absence of oxygen and in the presence of anaerobic organisms and yields biogas. By the proper maintenance the stability of the plant increases also the organic load is kept minimum. Factors affecting the biogas production are temperature, loading rate, solid concentration, pH value, retention period, nutrients concentration, toxic substance.

Firstly we had visited the conventional type of compact biogas plant which is situated in Nashik region in Meeri at one of the residential user. It is compact biogas plant which uses food waste rather than any cow dung as feed stock, to supply biogas for cooking. Just 2 kg of such feedstock produces about 500 g of methane, and the reaction is completed with 24 hours. The conventional biogas systems, using cattle dung, sewerage, etc. use about 40 kg feedstock to produce the same quantity of methane, and require about 40 days completing the reaction. So we think about alteration for such model which produces more quantity of gas in less time and cost with maximum food waste management.so here we made a pilot model which works on canteen waste feeding and gas generated can be use itself as fuel for cooking in canteen on everyday basis.So regarding biogas and its production we have adopted the following method and modifications as discuss below:

III. MATERIALS AND METHODS

For designing our model capacity, we note that quantity of waste generated daily from our collage canteen and it wasa 10kg of food waste.It contains the cooked and uncooked rice, vegetables, damage or over dried fruits, grains. This waste is crushed by mixer grinder and slurry was prepared mixing with equal quantity of water.

Working of pilot model:

1. Firstly we fed the digested slurry of 100lit. which is taken from the another biogas plant(as shown in pic.5) for the purpose is to make a culture of the microorganisms so that when fresh food waste is added then biogas production is enhanced, for initial starting of the plant the slurry takes 3 to 4 days to start producing the gas, after that the 10kg of food waste is collected and grinded into the grinder(as shown in pic.6) this waste is converted into the slurry by mixing of equal quantity of water into it the loading increases gradually from 0.5kg upto 15kg.

2. Continuous Feeding of slurry is done for several days to fill the predigester fully. In predigester the pre-acidification process i.e. 'Hydrolysis'

3.At the predigester the slurry is partially digested and then it is transferred to the main digester by liquid flow through outlet of predigester and inlet of main digester respectively. The hot water is also mixed with the waste to maintain the temperature in the range of 30 – 40^{o} c.

4. From the predigester tank, the slurry enters into the main digester, there is partition made up of wooden plank which divides the digester into two compartments having capacity 200lit each. At this stage the digestion process is started. 'Digestion' is a biological process that occurs in the absence of oxygen and in the presence of anaerobic organisms at ambient pressure and temperatures of 35-40ºc. We are maintaining the temperature into the digester range 30-37 ºc residence time over 20 days called 'Mesophilic Digestion'

5. The gas produced in the main digester and gets collected in gas holder tank because, methane is lighter than air. The tank is slowly lifted up to the maximum height of 0.30m. At the top of the tank the gas outlet valve is provided to easily removal of the gas by user's requirement.

6. Furthermore, the gas pipeline is connected to the gas stove there are chances of negative pressure at the pipe end which may suck in the outside air into the tank. This flow is known as back flow. This can be avoided by placing ballast on top of the gas holder tank. The ballast in the form of old car tyres, bricks, heavy weight stone etc. After placing the ballast, open the valve and check the gas flow. You can hear a hissing noise when the gas is flowing out. Also the gas flow can be checked out by placing your fingers in front of the gas valve opening.

Lab work and testing: The samples were collected at the inlet and outlet of the plant is tested. The more common analyses used to characterized food waste plant are:

1. Moisture Content
2. pH Value
3. BOD
4. COD
5. Total Solids (Fixed solids, Volatile solids)
6. NPK Value
7. Carbon/Nitrogen Ratio

Moisture Content: Moisture content of food waste is usuallyexpressed as the weight of moisture per unit of wet material.
Moisture content (%) = [(wet weight – dry weight)/ (dry weight)] X 100

pH Value: This is the concentration of hydrogen ions in solution and indicates the level of acidity or alkalinity of an aqueous solution. If the pH of the solid waste is outside the range 5-10, there may be considerable interference with biological processes. The range of pH for food waste is 6-8.

Biochemical oxygen demand (BOD): BOD is defined as the amount of dissolved oxygen required by bacteria to oxidize the decomposable organic matter, present inwastewater under aerobic condition. BOD is the amount of oxygen used by organisms while consuming organic matter in a solid waste sample. It is possible to assess theperformance of a solid waste by measuring the BOD_5 of the inlet and the outlet.

Chemical oxygen demand (COD): The COD is a measure of the oxygen equivalent of the organic matter content of a sample that is subjected to oxidation by a strong chemical oxidant. The test is extensively used because it takes less time (about 3 hours) than other tests such as the BOD_5, which takes 5 days.

Total solids (TS): This is the sum of the organic and inorganic solids concentrations and can be subdivided into suspended and dissolved solids. Generally, comprises of 70% organic and 30% inorganic solids and can be removed by physical or mechanical means.

Total volatile solids: Indicate amount of organic matter present in wastewater.

Total fixed solids: Indicate amount of inert inorganic matter present in wastewater.

NPK value: The sludge has good manorial value of Nitrogen, Phosphorous, Potassium (NPK: 1.6:0.85:0.93) and it is observed to drain easily.

Carbon/Nitrogen Ratio: Average C/N Ratio of about 24.

IV. RESULT AND DISCUSSION

Table 1: Gas Production Rate

Day	Mass of Feed (kg)	Height of Tank above digester liquid level (m)	Volume of Gas (m^3)
1.	0.5	0	0
2.	1.0	0	0
3.	1.5	1.5	0.753
4.	3	1.52	0.769
5.	5	1.54	0.794
6.	10	1.58	0.839
7.	10	1.59	0.889

The model plant is started with digested slurry and food wastes then we are getting result of biogas yield from this organic waste after 7 days. The rate of loading increases slowly to stabilize the digester, table contains measurement of volume of biogas produced day by day.

1. Moisture Content: At Inlet: 77.76%
At Outlet: 79.40%

This is due to the fact that during digestion of the waste the total solids have been decreased and thus the water content in the waste has been increased.

Table 2: Day to day pH and temperature values

Day	pH	T^0C
1	7.9	36
2	7.8	36
3	7.5	36
4	7.4	37
5	7.2	35
6	7.01	34
7	6.8	36

There is variations in the main digester performance were observed in the period of digestion, the observed pH of 6.8 to 7.9 were primarily within the acceptable range for anaerobic digestion for the entire operation. This implies average buffering capacity of the mixed substrate.

Table 3: Percentage reduction of BOD and COD at Inlet and Outlet

Location	BOD	COD
At Inlet	200-800mg/lit.	400-1000mg/lit.
At Outlet	100-400mg/lit.	260-600mg/lit.
% Reduction	50-55%	35-40%

Total Solids: At Inlet: 3230 mg/lit.
At Outlet: 2843.33 mg/lit.
Total Volatile Solids: At Inlet: 3193.33 mg/lit.
At Outlet: 2806.67 mg/lit.
Total Fixed Solids: At Inlet: 16.67 mg/lit.
At Outlet: 36.67 mg/lit.
At inlet the concentration of total solids & volatile solids is more than the outlet. After the completion of anaerobic digestion process this concentration get reduces. Therefore, it indicates that the continuous feeding for digestion process is very well efficient in removing the total solids.

Costreduction using biogas:

Byusingbiogaswehave reducedRs.2, 29,950 (1250/2) X (365)peryear.We have taken the survey that in college canteen they are using 3 cylinders per day and canteen waste is 10kg/day . We can produce 9.5kg (half cylinder/day)of biogas from the canteen waste per day we can save182.5cylinders/year and cost reduced is2,29,950/year.

Table 4: Cost estimating for pilot model

Sr. No.	Description	Amount (Rs.)

1.	PVCtanks 750lit.(2nos.)	6750/-
2.	PVC pipe and fittings	2511/-
3.	Water jacket	2500/-
4.	Steel arrangement	1000/-
5.	Total	12761/-

V. CONCLUSION

The Sustainable method of solid waste management by biogas is most suitable, efficient andeconomical. Since food waste is easily biodegradable and is having high volatile solids, it can be potentially used as a feed stock for biogas production. Thus continuous feeding helps in daily biogas production and can be used at a small as well as larger scale to manage the organic waste and also produce the energy which can be used for the domestic and commercial purpose like cooking, lighting etc. Also converting the food waste into biogas not only becomes an alternative source of energy but also helps in reducing the methane production from organic waste which is one of the greenhouse gases. By this project we also develop the awareness in the public about biogas generation by food waste.

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