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Sustainable Method Of Solid Waste Management: Anaerobic Digestion

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Abstract— The present scenario foresees the peak demand for energy in our country. The harvesting the energy from the waste is one of the best methods to overcome this demand. Biogas can be obtained from the waste by anaerobic digestion process. The anaerobic digestion process is the biological oxidation of organic matter by action of microorganism in the absence of atmospheric oxygen. Organic matter after degradation in turn generates the stable product with biogas.

The objective of this study is to explore the food waste leachate as a power source for bio-gas generation in anaerobic digester by studying the exceptional parameters like COD, BOD and bio-gas generation. Conventionally cow dung is used for production of biogas. We are using organic waste in addition to cow dung to generate biogas efficiently. As organic material having the high calorific value and nutritive value to microbes, it increases efficiency of methane production. The approach and technical procedure need to be explored to reduce the bio-gas cost and to increase its potential. The Pilot model work has been done in anaerobic digestion tank. The potential of biogas generation is expected to be increased and cost is also expected to be reduced based on the replacement of LPG.

Keywords— Anaerobic Digestion, Food Waste, leachate, Biogas, COD

I. INTRODUCTION

During the past decades, whole world is facing enormous problem of solid waste management the total solid waste generated per year is in huge quantity all over the world and our country is also part of this, so it is necessary to find sustainable method for solid waste management, Increasing population, booming economy, rapid urbanization and the rise in community living standards have significantly accelerated the solid waste generation in the world. Solid waste has become one of the global environmental issues. Continuous depletion of natural finite resources is leading the globe to an uncertain future. On other hand due to scarcity of petroleum and coal it threatens supply of fuel throughout the world also problem of their combustion leads to research in different corners to get access the new sources of energy, like renewable energy resources. Solar energy, wind energy, different thermal and hydro sources of energy, biogas are all renewable energy sources. Increasing municipal waste has become one of the major environmental concerns in modern cities. Food waste was generally dumped with other municipal solid waste or discharged to the ocean. However, land filling of food waste has been prohibited since 2005 and marine disposal of food waste has been banned. The tremendous growth of food waste production, the management strategic for food waste has raise a lot of environmental issue. Due to high moisture content, high clarify value and easy decay of organic waste, current management practice of food waste disposal is less satisfactory in terms of unsustainable resources recycle great environmental impact and costly investment. Renewable energy obtained from organic waste as an alternative energy source. Using bio gas as an alternate source of energy is gaining more attention globally in recent decades. There have been an increasing number of studies performed to evaluate the conversion of waste streams such as animal manure, municipal solid waste, energy crops, municipal bio-solids and food waste to

biogas. According to International Energy Association, there are over 9000 anaerobic digester in operation using this material to produce biogas. The practice of converting waste to energy provides two benefits of environmental protection and energy recovery.

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.

Carrasco et al (2004) studied the feasibility for dairy cow waste to be used in anaerobic digestive system. Because the animal's wastes are more reactive than other cow waste, the study suggests dairy cow waste should be chosen over other animal wastes. Thomsen et al (2004) found that increasing oxygen pressure during wet oxidation on the digested bio waste increased the total amount of methane yield. Specifically, the yield which is normally 50 to 60% increased by 35 to 40% demonstrate the increased ability to retrieve methane to produce economic benefits. Cho and park (1995) proposed using substrate as a food waste in Anaerobic Digester Bio-gas yields 472 ml CH4/g. Ye at al (2011) reported that using a fresh leachate in UASB bio gas generated is 0.31CH4/g.

Lissens et al. (2004) completed a study on a biogas operation to increase the total biogas yield from 50% available biogas to 90% using several treatments including: a Mesophilic laboratory scale continuously stirred tank reactor, an up flow biofilm reactor, a fibre liquefaction reactor releasing the bacteria Fibrobacter succinogenes and a system that adds water during the process. These methods were sufficient in bringing about large increases to the total yield; however, the study was under a very controlled method, which leaves room for error when used under varying conditions. However, Bouallagui et al. (2004) did determine that minor influxes in temperature do not severely impact the anaerobic digestion for biogas production.

III. CURRENT PRACTICE FOR DISPOSAL OF SOLID WASTE IN NASIK CITY

1. The solid waste is collect and transport from city in tractors.
2. The transported waste is then heaped on the concrete platform having drainage facilities.
3. The water & culture slurry is spread on garbage so as to accelerate the process of cellulose digestion, which is carried out in the presence of microbes.
4. The total processing period is of 28 days. Each heap is turned inside out after every 7 days.

5 During this heat is generated due to the oxidation, which is allowed to spread uniformly

IV. PROBLEM DEFINITION

1. It requires labor for loading the solid waste in trucks or tractors, which result in extra cost.
2. The transportation of vehicles requires fuel, which again leads to addition in cost.
3. The vehicles emit gases, which leads to air pollution.
4. The waste is dumped in open, which leads to air pollution.
5. Foul gases are produced & this results in unhygienic conditions.

6. Lot of heat is generated due to the process of oxidation.
7. Non-degradable matter like plastic & glass materials are to be removed manually at early stages of processing.

V. SITES VISITED

5.1 Household type biogas plant situated at Meri, Nashik.

The plant is established by ARTI Institute of technology, Pune consist of two water tanks. Digester tank Capacity 1000 lit. And Gas holding tank capacity 750 lit. Starchy and Sugary waste material obtained from kitchen is used as feedstock. Daily 1kg of feeding along with 1 lit water is required. This will keep the biogas burner on for 1.5 hrs. Adequate to cook meal for a family of 4-5 people.

5.2BGFP Project at Village-Talwade, Tal-Trimbakeshwar, Dist.-Nashik (M.S.) (Ashoka Biogreen Pvt. Ltd.)

This is large scale plant and it is working on the feeding of cow dung + water only. Feeding of 10 tonne cow dung and 10 tons water is also added, it consist predigested which serves the purpose of partially digesting the waste before it transfers to the main digester. It also helps to increase retention time of feedstock resulting in reduction into retention time of whole plant process. Due to predigested the digestion process gets accelerated.

For designing our model capacity, we note that quantity of waste generated daily from our collage canteen and it waste 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.

VI. METHODOLOY

6.1 Working of pilot model:

1. Firstly we fed the digested slurry of 40lit. which is taken from the another biogas plant 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 this waste is converted into the slurry by mixing of equal quantity of water into it the loading increases gradually from 0.5kg up to 15kg.
2. Continuous Feeding of slurry is done for several days to fill the predigested fully. In predigested the pre-acidification process i.e. ‘Hydrolysis’
3. At the predigested the slurry is partially digested and then it is transferred to the main digester by liquid flow through outlet of predigested and inlet of main digester respectively. The hot water is also mixed with the waste to maintain the temperature in the range of 30 – 40o c.
4. From the predigested 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 tires, 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.

VII. 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 usually expressed 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 in wastewater 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 the performance of a solid waste by measuring the BOD5 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 BOD5, 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.

VIII. RESULT AND DISCUSSION

Table 1: Organic food waste characteristics

Composition	Quantity	Unit
Moisture content	75-90	%
pH	7.0-7.5	-
BOD	110-400	mg/ lit
COD	250-1000	mg/ lit

Table 2: Gas Production Rate

Day	Mass of Feed (kg)	Volume of Gas (m^3)	Cumulative volume of biogas (m^3)
1.	0.5	0	0
2.	1.0	0	0
3.	1.5	0.659	0.659
4.	2.0	0.752	1.411
5.	2.5	0.793	2.204
6.	3.0	0.895	3.099
7.	3.5	0.989	3.998

Table 3 : Day to day pH and temperature values

Day	PH	Temperature
1	7.9	36
2	7.8	36
3	7.5	36
4	7.4	37
5	7.2	36
6	7.01	37
7	6.8	36
8	6.7	34

IX. CONCLUSION

The Sustainable method of solid waste management by biogas is most suitable, efficient and economical. 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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