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PRODUCTION OF BIOGAS USING FOOD WASTE FROM SRIT HOSTEL

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Abstract:

Biogas is typically a gas produced by the anaerobic digestion of biodegradable materials. One of the most promising processes for the energetic transformation of waste is the anaerobic digestion of waste to produce biogas. Food waste, which has become one of global concerns because of its massive amount, contains high organic content, which is used by the microbes as nutrients. The present project aims at production of biogas using food waste generated from SRIT hostel. Our institution has three hostels and two messes, cooking food for more than 1000 students, and there is large quantity of food waste generated daily. The option available for the management of this huge waste is animal feed. So this large quantity of food waste generated should be utilized for better purposes. A survey is carried out and it was found that average food waste generated per person is 243g. The set up consists of a digester which is of 2.75 litres capacity and it was filled with 2/3rd of its capacity with mixed food waste and cow dung in 1: 1 proportion. The initial and final characteristics of the feedstock, such as pH, total solids, volatile solids, C/N ratio and COD are analyzed. The volumetric yield of biogas is noted at regular intervals using water displacement method. The cumulative quantity of biogas produced for 31 days is 565 cm^3 per 900 gram of feedstock.

Key Words: Biogas, Anaerobic Digestion, Digester, Total Solids, Volatile Solids & C/N Ratio

1. Introduction:

The burning inconveniences that are faced by the world today are efficient management of all types of wastes and energy crisis. Rapid growth of population and uncontrolled and unmonitored urbanization has posed serious problems of energy crisis and solid waste disposal. The generation of municipal solid waste (MSW) continues to increase worldwide. Current global municipal solid waste (MSW) generation level is 1.3 billion tons per year, and is expected to increase to approximately 2.2 billion tons per year by 2025. In MSW concerns, Food waste has become one of global concerns because of its production in massive amount in line with economic development and population growth. Accounting for 37–55 % of the total MSW is an organic fraction. Disposal of MSW is a major solicitude nowadays in most areas of developed and developing countries and the improper management of it creates human health and environmental problems. Nowadays, the most common methods of disposal are incineration, land filling, composting etc. Often, the waste which is disposed in landfill or inadequate management of wastes like uncontrolled dumping leads to polluting surface and groundwater through leachate. In light of rapidly rising costs, scarcity of petroleum and coal and other associated energy crisis have led to the various researches on the new sources of energy that will leave less of an environmental 'footprint' than coal or oil, and that will be more sustainable. The most promising solution to this is the usage of renewable sources of energy and cut down the usage of depleting fossil fuels. Biomass has globally remained renewable energy source and there are many new technologies currently available for producing energy from biomass such as gasification, ethanol fermentation, anaerobic digestion, trans-esterification etc. Anaerobic digestion has become one of the efficient methods, in this regard. As food waste contains large amount of organic substrate content and putricible matter it is considered to be a source of energy instead of waste. The production of biogas through anaerobic digestion offers significant advantages over other forms of bio energy production. In anaerobic digestion, organic materials are degraded by bacteria, in the absence of oxygen, converting it into a methane and carbon dioxide mixture. The digestate or slurry from the digester is rich in ammonium and other nutrients used as an organic fertilizer. In Anaerobic digestion, the conversion of complex organic compounds which are found in organic wastes, into methane and carbon dioxide requires different groups of microorganisms and is carried out in a sequence of four stages, namely hydrolysis, acidogenesis, acetogenesis and methanogenesis.

2. Methods:

Food Waste Collection and Analysis: The survey of food waste was done in the messes of the hostels of Sri Ramakrishna Institute of Technology (SRIT) at Coimbatore in Tamilnadu, to determine the amount of food waste generated from the hostels. There are three hostels in the campus cooking food for more than 1000 students. The survey was conducted at the 2 messes on daily basis mentioned below during a week in the month of January and February 2017. The collected food waste sample was physically assessed and was found to consist of the following mixture: cooked rice in major portion, vegetable peelings, tomato, brinjal, cabbage, beet root, radish and cereals. All collected samples along with kitchen waste were analyzed for pH, COD, C/N ratio, total solids (TS) and volatile solids (VS) contents according to the standard methods of American Public Health Association (APHA).

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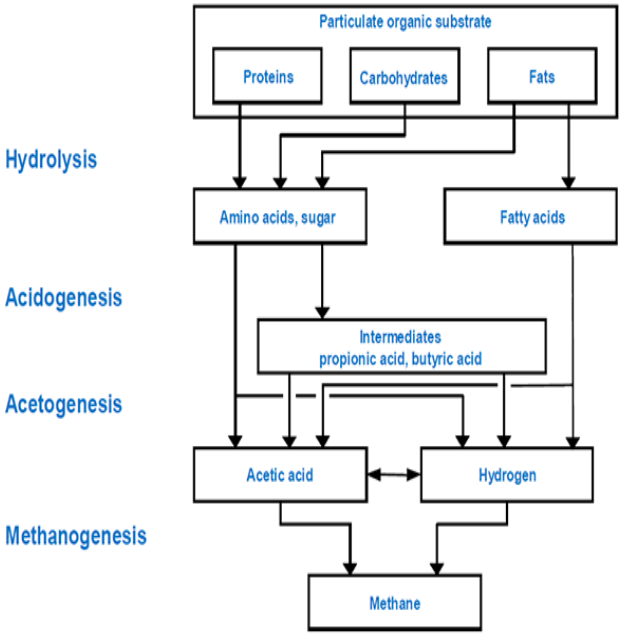

Figure 1.1: Anaerobic digestion process

Cow dung slurry was used as a source of inoculum since rumen of cow contains anaerobic microbial population. It is used for co digestion in the anaerobic digestion. And the used inoculum was one day old and it was collected from nearby area.

Preparation of Feedstock: These materials were collected and the non-biodegradable wastes were removed. After that, these wastes were shredded and grinded well, using a mixer and was made into a homogenous mixture. That is the preparation of the feedstock included homogenization in a kitchen blender, diluting with water and sampling for further analysis and feeding inside the digester.450 g of food waste was weighed and mixed with 450 g of cow dung that is in 1:1 proportion. The food wastes were grinded and mixed thoroughly with cow dung. The mixture was then thoroughly mixed with 900ml of water. This was used as feedstock.

Experimental Set Up: The pilot plant set up was done for the anaerobic digestion of feedstock to produce biogas. The experimental setup consists of 3 units they are, digester, gas collecting unit and measuring unit. A glass digester of capacity 2.75 litres is used as digester. And a plastic can of 5 litre capacity, with brine solution inside is used to collect gas from digester, through a gas pipe from the digester. The gas from the digester compresses the brine solution which is then transferred to the measuring jar through outlet provided at the bottom of gas collecting unit. Thus when gas is produced, there will be increase in the level of water in the measuring jar. The digester setup is shown in figure.

Figure 2.1: Pilot plant setup

Feeding of the Digester: The mode of feeding used was batch feeding. The digester was filled with two third of its capacity with food waste and cow dung in definite proportion. The mixture of the co digestion, were then poured into the digester for anaerobic digestion.

Biogas Measurement: The biogas measurement is done using water displacement method. This method was adopted for the pilot plant based volume measurement of biogas because it is inexpensive, easy to set up, robust, capable of working for long periods without maintenance. The height of water in the measuring cylinder is monitored daily. The increase in level of water indicates the production of biogas.

3. Results and Discussions:

Characteristics of Food Waste and Feed Stock: The preliminary survey of the food generated was done. From the survey conducted it was estimated that, average food waste generated per person is 243g. All the values for TS and VS are reported on wet weight basis. The initial characteristics of food waste and feed stock are tabulated below the table 3.1 and table 3.2.

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Table 3.1: Characteristics of food waste

S.No	Characteristics	Values
1	pH	5.8
2	Total Solids (TS) %	30.9
3	Volatile solids (VS) %	26.35
4	VS/TS %	85.30
5	COD (mg/l)	5000

Table 3.2: Characteristics of feed stock

S.No	Characteristics	Values
1	pH	6.99
2	Total Solids (TS) %	24.86
3	Volatile solids (VS) %	19.32
4	VS/TS %	77.71
5	COD (mg/l)	3400
6	C/N ratio	22.8

Bio Gas Production: The pH of feedstock is nearly 7, resulted in this range suitable for digestion process. The experiment was carried out under mesophilic condition which is favorable for digestion process. The temperature outside the digester was found to be 29°C and the slurry temperature was 32°C. In particular, during a first period of about 16 days, there is no biogas production in digester. This phase was characterized by organic matter hydrolysis and VFA production.

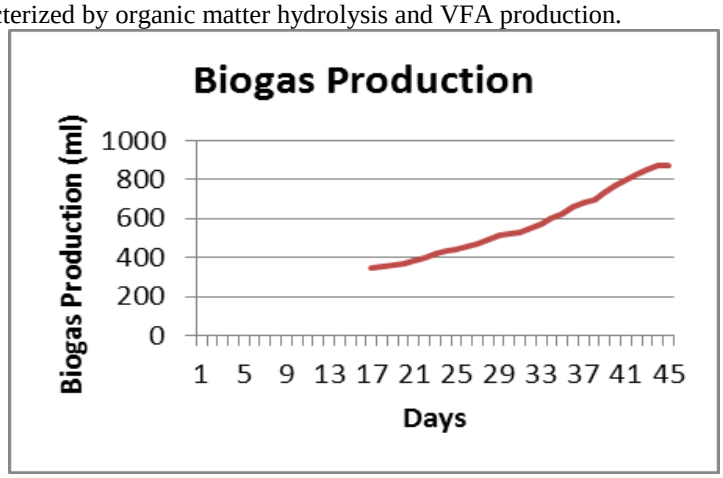

Figure 3.2: Biogas Production Rate

The biogas production started on the 17th day from the start of the experiment. Soon after the gas production started in the digester. On 26rd day the biogas caught flame for the first time and it burned with a blue flame which continued for about 8 seconds. Initially the flame of matchstick extinguished when it was brought near the graduated beaker, containing gas. This indicated that the gas was not rich in methane and that the produced gas was probably rich in CO_2. On 34nd day the biogas caught flame for the second time and it burned with a blue flame continuously which indicates rich in methane. The biogas measurement was done using water displacement method. It was monitored daily by determining the height of water in the measuring cylinder. This method was adopted for the pilot plant based volume measurement of biogas because it is inexpensive, easy to set up, robust, capable of working for long periods without maintenance. The amount of water increased when there was production of gas. The methane production for particular day can be obtained by subtracting the previous water level from the current water level. And also the total volume of biogas produced for about were recorded

4. Conclusion:

From the present study it can be inferred that the food waste generated from our institution has the potential to produce biogas under the prevailing mesophilic conditions. The volumetric yield of biogas was noted at regular intervals that is daily using water displacement method. The food waste along with cow dung when used in co digestion, the quantity of biogas produced was 565cm^3 per 900 gram of feedstock for the hydraulic retention period of about 31 days. The initial characterization of food waste, cow dung and feedstock were done.

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