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Analysis on Different Operational Parameters of a Biogas Plant using Kitchen waste

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Abstract

The objective of this work is to create biogas which will be more cost effective, eco-friendly, cut down on landfill waste, generate a high-quality renewable fuel, and reduce carbon dioxide & methane emissions. Overall by creating biogas reactors on campus in the backyard of our hostels will be beneficial. Kitchen (food waste) was collected from different sources as feedstock for our reactor which works as anaerobic digester system to produce biogas energy. The anaerobic digestion of kitchen waste produces biogas, a valuable energy resource anaerobic digestion is a microbial process for production of biogas, which consist of primarily methane (CH_4) & carbon dioxide (CO_2). Biogas can be used as energy source and also for numerous purposes. But, any possible applications require knowledge & information about the composition and quantity of constituents in the biogas produced. The continuously-fed digester requires addition of sodium hydroxide (NaOH) to maintain the alkalinity and pH to 7. For this reactor we have prepared our Inoculum than we installed batch reactors, to which inoculum of previous cow dung slurry along with the kitchen waste was added to develop our own inoculum. A combination of these mixed inoculum was used for biogas production at 37°C in laboratory(small scale) reactor (20L capacity) In our study, the production of biogas and methane is done from the starch-rich and sugary material and is determined at laboratory scale using the simple digesters.

Keywords: Biogas; Kitchen waste; anaerobic digestion; inoculum.

1. INTRODUCTION

Inadequate management like uncontrolled dumping bears several adverse environmental and public health problem besides destroying the city's beauty and hindering cultural and religious activities. It not only leads to an uglification of the living area, but also to a high risk of polluting surface and ground water through leachate and furthermore promotes the breeding of flies, mosquitoes, rats and other disease vectors. In order to tackle these problems the disposal of organic material needs to be avoided. Aiming at sustainable development the organic waste as a source of nutrients and energy has to be reused however, the composition of the solid waste varies with cities and countries depending on the standard of living, lifestyles social and religious traditions, eating habits and so forth. In order to minimize the risk to the environment and human health, economically feasible solutions are sought for the treatment of solid waste particularly in urban areas. A plan to turn solid

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organic waste (kitchen waste) into energy through different technology has been possible; however, maximum energy recovery, and less discharge is possible through anaerobic digestion that seems viable economic option for the country like India. So, replacing the conventional energy resources from the biogas technology would reduce the effect on global warming as well as climate change.

2. Analysis of GAS produced in our reactor

This digester contains the following composition.

- 20lit digester.
- Cow dung + inoculum + water added.
- Cow dung – 2.9 lit
- Inoculum - 3.3 lit
- Water – 14.5lit
- PH – 5.02
- NaOH & $NaHCO_3$ added to increase/adjust pH.

A separate container for coconut shells, egg shells, peels and chicken mutton bones. These will be crushed separately by mixer grinders. Different containers of volumes 5l to collect the wet waste, stale cooked food, waste milk products. The vegetables refuse like peels, rotten potatoes coriander leaves collected in bags. Important aspect in smoother running of plant by avoiding the choking of the plant. This occurs due to thick biological waste that not reaches to the microorganisms to digest. The easy answer to this problem is to convert solid wastes into liquid slurry. Mixer can be used to convert solid into slurry.

2.1 Syringe method:

Syringe method was used for the measurement of amount of methane and carbon dioxide in our gas produced .A syringe fitted with flexible tube and dilute sodium hydroxide (NaOH) solution was used for carbon dioxide percentage estimation, since NaOH absorbs CO2 but dose not absorbs methane.

Figure 1: Experimental Setup

2.2 Procedure followed:

1. Prepare 100 ml of dilute sodium hydroxide solution by dissolving granules of NaOH in about 100 ml of water.
2. Take 20-30 ml sample of biogas produced during experiment into the syringe (initially fill syringe with H_2O to reduce air contamination) and put end of the tube into the NaOH solution, then push out excess gas to get a 10 ml gas sample.
3. Now take approximately 20 ml of solution and keep the end of the tube submerged in the NaOH solution while shaking syringe for 30 seconds.
4. Point it downwards and push the excess liquid out, so that syringe plunger level reaches 10 ml. Now read the volume of liquid, which should be 3-4 ml indicating about 30-40% of gas absorbed so we can say the balance of 65-60% is methane.
5. If the flame does not burn properly and you get over 50% methane (a reading of less than 5 ml of liquid) you must have nitrogen or some other gas present.

2.3 Analytical Methods & Calculations

Total Solids (TS %) –

It is the amount of solid present in the sample after the water present in it is evaporised. The sample, approximately 10 gm is taken and poured in foil plate and dried to a constant weight at about 105 0C in furnace.

TS % = (Final weight/Initial weight) * 100

Volatile Solids (VS %) –

Dried residue from Total Solid analysis weighed and heated in crucible for 2hrs at 500 0C in furnace. After cooling crucible residue weighed.

VS % = [100-(V3-V1/V2-V1)] * 100

Where,

V1= Weight of crucible.

V2= Weight of dry residue & crucible.

V3= Weight of ash & crucible (after cooling)

Volatile Fatty Acid (VFA) –

Volatile fatty acids (VFA's) are fatty acids with carbon chain of six carbons or fewer. They can be created through fermentation in the intestine. Examples include: acetate, propionate, and butyrate. There are many titration methods for VFA measurement. The following method is used for my experiment.

Method of Titration:

1. Take 100 ml sample in beaker
2. Filter the sample.
3. Check pH of filtrate.
4. Take 20 ml of filtrate and add 0.1M HCl until pH reaches 4
5. Heat in the hot plate for 3 minutes.
6. After cooling titrate with 0.01M NaOH to take pH from 4 to 7.
7. Amount of HCl & NaOH recorded

Total VFA content in mg/l acetic acid = (Volume of NaOH titrated) * 87.5

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Results and Discussion:

The biogas yields produced from our reactor in ml are noted down as follows

Day Wise	Biogas Produced in ml	PH	TS %	VFA(mg/l)
Day 1	90	7.2	6.0	1875.6
Day 2	140	5.3	5.4	2034.5
Day 3	120	6.25	5.3	1867.8
Day 4	50	4.63	4.7	2012.5
Day 5	70	7.25	5.1	2187.5
Day 6	80	6.6	4.9	2537.6
Day 7	115	6.9	6.0	2231.5

From the above table the graphs are plotted, based on the results produced from the 20 litres of biogas digester for the parameters of biogas production, Total solids percentage, PH, VFA (mg/l) .

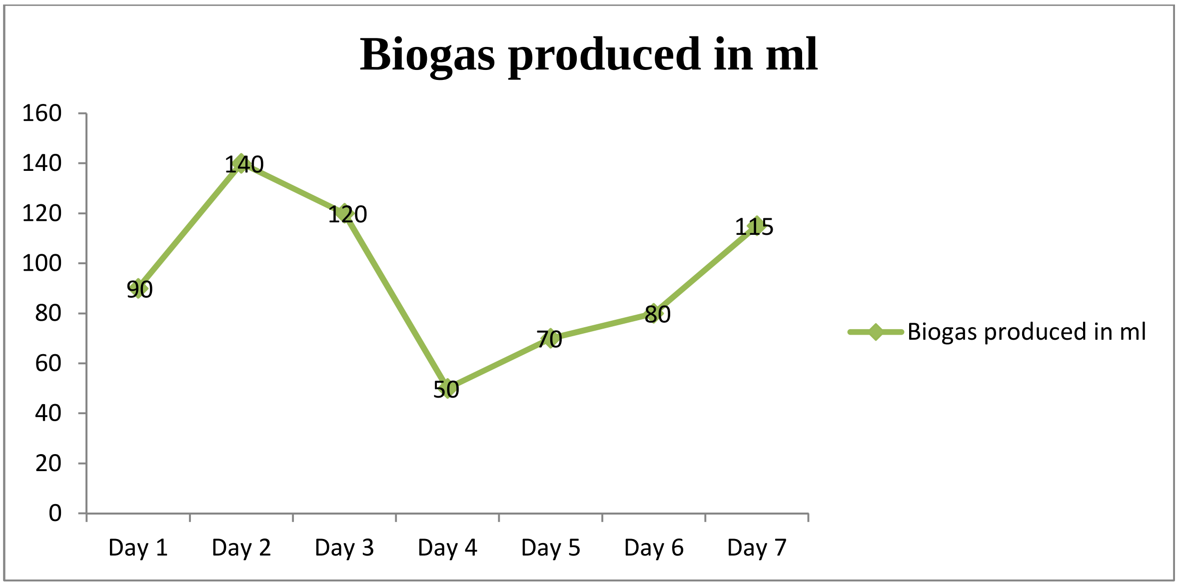

Figure 2: Biogas Produced in ml vs Number of Days

The graph shows the amount of biogas produced in ml .It shows that the production rate mainly depends on the pH maintained and the total solids %,The amount of biogas produced is constantly increasing from the from the fourth day because of better formation of methanogens inside the anaerobic digester.

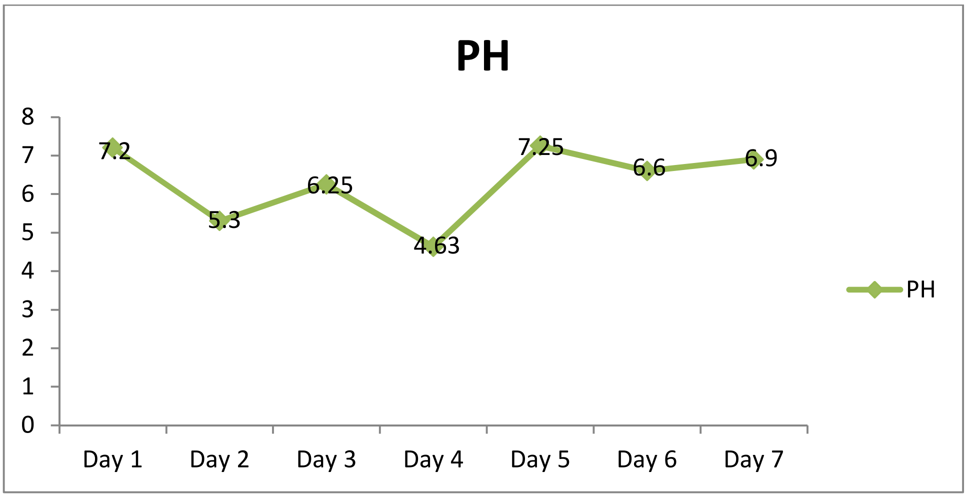

Figure 3 : PH vs Number of days

From the above graph its shows that pH has been maintained on average of 5.6.The optimum pH for methanogenic bacteria is in the neutral to slightly basic range. It shows that the rate of methane production declines when the pH value falls below 6.

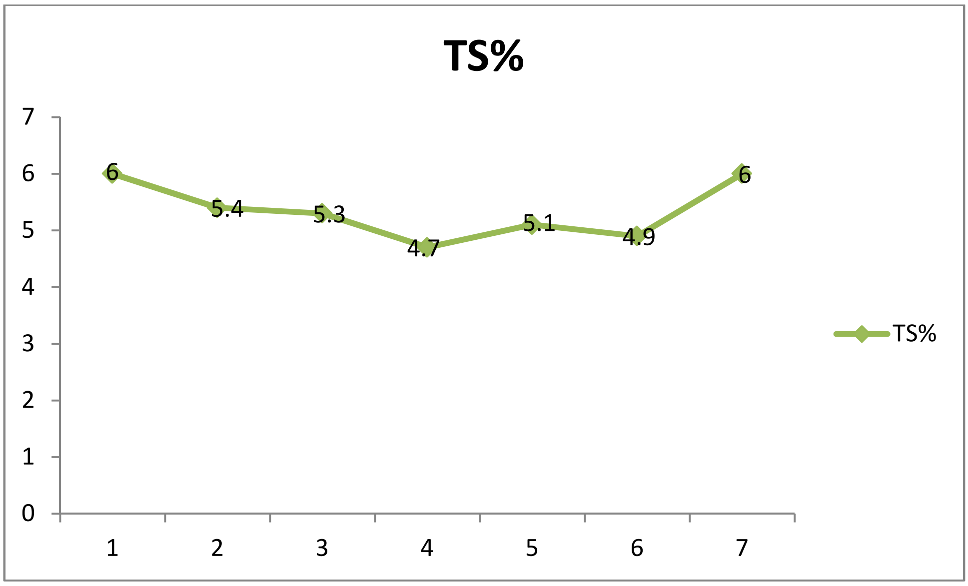

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Figure 4 : TS% vs Number of days

From the above graph it shows that the TS% has been maintained constantly on an average of 5.4, the total solids % determines the characteristics of sludge. Total solids are used to determine the loading rate of anaerobic digester and gives clues as to when maintenance is required.

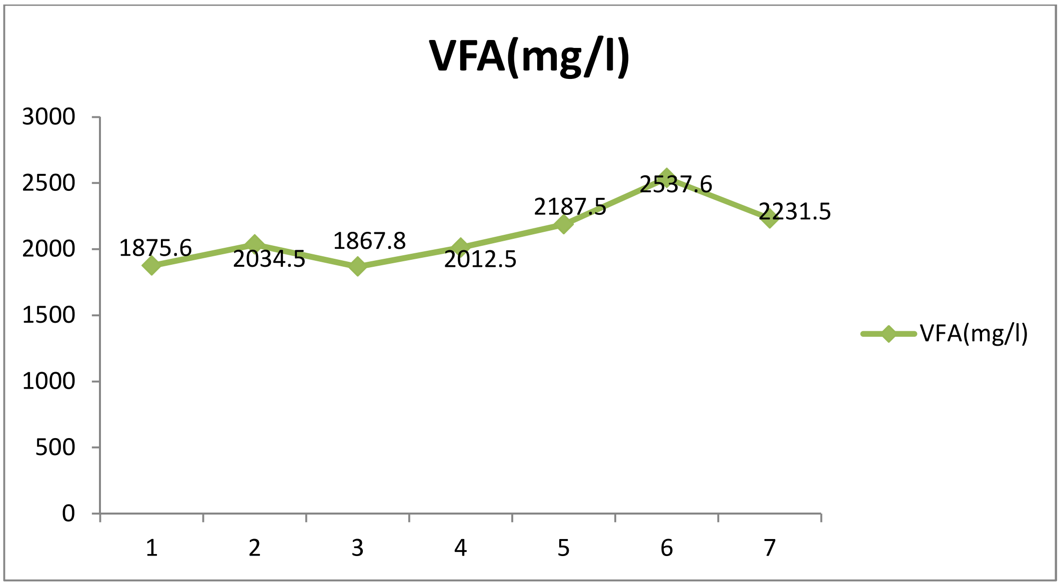

Figure 5 : VFA(mg/l) vs Number of days

The graph it shows that there is a significant rise in VFA (mg/l) as the number of days are increasing because the volatile fatty acid accumulation can lead to a drop in pH, which inhibits the microorganisms. The continual drop of pH can lead to failure of anaerobic digester. Therefore VFA are needed by small amounts for the intermediary step of metabolic pathway of methane production.

3. Conclusion:

The Concept of Kitchen Waste Utilization using Plastic Biogas Digester for Biogas Production offers effective Waste Management and Resource Development solutions with positive measures for the economy, improved air quality and sustained energy security. So, anaerobic digestion of Kitchen waste using Plastic Biogas Digester is a proven technology for processing source separated organic wastes and has experienced significant growth recently. In overall, Biodigester seems more feasible and economical biogas plant for households in urban areas, as organic solid waste generated in rural region are preferably used as animal feed. This plant helps to the management of an organic waste generation in urban areas as well as saves the consumption of LPG gas and money in the long term (by replacing conventional cooking fuel). In is interesting to note, however, that in our study it was found that, the average daily gas production per Kg of dry kitchen waste is 10 L. So, by storing the 2-3 days' gas it will be equivalent to consumption of 1 days LPG gas.

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Author Bibliography

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