

Biogas Production from Kitchen Waste: Case Study

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ABSTRACT: In our institute we have one college canteen, where daily a large amount of kitchen waste is obtained which can be utilized for better purposes. Biogas production requires Anaerobic digestion. Project was to create an Organic Processing Facility 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 college canteen feedstock for our reactor which works as anaerobic digester system to produce biogasenergy. 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 (CH₄) & carbon dioxide (CO₂). 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. 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, Anaerobic Digestion, Kitchen waste, Bio-digester

I. INTRODUCTION

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 resources. But, biogas is distinct from other renewable energies because of its characteristics of using, controlling and collecting organic wastes and at the same time producing fertilizer and water for use in agricultural irrigation.

Biogas does not have any geographical limitations nor does it require advanced technology for producing energy, also it is very simple to use and apply. Deforestation is a very big problem in developing countries like India, most of the part depends on charcoal and fuel-wood for fuel supply which requires cutting of forest. Also, due to deforestation it leads to decrease the fertility of land by soil erosion. Use of dung, firewood as energy is also harmful for the health of the masses due to the smoke arising from them causing air pollution. We need an ecofriendly substitute for energy.

Kitchen waste is organic material having the high calorific value and nutritive value to microbes, that's why efficiency of methane production can be increased by several order of magnitude as said earlier. It means higher efficiency and size of reactor and cost of biogas production is reduced. Also in most of cities and places, kitchen waste is disposed in landfill or discarded which causes the public health hazards and diseases like malaria, cholera, typhoid. Inadequate management of wastes like uncontrolled dumping bears several adverse consequences: It not only leads to polluting surface and groundwater through leachate and further promotes the breeding of flies, mosquitoes, rats and other disease bearing vectors. Also, it emits unpleasant odour & methane which is a major greenhouse gas contributing to global warming.

1.1 Biogas

Generation of Biogas under anaerobic environment by means of micro-organism through fermentation of organic matters. Biogas-technology is the required part of the biological geo-chemical carbon cycle. Each can be used in rural and urban areas.



Table-1: Biogas Composition

Component	Compositionin %
CH4	55 to 60
CO2	35 to 40
Water	2 to 7
H2S	20 to 20,000 ppm
Ammonia	0 to 0.05
Nitrogen	0
Oxygen	0 to 2
Hydrogen	0 to 1

1.2 Biogas Characteristics

Biogas composition depend also on feedstock, and is about 20 percent lighter than air, with an ignition temperature varying between 6500 - 7500 degree C. An odourless & colourless fuel equivalent to LPG petrol, which burns with blue flame. Its caloric-value is 20 Mega-Joules/cum and in a conventional biogas furnace it usually ignites efficiently of 60 per cent.

Such fuels are advantageous as gas for replacing fire-wood, cow dung, petroleum, Liquid Petroleum Gas, gasoline & electricity, depending on the essence of the mission, and furnishing preconditions and constraints in the vicinity.

After its anaerobic-digestion, biogas-digester structures offer a residual- organic-waste which has the most beneficial nutritional qualities over the everyday organic fertilizers, since it is in the ammonia composition which can be used as compost. Additionally, anaerobic biogas-digester can be used as treatment and disposal of wastes, primarily for human trash, and can thus avoid sustainable sources of environmental infectious disease and the development of pathogenic bacteria and bacterial disorders. Biogas-technology tell-how is highly valued in faecal matter and cooking waste leftover farming remedies.

1.3 Biogas Properties

- The volume changes according to pressures and temperatures.
- The Change in thermal efficiency both as mechanism of temperatures, pressures and content of vapour.
- The Change of the water-vapour by pressures and temperatures.

1.4 Factor Affecting Biogas-yield

Many factors that affect the system of fermenting organic substances under anaerobic conditions are,

- Amount and character of organic matters
- Temperature setting
- Substrate acidity and alkanity
- Material Flow and Dilution

1.5 Objectives

- To understand the basics of production of Biogas from Organic wastes
- To analyse biogas production yield
- To compare Production of Biogas with conventional plants

II. MATERIALS

KITCHEN WASTE

Kitchen waste (KW) sample was collected from Canteen, University B D T College of Engineering, Davanagere. This canteen food-waste constitutes of vegetables, cooked-rice, plastic covers, papers, peels and unused parts of vegetables, later it is segregated to obtain fermentable fractions sample, then it was crushed in mixers for experimentation. The pictorial view of Sample of KW is as shown in Plate 1 below.



Plate 1: Kitchen Waste Sample

Different Volume of containers used between 5 liters to 20 liters to store the kitchen wet-waste, cooked-stale food, milk-waste-products with tight lids. Kitchen vegetables-waste such as peel-off, rotten-potatoes and leaves of coriander are segregated in different polythene covers of different size. The handling these containers should be carrying out with optimum safety and used hands protections.

III. METHODOLOGY

3.1 EXPERIMENT ON BULKY SCALE

In the Bulk scale we can use two syntax tanks will be used, one of 1000 lits capacity used as digester and other of 750 L capacity used as for Bio-gas collector. The following various parameters are examined:

- TS- Feedstock rate is increases from 0.1kg to 5kg, then check the yield of Biogas and quality of the output.
- pH- find out the change in pH & maintain required pH.
- Note down the variation in Temperature
- Quality and Quantity of biogas production.

3.2 BIOGAS ANALYSIS DEVELOPED AT OUR BIO-DIGESTER

1. NEEDLE-SYRINGE PROCEDURE

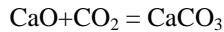
The needle method has been used in calculating the quantity of CH₄ & CO₂ produced from our experiment. In CO₂ % calculation, a needle installed with a flexible-tube as well as a dissolved NaOH solution was also used, because sodium hydroxide absorbing the carbon dioxide and this NaOHwon't disturb the CH₄ produced.

PROCEDURE:

- 100 ml of diluted NaOH solution is being prepared with the usage of GrannularNaOH is then dissolved in 100ml water.
- 20 to 30 ml of generated biogas sample in our experiment, is taken in a needle and insert one-end of pipe in Sodium hydroxide solution, and then thrust out excess biogas to obtain 10 ml Biogas-sample.
- Then taking about 20 ml of solution, hold the tube end immersed in the sodium hydroxide by spinning the needle for thirty seconds.
- With downward facing drive the remaining water out, till the needle-plunger-level reaches to Ten ml. Then observe liquid volume, it is of about three to four ml indicates 30 to 40% Of CO₂ observed, and the remaining is the 60 to 65% of CH₄.
- If a flame doesn't ignite efficiently, that means you'll get about 50 percent of CH₄, it may contain nitrogen or some other gas in it.

3.3 PURIFICATION OF BIOGAS

- The produced biogas is passed through the scrubber.
- The scrubber is a device which is made up of limewater in which gas is passed to purify it.
- CH₄ and CO₂ as major constituent components in Bio-Gas.
- To reduce the carbon dioxide in biogas it is passed through lime water in which carbon will react with calcium oxide in order to produce calcium carbonate.



- All the carbon content in biogas is reduced
- 11% of Methane content is improved using this scrubber



PLATE 2: SCRUBBER USED TO PURIFY BIOGAS

IV. EXPERIMENTAL RESULTS

In this test, we had seen that we can able to produce around about 10 L-biogas daily in 20 L of small bio-reactor. Finally, main aim of our case study attempting to build 1000 L capacity reactor to College canteen & boy’s-hostel of UBDTE College, Davanagere. Therefore, we have decided that, daily production of about 650 L of biogas within a 1000 L bio-digester with standard parameters (we need to keep pH, VFA, Alkalinity, etc.)

TABLE 4.7: AVERAGE CONSUMPTION OF LPG

Sl No.	Name	LPG Requirement (for a month)
1	UBDTE Boys-Hostel	1412.4 kgs
2	UBDTE College Canteen	2547.5 kg

INVESTIGATION 1

Biogas-Calorific-value - 6 kWh/cum

LPG-Calorific-value - 26.1 kWh/cum

Assuming to boil sample of 100gm of water

Energy required for the above – 259.59 kJ

So, required amount of Biogas to heat 100gms of water is 12.018 litre and similarly we require 2.76 litre of LPG

Thus, using biogas of 5.408 litres per day to boil

Therefore, Water that could be heated with this much Biogas = 5.408 litre per day

Now, the quantity of LPG needed to heat 5.408 litre of water daily = 149.26 litre. Thus, We could save as many as 10 LPG cylinders a day.

INVESTIGATION 2

We utilized produced biogas from the plant for preparing the morning meal and also for evening-chats. (Morning 1 hour and same duration at evening)

Usage of 2 hour for 650 litre – 66.46X103 joules per day

Let, V- Quantity of LPG utilizes to generate equal quantity of energy.

So, V=2827.56 litre

Or Mass= 6.079 kgs

Thus, Usage of LPG in a month is 182.38 kgs, it is equal to 12.84 standard cylinders.

Conclusion:

From 1000 litre capacity bio-reactor we can preserve 13 standard weighed cylinders.

INVESTIGATION 3

COMPARISON OF BIOGAS-DIGESTER WITH CONVENTIONAL-PLANT

The biogas-plant-structure is an air tight tank or vessel which stores natural fermentable matters, it’s a place where micro-organism breakdown the organic matters continue to produce biogas, and combination of in most cases CH4 and CO2. Biogas is being utilized for cooking or other uses as a coal, and the large residues will be used as



organic fertilizer. From this we validated that, by way of the usage of feed-stock having excessive calorific-value and nutritive-value to microorganism, effectiveness of CH₄ technology is improved with the aid of quite a few orders of magnitude. It is a proven extraordinarily cost effective and environmental friendly system. Table 4.9 below explains the comparison of both.

TABLE 4.8: COMPARISON OF CONVENTIONAL-BIOGAS WITH KITCHEN-WASTE-BIOGAS SYSTEM

Particulars	Conventional-Biogas Systems	Kitchen-Waste-Biogas System
Feedstock Quantity	40 kgs with 40 litre water	1.5 to 2.0 kgs with 15 litre water
Feedstock-Type	Cow Dung	Cow dung, Starch & sugar materials
Quantity and kind of slurry(effluent)	80 litre and sludge	12 litre and watery
Total retention time	40 days	52 hours
Installation size of the plant	4,000 litre	1,000 litre
Biogas Production	650 litre	650 litre

V. CONCLUSION

- We can conclude from the above facts we can generate biogas up to 650 litres every day within 1000 litre capacity bio- reactor, beneath best circumstances.
- We can save LPG cylinders up to 30, if we construct 1000 litre capacity Biogas plant for daily 2 hours usage.
- We can conclude that enhanced-biogas production by using kitchen-waste, rice-waste is mixed with cow-dung in 3:2 ratios, even with lesser amount of kitchen waste and by maintaining the pH of 6.2-6.5 bio gas production can increased considerably.

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