PRODUCTION OF BIOGAS USING FOOD WASTE

Submitted in partial fulfilment of the requirements
of the degree of Bachelor of Engineering

by

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CERTIFICATE

This is to certify that the Project Report entitled **"PRODUCTION OF BIOGAS USING FOOD WASTE",** duly submitted by the following students: Mr. Ansari Zaid Akhtar (13CES10), Mr. Khan Aaftab Aalam (13CES18), Mr. Khan Salman (13CES25), Mr.Shaikh Mohd Ajaz (14CES43) in partial fulfilment of requirements of the first stage project seminar of **Bachelor's Degree in Civil Engineering** conferred by the **University of Mumbai**.

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This dissertation report entitled **"PRODUCTION OF BIOGAS USING FOOD WASTE"**by Mr.Ansari Zaid Akhtar (13CES10), Mr.Khan Aaftab Aalam (13CES18), Mr.Khan Salman (13CES25), Mr.Shaikh Mohd Ajaz (14CES43) is approved for the degree of "Civil Engineering"

Examiners

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Date: 05-05-2018

Place: Panvel

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ABSTRACT

As the world population is growing every year solid waste generation also increases. Every year around 1.2 billion tones of solid waste is generatedin which 60 to70% of waste is food waste which goes into landfill. The food waste contains high organic resource, which can utilize the for the generation of renewable energy sources. Biogas is one of the valuable energy resource which usually contains components like methane, carbon dioxide and hydrogen sulphide which is harmful for environment. Anaerobic digestion is a method to produce biogas efficiently. In the absence of oxygen anaerobic digestion takes by the help of anaerobic bacteria. This research work was focused on the generation of biogas from kitchen waste generated in the AIKTC campus. Most of the waste collected from Engineering canteen which contains fresh food waste along vegetables and fruit peels. Kitchen (food) waste will be collected from two canteens of AIKTC as feedstock for the reactor which works as anaerobic digester system to produce biogas energy. The experiments were carried out in a two type of anaerobic digester with and without cowdunk. Parameters like pH and biogas production was measured. At an average 4300 ml of gas was generated in the tube in three days. In AIKTC, there are two canteens, and both having their own individual mess, where daily about 20 kg of kitchen waste is obtained which can be utilized for bioreactor. Both bioreactor study provided biogas however the generation rate is very good in the reactor with cow dunk.

Keywords: ***Anaerobic Digestion, Biogas, Food Waste, Methane***

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ABBREVIATION NOTATION AND NOMENCLATURE

MSW	Municipal Solid Waste
HCV	High Calorific Value

Chapter 1

Introduction

1.1 General

Energy production is one of the oldest concerns in energy generation throughout the ages. Due to the increasing population it creates a major scarcity of different types of the natural sources like liquid and other solids resources, due to this it creates a major issue to the researches to find the new type of the renewable sources such solar energy, wind energy and different types or forms of thermal energy and hydro energy by using water resources from river and others types of useful renewable sources. Among all of these Biogas is also a renewable source.

In today's world the major important problems of the societies is continuously increasing of solids wastes or in other term production of organic wastes. In India generally the municipal solid waste contains different types of the food wastes, animal manure, waste materials from industries and other commercials areas falls under these categories.

Biogas is generally termed as dung gas, garages, marshes gases, gas from the sewage, and swamp gas. The food waste which is leftover and thrown much cause serious health problems.

Biogas is one of the important renewable sources in the rural due to the scarcity of other resources.

The production of biogas using anaerobic digestion and feedstock's has become the one of the greatest energy resources which has the ability to overcome the several crisis in future, and it can be used in over the past many decades.

1.2 Need of the study

Production of the biogas from the food waste also includes special type of study and specific time. As the world's population is increasing faster day by day it creates major problems of natural resources. In developing countries generates huge soild waste most of them dumped unscientifically.

Deforestation is a very big problem in developing countries like India,70% of population belongs to rural area where agriculture is the main source of living, most of the part depends on charcoal and fuel wood for fuel supply which requires cutting of forest. Also deforestation 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 Eco friendly substitute for energy.

The use of fossil fuel and cow manure can cause severe health issues due to the arising smoke from the fire and it also air pollution. Therefore we need an Eco-friendly alternative energy to restrict the deforestations..

1.3 Benefits of Biogas

- Biogas is eco-friendly.
- Biogas generation reduces soil and water pollution.
- Biogas generation produces organic fertilizer.
- It's a simple low cost technology that encourages a circular economy.

1.4 Motivation of study

Three-fourths of Mumbai's garbage in the past year was made up of the food we waste, an unreleased environment report by the civic body for 2015-16 shows. The report said 73% of the garbage that makes its way into the city's dumping grounds was food waste. The quantity of municipal solid waste generated within Greater Mumbai is 7,800 MT per day and overall 9,000 MT per day in Mumbai.(https://www.hindustantimes.com/mumbai-news/food-makes-up)

In AIKTC everyday around 20 kg of food waste is generated in degree canteen and 10 kg of waste generated in polytechnic canteen on working days. Apart from this dry waste which is generated around 80 kg contribute in the waste generation in the college.

In AIKTC most of food waste produced are fresh. If we would be able to utilize this food waste for biogas production. Biogas can be utilized for cooking which can provide alternative fuel.

1.5 Aim

The aim of the study to design and generate biogas by using small scale bioreactor

1.6 Objectives of the Study

- To Analyze the Characteristics of Food Waste
- To design a lab scale anaerobic digester
- Collect and analyse the amount of biogas generated.

Chapter 2

Literature Review

2.1 General

The idea that waste vegetable and other food waste gives the flammable gas has been understood since the ancient Persians. The use of farm manure to obtain the methane was developed in Bombay in 1903 during the British Era but it was developed by the by Villagers of Indians by Khadi and Villages Industries Commission in the early 1960s.

Many of the biogas production was designs in India by different groups which is now called Biogas Sector Partnerships.

2.1.1 Annual Global Food Waste

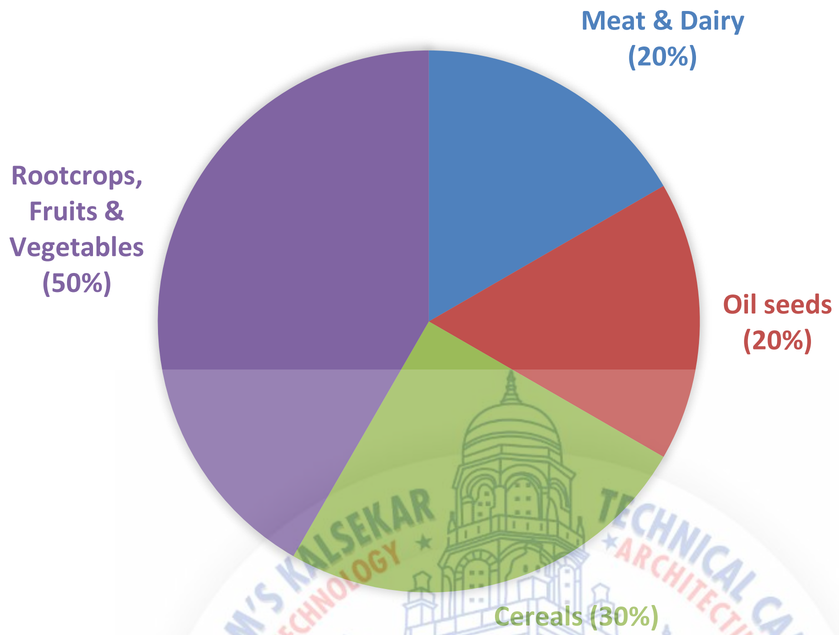


Figure 2.1 Annual Global Food Waste (Source: Thechicagocouncil.org)

2.1.2 Biogas

Biogas is the mixture of gas produced by the breakdown of organic matter in the absence of oxygen which is called anaerobic digestion. It can be produced from the available raw materials such as food wastes, cow dung and as well as recycled wastes. It is a renewable energy with less carbon content. Biogas mainly contains the methane (CH_4), carbon dioxide (CO_2), and very small amount of hydrogen sulphide (H_2S).

Methane is the simplest alkane and its relative abundance makes it attractive fuel. Methane is present in the nature like fruits vegetables, seeds etc. From the source the methane is collected and can be used for the future alternative fuels.

Table 2.1 Composition of Biogas Source

Component	Concentration (by volume)
Methane (CH4)	55-60 %
Carbon dioxide (CO2)	35-40 %
Water (H2O)	2-7 %
Hydrogen sulphide (H2S)	20-20,000 ppm (2%)
Ammonia (NH3)	0-0.05 %
Nitrogen (N)	0-2 %
Oxygen (O2)	0-2 %
Hydrogen (H)	0-1 %

2.1.3 Factors Affecting Yield and Production of Biogas

Many factors affecting the fermentation process of organic substances under anaerobic condition are,

- The quantity and nature of organic matter
- The temperature
- Acidity and alkanity (PH value) of substrate
- The flow and dilution of material

2.1.4 Anaerobic Digestion

Anaerobic digestion is a series of biological processes in which microorganisms break down biodegradable material in the absence ofoxygen. One of the end products is biogas, which is combusted to generate electricityand heat, or can be processed into renewable natural gas and transportationfuels. The organic materials are composed of organic compounds resulting from the remains or decomposition of preciously living organisms such as plants and animals and their waste products.

The product is composed typically of methane and carbon dioxide and small amounts of H2S and traces of other gases. The biogas can be burnt to generate heat and power or can be processed into gas or liquid fuel.

The benefits of anaerobic digestion apart from generating energyincludes: reduction in greenhouse gas emission, better air quality due to reduced odor, improved ground water quality as the pathogen activity is reduced, reduced fertilizer & bedding cost.

Biological Process

1. Hydrolysis
2. Acidification
3. Methenogenesis

1. Hydrolysis:

Hydrolysis in simple term means the breakdown of the chemical bond in presence of water. When carbohydrates is treated in presence of water it gets broke down into sugar molecules and sucrose is broke down into the glucose. The reaction of cation and anion with water molecule within the pH is done cleavage of H-O bond in hydrolysis takes place.

Hydrolysis is the opposite of the condensation reaction in which the molecules form a long chain by removing the water molecule. In short terms the proteins carbohydrates and other product is converted into fatty acids.

2. Acidification:

In this process the acid producing bacteria decomposes the third steps, converts the intermediates of fermenting bacteria into acetic acid, hydrogen carbon dioxide. This bacteria are mostly anaerobic and they grow in acidic conditions.

3. Methanogenesis:

Methane-producing bacteria, which were involved in the third step, decompose compounds having low molecular weight. They utilize hydrogen, carbon dioxide and acetic acid to form methane and carbon dioxide.

ARTI – appropriate rural technology of India, pune (2003) has developed a compact biogas plant which uses waste food rather than any cow dung as feedstock, to supply biogas for cooking. The plant is sufficiently compact to be used by urban households, and about 2000 are currently in use – both in urban and rural households in Maharashtra. The design and development of this simple, yet powerful technology for the people, has won ARTI the Ashden Award for sustainable Energy 2006 in the Food Security category. Dr. Anand Karve (ARTI) developed a compact biogas system that uses starchy or sugary feedstock (waste grain flour, spoilt grain, overripe or misshapen fruit, nonedible seeds, fruits and rhizomes, green leaves, kitchen watse, leftover food, etc). 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 to complete the reaction. Thus, from the point of view of conversion of feedstock into methane, the system developed by Dr. Anand Karve[2][3] is 20 times as efficient as the conventional system, and from the point of view of reaction time, it is 40 times as efficient. Thus, overall, the new system is 800 times as efficient as the conventional biogas system.

Beedu,R., and Modi,P., (2014) studied the Different types of waste such as food waste,residues of crops used.Area of tank in which biogas is generated is 1 and 0.75 m3capacity. Even if the plant will not fed for 2 to 3 days its production does not gets effected.

Srinvasa et al., (2017) Around 2 tonnes of food waste like vegetables, fruits peeling was collected from 300 flats for a period of 7 days and it produces 45ml biogas daily in a 8Lreactor with ratio of 75:25.

Ogur.E.O., and Mbatia.S.,(2014) The study's main objective was to design an anaerobic digester which utilizes food waste to generate biogas for use in Kabete Technical Training Institute's (KTTI) kitchen. The institute's main source of energy was mainly wood,fuel, supplemented with liquefied petroleum gas (LPG) which is very expensive. The amount of waste generated from the kitchen was found to be of sufficient quantity to generate enough biogas for use in the kitchen hence the level of biogas production would in turn mean that this technology could be a viable investment for the institute to make.

Joy et al.,(2014) The left over slurry from the generator can be utilized pH of the waste water was measured to find out their effect in methane formation reactions. It was concluded that ambient conditions are sufficient to produce the gas under laboratory conditions and the best way is to treat the vegetable waste in water under anaerobic condition and use this waste water forbiomethanation reaction.

Naveen et al.,(2014) In this experiment 250kg of cow dung and 250 kg of food waste is taken In a 1000 litre float drum type reactor, rest 250 litre of water is added. Experiment is carried out for 30 days. The pH value is maintained at 7.15 throughout the experiment. Outcome of biogas yield is 0.8316m3/kg.

Kumar et al.,(2015) Different types of methods and materials for the production of biogas.In this the maximum biogas production was obtained at this condition at food to microorganism ratio 0.75.

Kumar,H., and Kumar,R.,(2014) Anaerobic Decomposition is the breakdown of complex organic molecules into useful form of energy by microorganisms in absence of oxygen. The mixture of biogas and water results in good production of the biogas yields.

Marimuthu et al.,(2014) Waste water taken in the form of slurry, 1 litre capacity of anaerobic digestion tank is taken and experiment is done 10 days at normal room temperature and the organic loading rate of 1500 mg/l. Using this process the production of biogas is 2ml/day.

Saratkumar et al.,(2016) Different food waste were collected around 200 kg per day from the hostel and it can produced 650 litres of biogas daily under ideal condition. (like maintaining pH , VFA , Alkalinity, etc.)

Sharada et al.,(2016) 20 litre of water tank coated with black paint is taken as a digester. 5kg of cow dunk is thoroughly mix with 8 litre of water and dumped in the digester, after a week food waste such as rice, vegetable peelings, and banana peelings is added. Experiment carried out for 30 days. Biogas yield is 0.101m3/kg.

Agrahari,R., and Tiwari,G.,(2013) Different ratio of kitchen waste is taken in an aluminium based biogas digester. Different parameters like solar intensity, ambient temperature, slurry temperature etc. calculated at different intervals for 30 days. Solar radiation increases the slurry temperature, which influences the biogas production. Out of all the ratios 1:2 is the best ratio of kitchen waste and water.

Ziauddin, Z. and Rajesh, P., (2015) Three different experiment where carried out. 1st experiment 2L bottle with 50gm kitchen waste+cowdung and rest water and it produces about 23.75 ml of biogas.2nd experiment consist of two different bottles of 1L and 2L which produces about 89.37 ml of biogas..3rd experiment produces about 60.02 ml of biogas.

Garunke,R., and Wilkie,A., (2008) Biogas is essential the bio-Digestion of any organic material under aerobic conditions.All the kitchens are anaerobically digested in the digestors to produce the bio gas.

Vikrant, D.,and Shekhar, P.,(2103) 15 kg of food waste collected which contains fruits vegetables, rice and wastewater is added to make semisolids. 20L capacitor tank is used to produce the biogas.The temperature used in this process was 37 degree Celsius.

Agrahari, R. P. Tiwari, G. N.,(2013) Different ratio of kitchen waste is taken in an aluminium based biogas digester. Different parameters like solar intensity, ambient temperature, slurry temperature etc. calculated at different intervals for 30 days. Solar radiation increases the slurry temperature, which influences the biogas production. Out of all the ratios 1:2 is the best ratio of kitchen waste and water.

S. P. Kale and S. T. Mehetre Certain amount of food waste like fruits, vegetables, cooked and uncooked food, milk etc. is added in a 35L tank to make to make it semisolid by adding hot water (55-60) degree Celsius.

Hemlata., Harsh,K., Naman,K., Mahesh,Venkat Rao. Cattle manure, kitchen waste, sewage sludge, poultry dropping, agriculture residues and other organic garbage in the absence of oxygen and thus produced biogas.Average dissolved solid was found to be 720 mg/lit in the sample.

Vivekanandan,S., Kamaraj,G(2011) Around 1.5 KG of rice chaff and 1.5 KG of cowdung was filled in a 3 set of digester of capacity 1 Litre. Aerobic process takes place and 27ml and 30 ml of biogas was produce on 3rd and 5th day

Dahunsi,S.O.,Oranusi, U.S. (2013) A 40 litre capacity tank in which 12 kg food waste and 3 kg excreta was taken for experiment purpose for 60 days at room temperature and about 84,750 cm3 gas was generated.

Indranil,.M,Anit,.M,Moinul,.H,Faiaz, A.,Praveen kumar,.S.(2015) 30 gm of food waste with 30 gm of cow dung was taken in a 2L digester along with 2 L water bottle.From 1 kg of food waste around 0.5 m3 of biogas was generated.

Srinvasa Reddy.N., Satyanarayana.S.V., Sudha.G(2017) Around 2 tonnes of food waste like vegetables, fruitspeeling was collected from 300 flats for a period of 7 days and it produces 45ml biogas daily in a 8L reactor with ratio of 75:25.

Thockom Subhaschandra singh ., P.Sankar Lal.(2015) The experiment was carried out under the meterological condition of enginnering college with a room temperature 30-35 degree celcius. The feeds are obtained from the engineering college canteen. Feeds mainly consist of leftover food waste and kitchen waste and cow manure and water in the ratio of 70:30 is found to be optimum. pH measurement is performed on weekly basis the gas is generated within 20 days of setup. After the setup the found the pH range 6.7-6.9 After 7-8 days they found that the co digestion of waste and cow manure yield good amount of biogas with around 60% of methane total biogas estimated around 0.05196m3.

Vunduru Nooka Sai Vikram Kumar (2016) In a 20 litre digester they mixed fresh water and cow dung thoroughly and pourd in digester after some days kitchen waste was added for checking the gas production. After this they found that they can produce 10 litre biogas daily in a 20 litre digester.The pH kept in between 5-5.5.

Laxman Lama., Sunil Prasad Lahani., Ram Lama.,Jhalak Raj Adhikari (2012) Initially 200-300 kg of cow dung were gradually mixed with water and made slurry of about 500-600 litre. Then digester was left without feeding for 30 days to develop the culture. After 30 days daily in average of 5 kg of dry waste waste collected and pored into the chopper for grinding and the slurry which are produced from the chopper directly put it into the digester.The room temperature was between 24-33 degree celcius. After the study they found that the average daily gas production per kg of waste is 35 litre.

Ramadhanarya., Dr Savita Sharma., Dr Ashok K sharma., Dr Sanjay Verma (2015) A 20 litre digester is taken in which they add the kitchen waste around 6 kg and 7 litre of water and also aprroximately 1 kg of fresh cow dung Which is kept at a room temperature 25-36 degree celcius and the pH range between 5.5-8.5. In this setup the found the biogas in the following manner.

No of days	Volume of biogas(ML)
1	-
5	400
10	8500
15	8600
20	10650
25	10900

S.Sharda., Mr.G.Surendra Babu., K.Hemalata (2016) In a 20 litre digester Tank which are coated with Black colour They take the measure of kitchen food waste which are free from acid and having the high calorific value and nutritive value of microbs which increases the efficiency of methane production along this kitchen waste they prepare an inoculum with fresh cowdung around 5kg it mixed with 8 litre of water and the digester was kept under observation of 30 days. And they find the biogas production started from 10^{th} day they found biogas produced is 0.462 m3.

Chapter 3

Materials and Methodology

3.1 Materials:

3.1.1 Plastic Container

Two empty Container of 20 and 2.5 litres capacity for collection of all the materials required for generation of gas.

The container is divided into three layers I.e. lower layer consist of cowdung, middle layer consist of food waste and the upper layer consist of water and air.

3.1.2 Kitchen Waste

Kitchen waste consist of food waste, egg shell, rice, chicken and mutton,vegetables etc.

Figure 3.2 Lab Reactor Model **Figure 3.1** Kitchen Waste.

3.1.3 Cow Dung

Cow dung, which is usually a dark brown color (usually combined with soiled bedding and urine) is often used as manure (agricultural fertilizer). If not recycled into the soil by species such as earthworms and dung beetles, cow dung can dry out and remain on the pasture, creating an area of grazing land which is unpalatable to livestock.

3.1.4 Blender

Figure 3.3 Blender used for food waste grinding

3.1.5 For experiment 1 (Cow dung and food waste):

- 20 litre water bottle
- Cow dung,
- tyre tube,
- plastic pipe
- valve
- pvc pipe
- blender
- burning valve
- Kitchen waste

3.1.6 For experiment 2 (Only Food waste):

- Pair of 2.5 litres plastic bottles,
- Syringe needle,
- Plastic valve
- T connector,
- Connecting pipe.

3.2 Methodology

3.2.1 Experiment no 1: cow dung with food waste

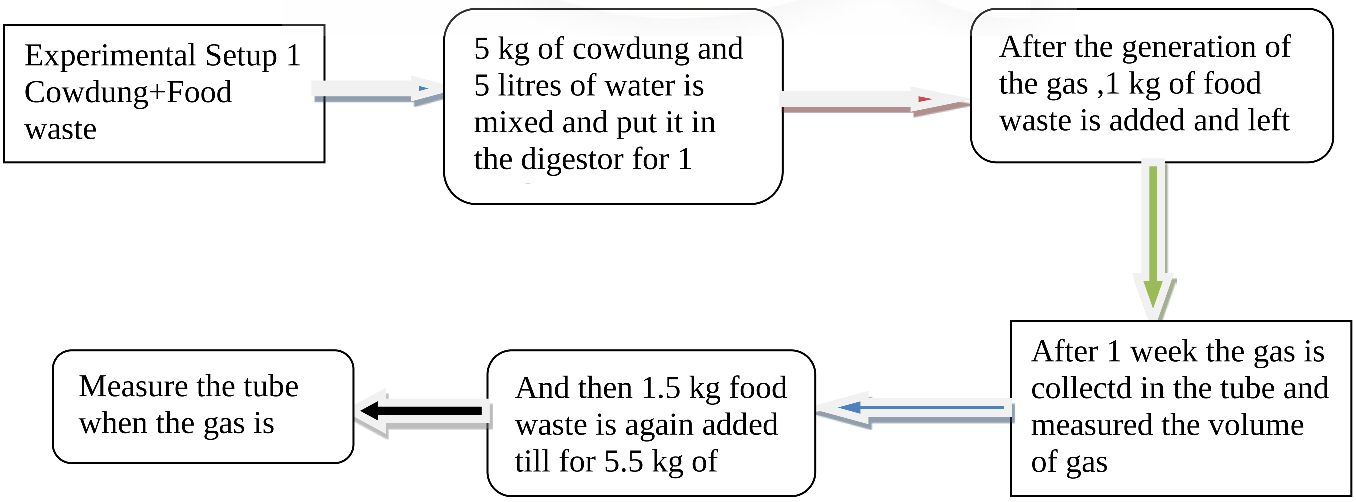


Figure 3.4 Bioreactor Experimental Setup 1 (Before gas generation)

Procedure

1. Firstly, the digester is taken and with the help of drilling machine two holes are made in the digester one at the top of the diameter equal to the valve and another hole is made at the bottom of digester of diameter equal to pvc pipe this is further used to remove the slurry.
2. The valve which is connected in the digester should be air tightened and a plastic pipe is connected to it for the outlet of gas.

Figure 3.5 Empty reactor

3. A tyre tube is connected to the outlet pipe for collection of the gas generated in the digester. The volume of the tyre tube is 4.3 litres. The tyre tube is connected to the valve on the digester with the help of gas collecting pipe to the tyre.
4. Now 5 kg of fresh cow dung and equal amount of water is taken in a container and are mixed thoroughly so as to form a semi solid liquid.

5. Then this mixture of cow dung and water is poured in the digester and the digester is air tightened and kept for 7 days for the generation of gas. The digester is then covered with black plastic for anaerobic digestion.

Figure 3.6 Rubber Tube with gas outlet pipe

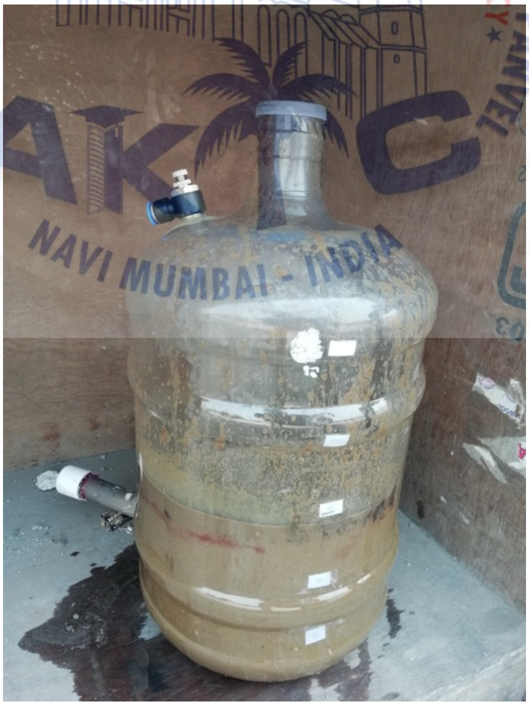


Figure 3.7 Bioreactor 1 (Acclimation)

6. As soon as the gas is generated and collected in tube the valve is closed so that the gas does not come again in the digester.

7. Then 1kg food waste is added in the digester for next one week this food waste consist of fruit peel, vegetables, breads etc.
8. Before putting this waste in the digester they are properly blended with the help of blender after blending the food waste is added into the digester.

Figure 3.8 Food waste Mixing

9. Cow manure and added food waste is mixed properly in the digester.
10. For each the day gas production is measured so we can find out the gradually increase and decrease of the gas production.

Figure 3.9 Bioreactor Experimental Setup 1 (Before gas generation)

11. Again 1.5 kg of food waste is blended and added into the digester. And the gas is measured for each day.

12. Again 2 kg of waste is added and amount of gas generated is measured.
13. Same procedure is repeated and total 5.5 kg of food waste is added into the digester.
14. Thus the digester consist of three layers i.e. bottom layer, middle layer and top layer Bottom layer consist of mixture of cow dung and water, middle layer consist of food waste and the upper layer consist of the gas.

Figure 3.10 Bioreactor Experimental Setup 1 (Before gas generation)

3.2.2 Experiment no 2: Only food waste

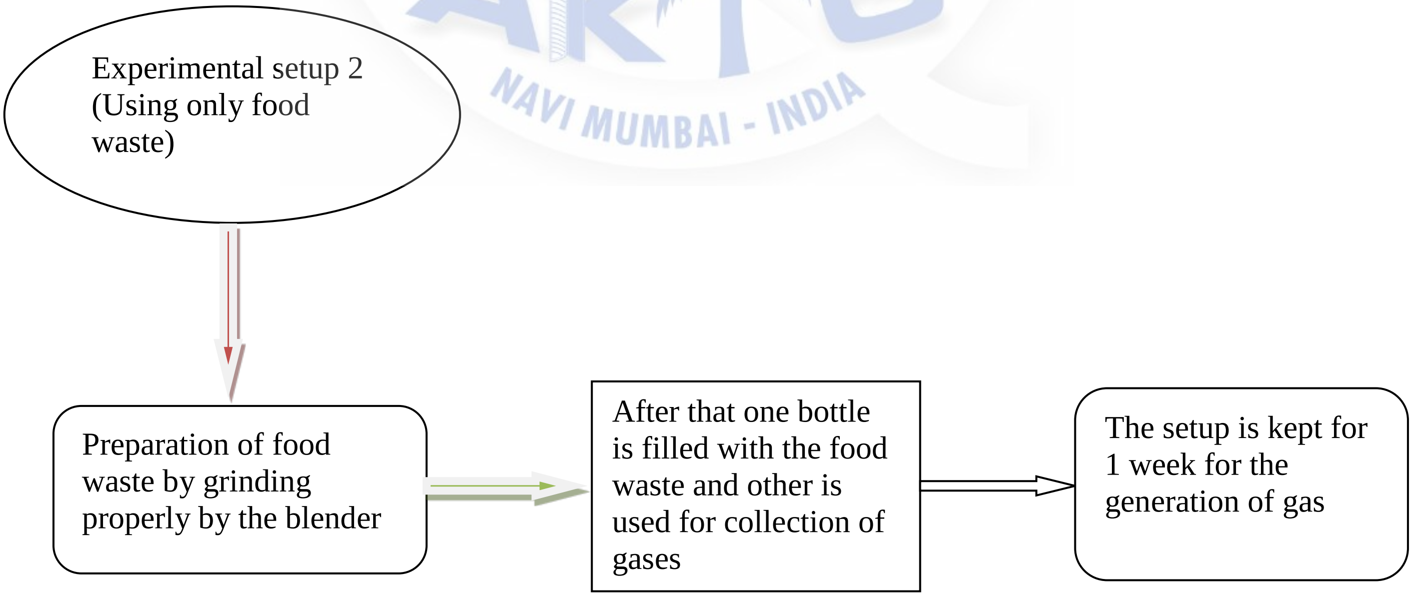


Figure 3.11 Flowsheet of Experiment 2(Only food waste)

Procedure:

Two bottles

1. Two bottles of 2.5 litres are taken for performing the test
2. Holes are drilled on the top of the bottle for connecting the pipe same thing is done with the other bottle. Holes should be of same diameter as that of pipe.
3. After drilling the hole on the top of the bottle the bottle is air tightened to avoid the leakage of gas.
4. In one bottle around 1 kg of food waste like fruit peels, vegetables, egg yolk are added and second bottle is kept empty for the collection of gas generated.
5. The pipe from both the bottles is connected to a common outlet pipe with the help of T connector.
6. A valve is connected to outlet pipe and at end of the valve syringe needle is fixed. After the complete setup is done it is kept for approximately 1 week for the decomposition of the food waste and the generation of gas.
7. The whole process takes place under anaerobic digestion.
8. The gas production is found but not measured.

Figure 3.12 Experimental Setup 2 (only food waste)

Chapter 4

Results and Discussions

4.1 Result of experiment 1:

4.1.1 For 1 kg food waste:

One kg of food waste is added in the digester after keeping the digester for one week with cow dung. We observed the pH and gas volume changes which are given in the Table 4.1.

Table 4.1 pH variation and volume of gas generation for 1 kg waste

day	pH	Gas volume(ml)
1	7.8	0
2	7.5	230
3	7.6	255
4	7.2	280
5	7.1	300
6	6.7	415

1. First day when we put the slurry in digester tank then the pH is 7.8 and the gas production was at zero level.
2. Second day when we observed the pH value decreased to 7.5 and the gas is generated about 230 ml.
3. Third day pH was increased to 7.6 and the volume of gas also increase as 255 ml.
4. Fourth day pH reading was decreased to 7.2 and the volume of gas was measured 280 ml.
5. Fifth day reading of pH decreases to 7.1 and volume of gas generation increased to 300 ml.
6. On sixth day pH decreases to 6.7 and gas generation increased to 415ml.

As from above reading we can say that pH of digester gradually decreases and gas production of the waste increases day by day. Volume of the collection tube is 4.3 liter so it takes six days to completely fill the tube. The pH and gas volume trend were shown in the Figure 4.1and Figure 4.2

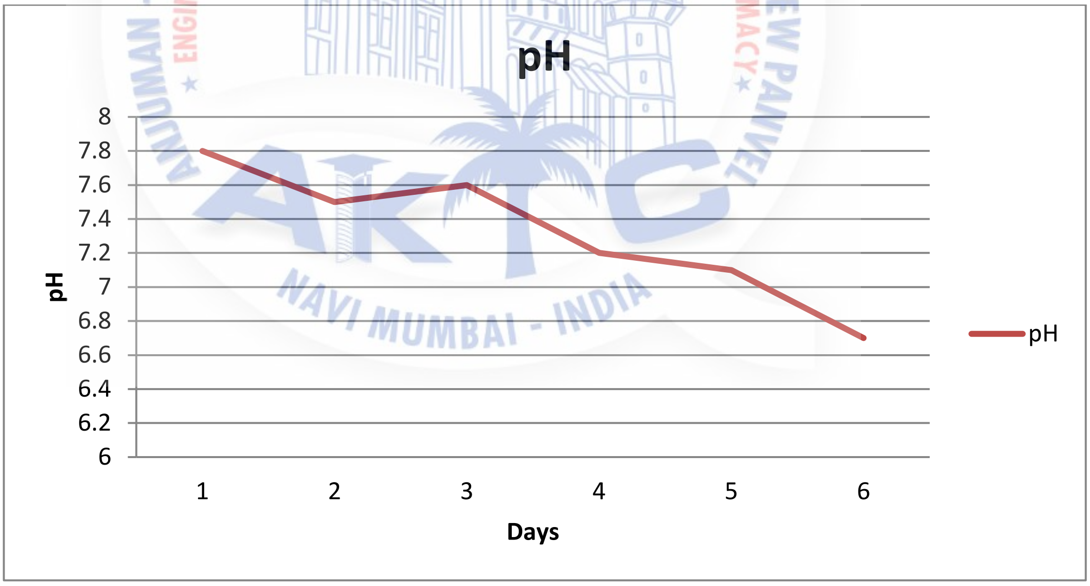


Figure 4.1 pH variation For 1 kg food waste (Days V/S pH)

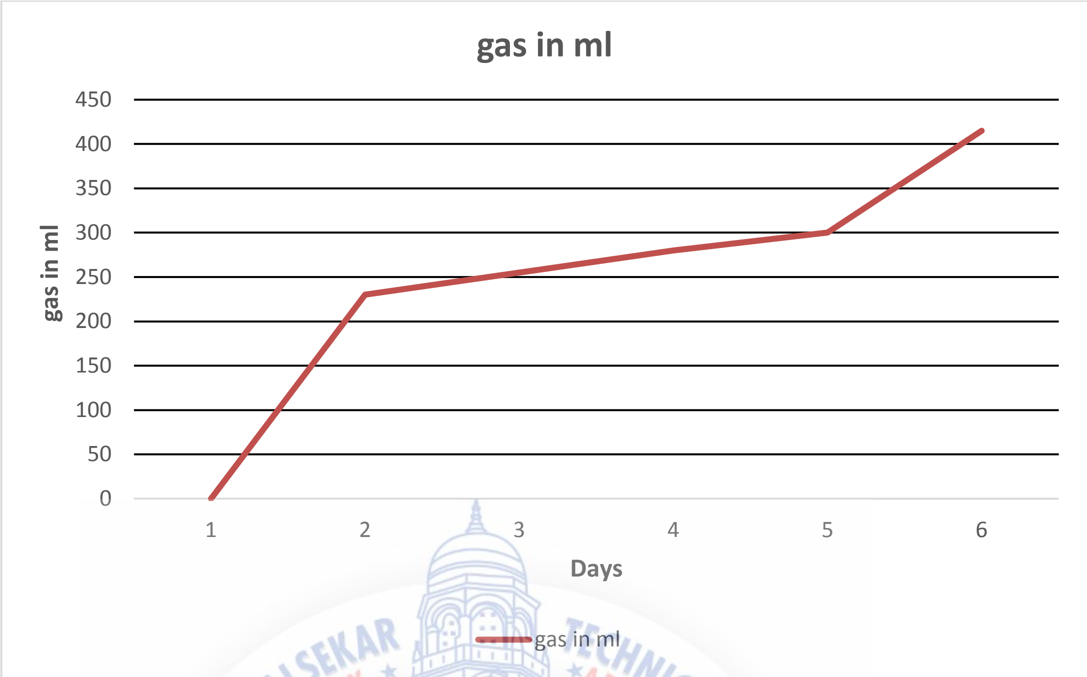


Figure 4.2 Volume generation For 1 kg food waste (Days V/S gas in ml)

4.1.2 For 2.5 kg of food waste

In the next week we blended 1.5 kg of food waste mixed with slurry but before putting the feed into the digester we emptied the tube in which the gas was collected.

Table 4.2 pH variation and volume of gas generation for 2.5 kg waste

day	pH	Gas volume(ml)
7	8	0
8	7.5	1050
9	7.3	850
10	6.8	775
11	6.5	950
12	6	675

1. On the first day when we added the food waste the pH value was 8 and gas generation was 0 ml
2. The next day the pH was decreased to 7.5 and the volume of gas generation was 1050 ml.
3. On third day of the second week the pH was 7.3 and the volume of gas generated was 850 ml.
4. On fourth day the pH was 6.8 and the volume of gas generation was 775 ml
5. On fifth day pH was 6.5 and the volume of gas generation was 950 ml.

6. On sixth day pH was 6 and volume of gas generation was 675 ml.

From the above table it is concluded that the value of pH gradually decreases and there is fluctuation in the value of generation of gas first day the value is 0 then increases to 1050ml then the value decreases gradually and increases on day 5 then decreases on day 6 shown in Figure 4.3 and Figure 4.4.

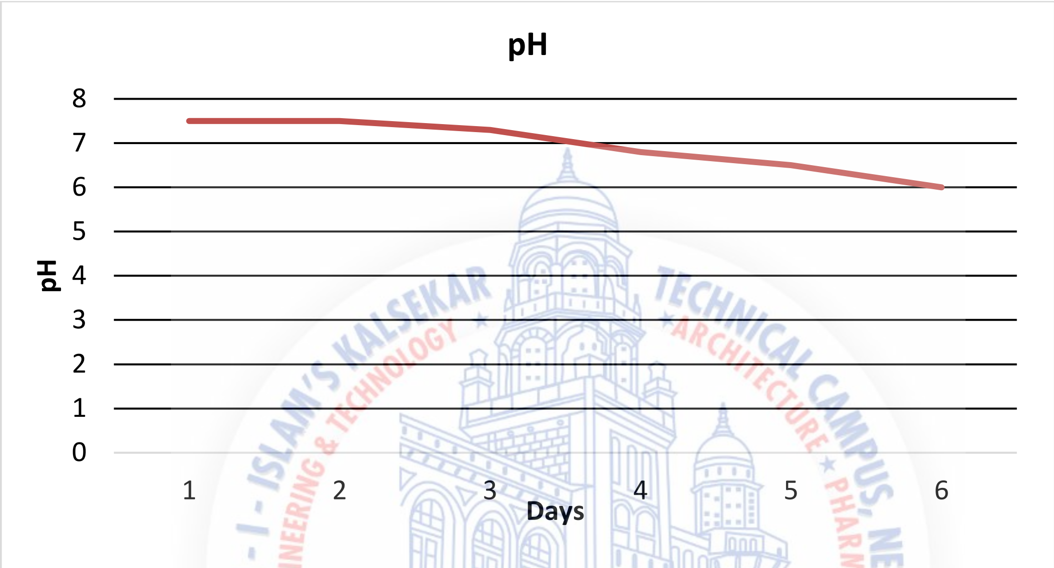


Figure 4.3 for 2.5 kg of food waste (Days V/S pH)

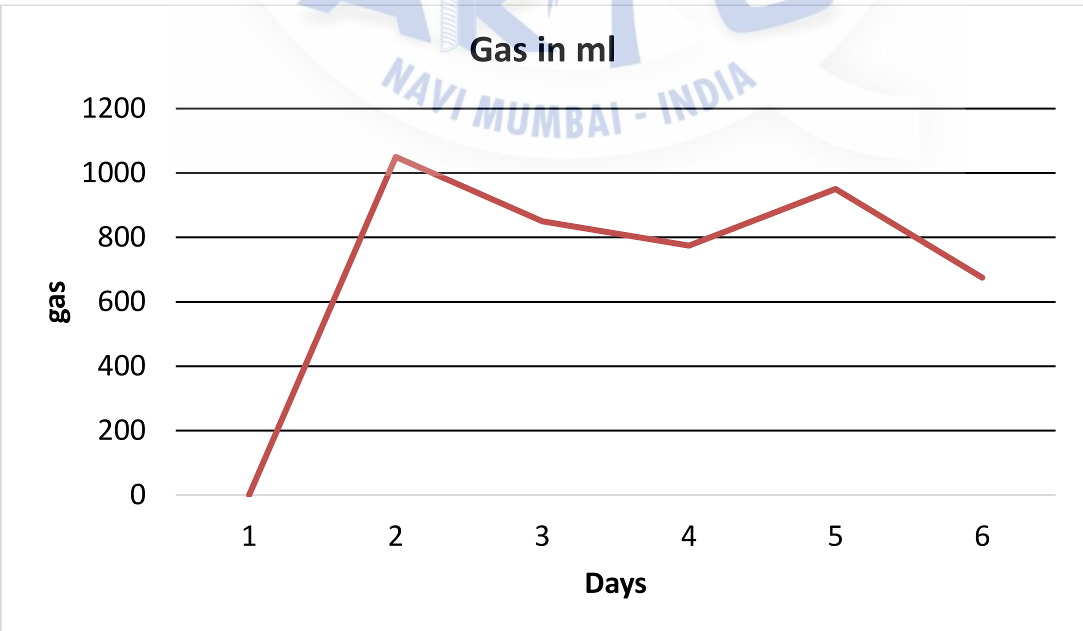


Figure 4.4 for 2.5 kg of food waste (Days V/S gas in ml)

4.1.3 For 4.5 kg of waste

In this week 2 kg of food waste is blended and added to the digester. And the pH and volume of gas generation is measured.

Table 4.3 pH variation and volume of gas generation for 4.5 kg waste

day	pH	Gas volume(ml)
13	7.4	0
14	7.1	1143
15	6.7	1057
16	6.1	1250
17	5.9	850

1. On the first day of the third week 2kg of food evenly blended with the blender poured into the digester and mixed thoroughly with the slurry present in the digester.
2. On first day of after 2kg of more food waste added the pH measured as 7.4 and gas generation was zero.
3. On second day the pH of the digester decreases to 7.1 and gas measured as 1143ml.
4. On third day the pH measured as 7.1 and the gas production measured as 1057ml.
5. On fourth day pH further reduces to 6.1 and gas production measured as 1250 ml.
6. On fifth day pH decreases to 5.9 and gas production reduces to 850ml.

As from the above observation we can say that pH of the digester gradually decreases and volume of gas fluctuates but it is observed that as we increase the food waste the no of days for gas production reduces shown in Figure 4.5 and Figure 4.6

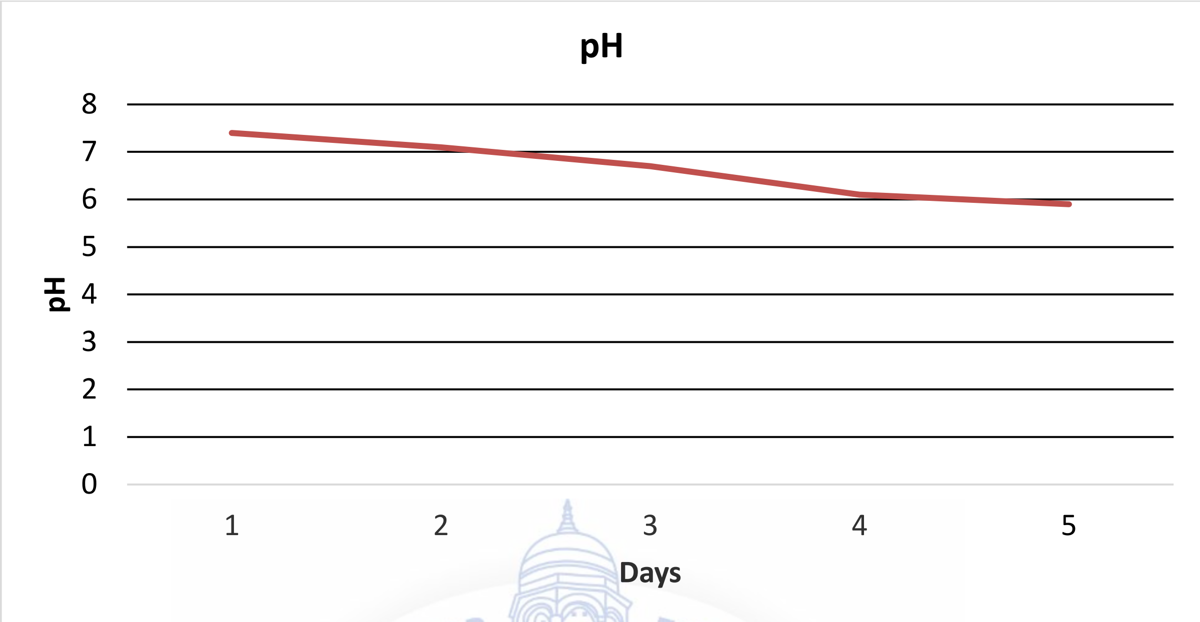


Figure 4.5 for 4.5 kg of waste (Days V/S pH)

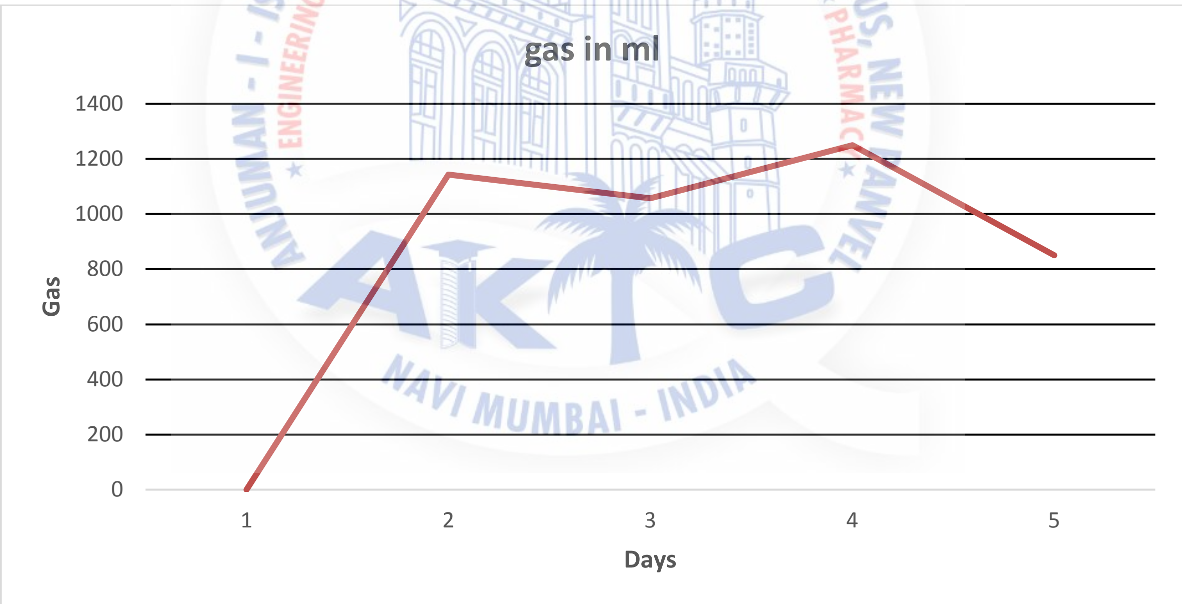


Figure 4.6 for 4.5 kg of waste (Days V/S gas in ml)

4.1.4 For 5.5 kg of food waste with 0.5 kg of cow dung (1 kg of mixture removed from the digester)

In the fourth week around 1.5 kg of sample of food waste was blended and was added in the digester and the gas was remove from the tube

Table 4.4 pH variation and volume of gas generation for 5.5 kg waste

day	pH	Gas volume(ml)
18	7.6	0
19	7.1	1580
20	6.5	1290
21	6.2	1430

1. On the first day pH was 7.6 and the gas generation was 0 ml.
2. On the second day the pH was 7.1 and the volume of gas generated was 1580 ml.
3. On the third day the pH value was 6.5 and the gas generation was 1290 ml.
4. On the fourth and final day pH value was 6.2 and the volume of gas generation was 1430 ml.

From this we conclude that the pH value decreases and there is a variation in the value of gas generation. It is observed the increase in the food waste reduces the no of days for gas production.

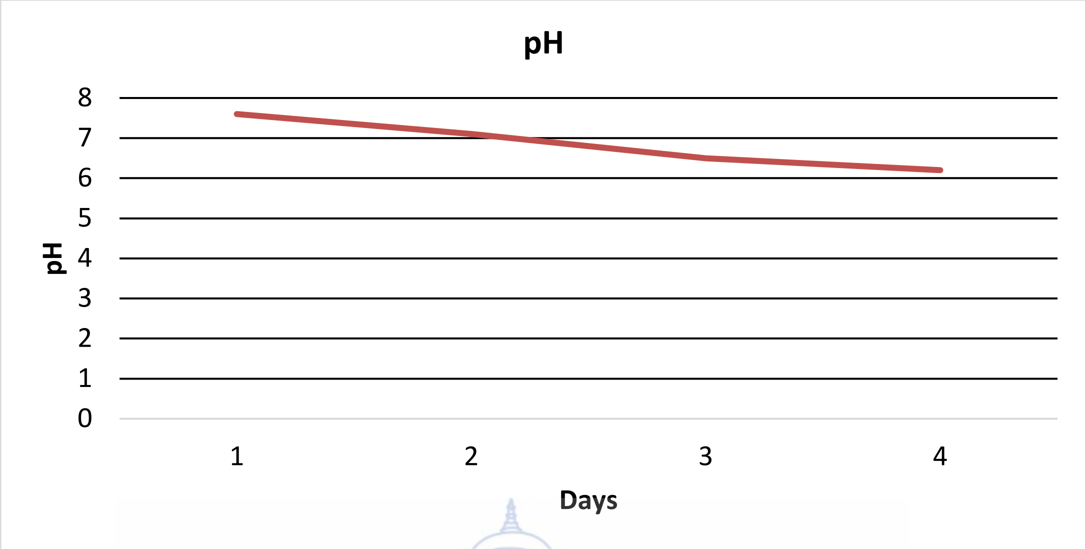


Figure 4.7 for 5.5 kg of food waste with 0.5 kg of cow dung (Days V/S pH)

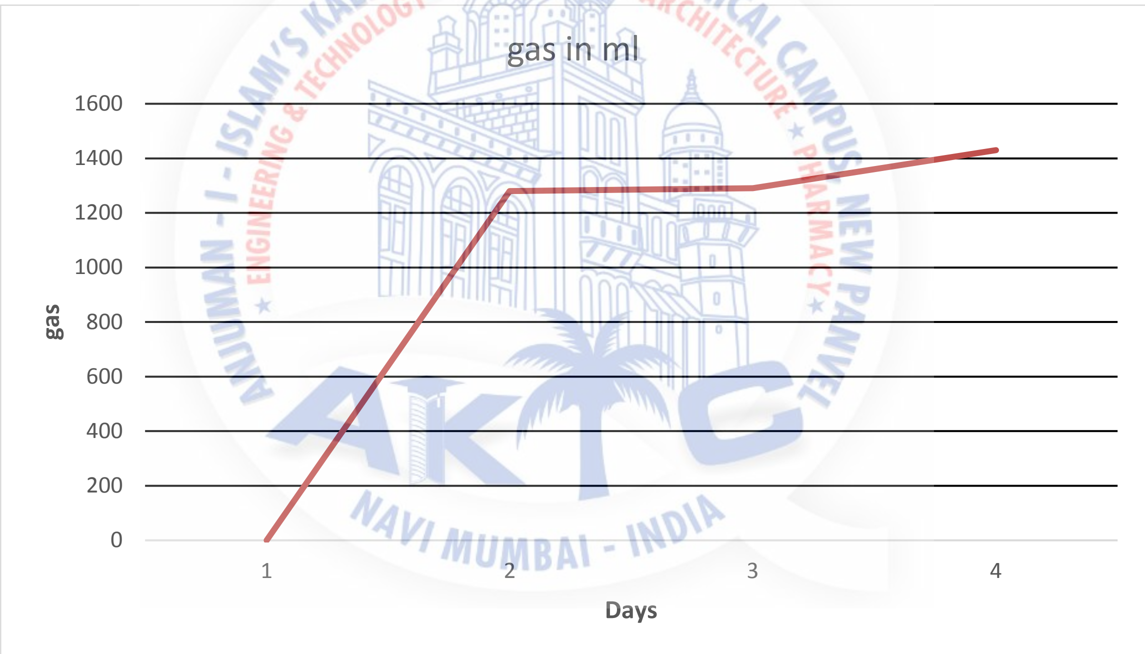


Figure 4.8 for 5.5 kg of food waste with 0.5 kg of cow dung(Days V/S gas in ml)

4.1.5 Overall result

- We had carried out the experiment for the 30 days.
- In each week the food waste is blended and added to the digester.
- Week 1: only cow dung was added
- Week 2: 1 kg of food waste added
- Week 3: 1.5 kg of food waste added
- Week 4: 2 kg of food waste is added after 4 days 1kg of feedstock removed from digester and 1 kg plus 0.5 kg of cow dung is added
- As the days increases the amount of gas generation fluctuates.
- It is observed that as we add the food waste the pH shows basic nature and then it gradually decreases
- As we increase the amount of food waste less no of days is required for filling the tube.
- The volume of the tube is measured by using the volume formula

Formula, $V = \pi (r_1^2 - r_2^2) h$

  - Where, r1 = outer radius of tube
    - r2 = inner radius of tube
    - h = height of tube
    - V = volume of gas
    - π = pi = 3.14159

- We measured the height of the tube so we get the volume of gas.

4.1.6 Graph for 21 days of is given below

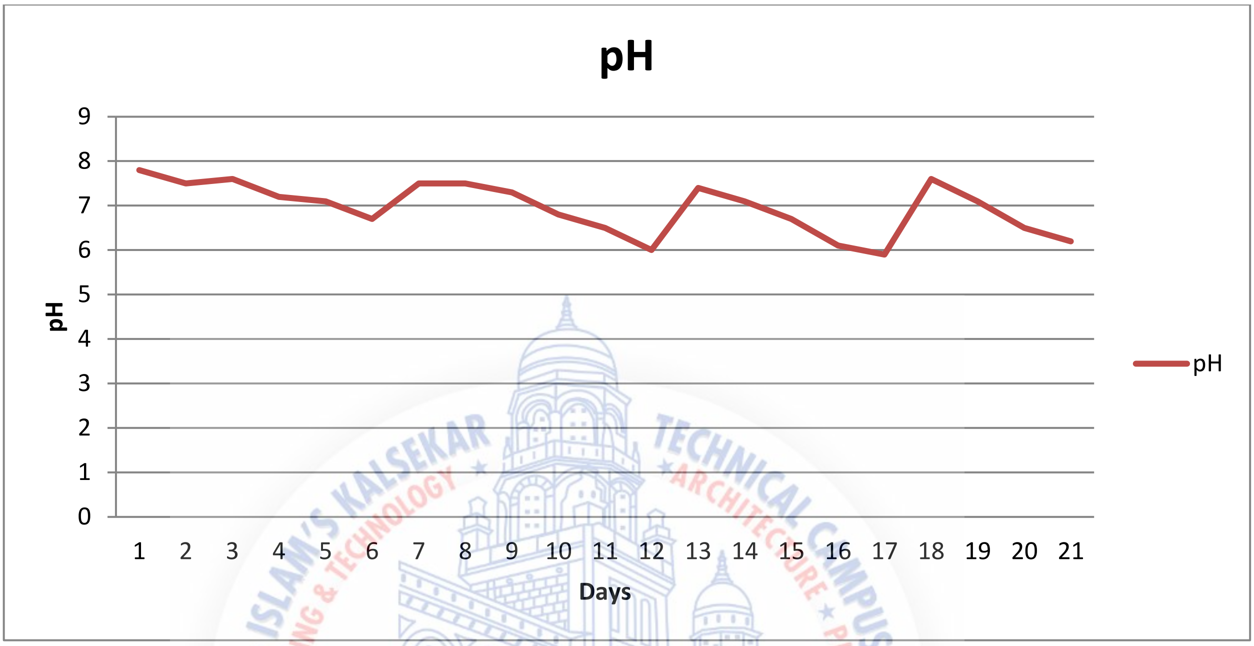


Figure 4.9 pH for 21 days of gas collection (pH V/S Days)

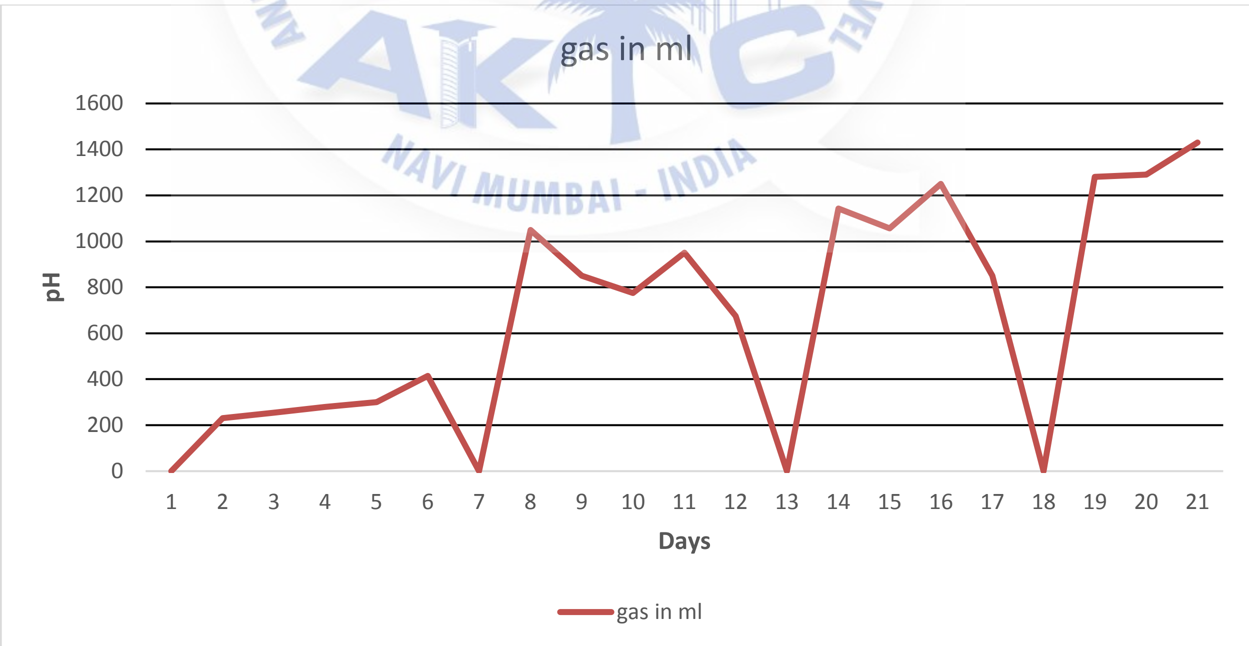
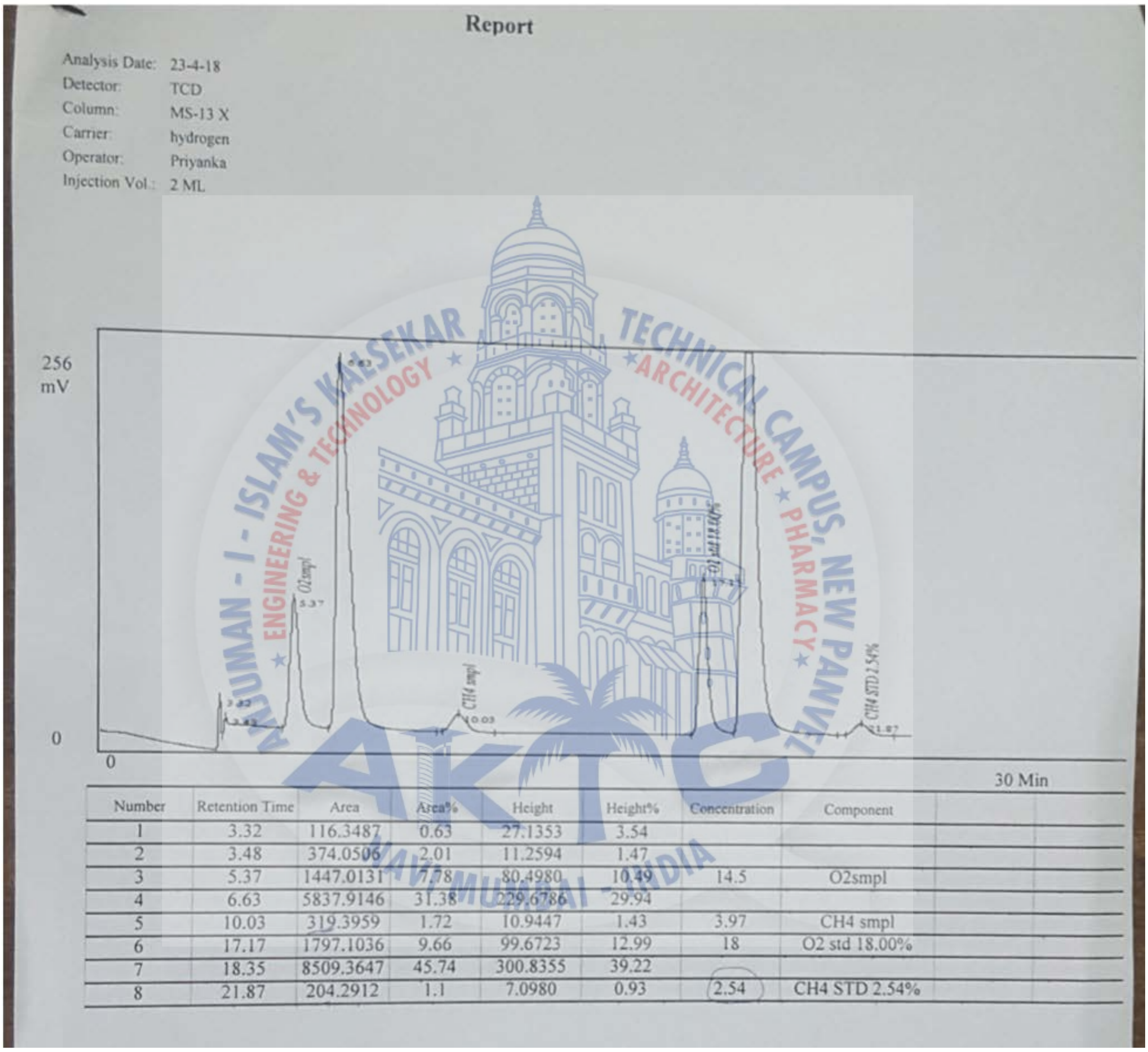


Figure 4.10 volume for 21 days of gas collection (Days V/S gas in ml)

In Experiment 2 Digester is kept for one week and not enough gas generation was found.

4.1.7 Methane generation:

The biogas sample was collected and analyzed in Chemtron scince labaratory private limited, Navi Mumbai for the methane concentration is shown in the Figure 4.11



Report

Analysis Date: 23-4-18
Detector: TCD
Column: MS-13 X
Carrier: hydrogen
Operator: Priyanka
Injection Vol.: 2 ML

Number	Retention Time	Area	Area%	Height	Height%	Concentration	Component
1	3.32	116.3487	0.63	27.1353	3.54		
2	3.48	374.0506	2.01	11.2594	1.47		
3	5.37	1447.0131	7.78	80.4980	10.49	14.5	O2smpl
4	6.63	5837.9146	31.38	229.6786	29.94		
5	10.03	319.3959	1.72	10.9447	1.43	3.97	CH4 smpl
6	17.17	1797.1036	9.66	99.6723	12.99	18	O2 std 18.00%
7	18.35	8509.3647	45.74	300.8355	39.22		
8	21.87	204.2912	1.1	7.0980	0.93	2.54	CH4 STD 2.54%

Figure 4.11 Methane concentration

Chapter 5

Conclusions

5.1 Conclusions

In AIKTC college canteen every day 8 to 10 kg waste is generated in both canteens. This is dumped in the dustbin. We have tried to generate biogas as the renewable energy source. We have taken 20 L of container and made digester for anaerobic digestion.5 kg of cow dung is mixed with the 5 liters of water and kept for one week .small amount of gas is generated in the digester .after that 1kg of food waste is added .gas generation starts from 3rd day of feeding of food waste. On an average every 3rd day the tube gets completely filled. After one week we added 2 kg of waste and after that another 2 kg of waste is added gas generated contain methane gas which can be used for cooking and various purposes so if we can use the whole canteens food waste then we will be able to generate as much energy which can be replaced with LPG gas.

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