

Analysis and Processing of Kitchen waste using portable Bio-Methanation Digester

Pavan Bharadwaj Pisipati

Mechanical Engineering M.V.S.R Engineering College

ABSTRACT

Biogas technology can be sustainable and cost effective in the long run. It is beneficial to the households for safe and smoke-free combustion for cooking in households. This project is concerned with designing a domestic facility that will treat kitchen waste to produce biogas. This biogas produced will be devoid, to very large extent of harmful bi products of anaerobic digestion. This system will use starchy or sugary feedstock waste grain flour, spoiled grain, over ripe or misshapen fruit, non-edible seeds, fruits and rhizomes, leftover food, etc. Two kilograms of such feedstock produces about 500g of methane and the reaction is completed within 24 hours. The process can be more efficient by adding 10kg of cattle dung and approximately 300 Kgs of methane gas can be produced. This is far more efficient than the conventional biogas system.

Keywords: Biogas, kitchen waste, of cattle dung, methane gas.

1. INTRODUCTION

The increasing demand for inexpensive, renewable and clean energy juxtaposed with the economic benefits has been the driving force of this industry. Every household, today, in India produces a large amount of organic waste. The main source of this waste comes from the kitchen. The idea of using this organic waste into a useful renewable energy has come into demand for the past few decades. The main reasons for the spread of renewable energy sources are to increase the security of the energy supply or, in optimal case, to realize total energy independence. Biomass is a major energy resource in rural areas of India. It plays a major role in domestic cooking and about 80 percent of domestic energy consumption in rural India is met by biomass fuel. About 90 percent of biomass using households of the country use wood, crop residue and animal dung as their primary cooking fuel. Biogas is perhaps the best alternative to fuel wood which is becoming a scarce resource. Biogas technology can be sustainable and cost effective in the long run. It is beneficial to the households for safe and smoke-free combustion for cooking in households. This project is concerned with designing a domestic facility that will treat kitchen waste to produce biogas.

Energy Content	6-6.5 kWh/m ³
Fuel Equivalent	0.6-0.651 oil/m ³ biogas
Explosion Limits	6-12% biogas in air
Ignition Temperature	650-750 °C
Critical Pressure	75-89 bar
Critical Temperature	-82.5 °C
Normal Density	1.2 kg/m ³
Smell	Bad eggs

So our project is basically concerned with the design of a domestic facility that will treat kitchen waste to produce the bio-fuel using the methanization process.

The system is 20 times as efficient as the conventional system and from the point of reaction time it is 40 times more efficient.

Thus the new system is 800 times as effective as conventional biogas system.

We are mainly concerned about making our design feasible and cost-effective so that it can be installed easily in urban sites as well as rural areas.

2. EXISTING BIOGAS PLANT SYSTEMS

- They are basically fixed in a particular place and mostly far from the place of source.
- Most of the conventional biogas plants are constructed underground and not being convenient to man.
- Impure gas produced since the absence of purifying equipment.
- Efficiency enhancement is difficult

3. PROPOSED BIOGAS PLANT SYSTEM

We analyze and process the kitchen waste to produce sufficient amount of methane.

We modified the conventional plant by:-

- Making a portable design of the plant
- Reducing the cost by effective material selection
- Providing a suitable temperature environment for the anaerobic digestion
- Installation of feasible purifying equipments

4. PLANT LAYOUT COMPONENTS

a. Substrate: Industrial and kitchen food wastes coming from food and meat production sites or processes such as wheat, potato mash, vegetable leftovers, brewer grains, apple marc. These kinds of substrates are usually very suitable and do not contain harmful substances.

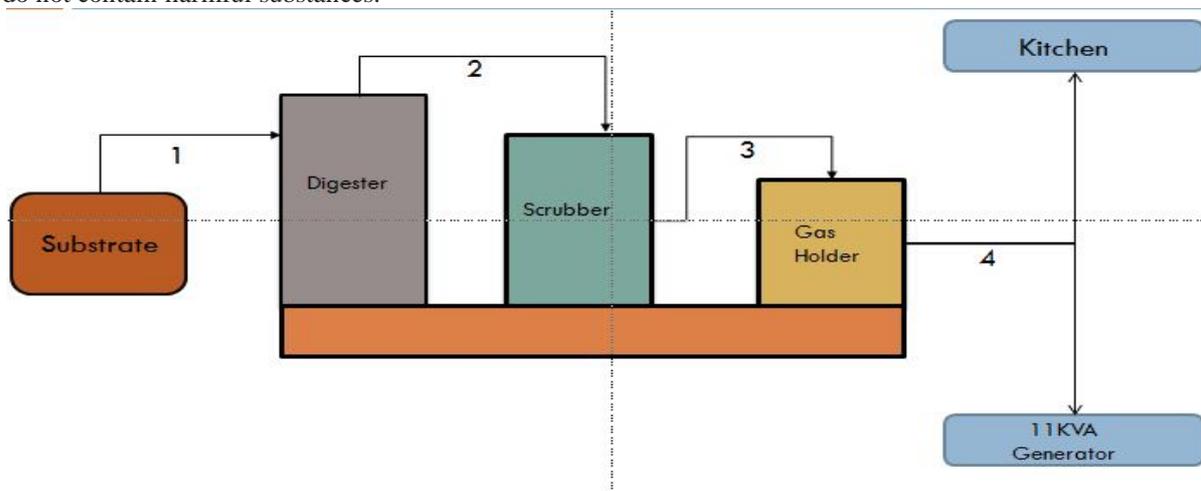


Fig 1:Plant Layout

b. Digester: The digester tank has been built using PVC materials to make it strong and rigid. It is an air-tight chamber in which anaerobic digestion of the available substrate occurs.

The size of the digester, i.e. the digester volume V_d is determined on the basis of retention time RT and the daily substrate input quantity S_d .

$$V_d = S_d * RT$$

Substrate Input (S_d) = biomass (B) + Water (W)

Biomass = Kitchen Waste + Cow Manure

c. Scrubber: The raw gas which comes out of the digester is transferred to the scrubber. Scrubbing is an operation that removes the unwanted components from the biogas. Biogas is composed of methane, carbon dioxide and other gases. The other gases involve Hydrogen Sulphide (H_2S) which is a harmful and poisonous gas which can corrode the materials. So to remove H_2S , the scrubber is installed with steel wool which would consume the H_2S and corrode itself, thus removing the gas from the mixture.

d. Gasholder: The gas holder is used to store the purified gas coming out of the scrubber. An inner collector is provided inside the gas holder, the collector is filled with 40% of water and the gas is led into it. The water in the gas collector has two functions, firstly it scrubs the carbon dioxide from the gas, and secondly it stores the gas under pressure. The gas is supplied to a stove or a Bunsen burner through pressure valves and PVC pipes.

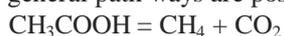
5. Thermodynamics of Methanation

After collection of the substrate it involves the following three stages:

1. Hydrolysis
2. Acidification
 - a. Acidogenesis
 - b. Acetogenesis

3. Methanogenesis

Two general path ways are possible





5. Factors affecting Biogas

- Substrate Temperature
- pH level
- Mixing ratio
- Pressure
- Inhibitors
- Loading rate

6. Projected implementation

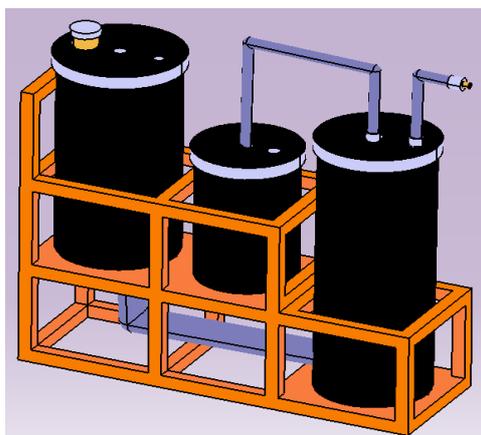


Fig 2: Trimetric Model

Stage1 (S1)

From previous studies it has been observed that mixing of cow manure and water in the ratio of 1:2 will be favourable for the perfect mixture of the biomass for production of gas.

15 Kgs of Cow manure + 30 Liters of water = 45 Liters of Biomass

This mixture of biomass is fed into the stirrer for 4 days, 45 liters each day. So totally the stirrer will be filled with 180 liters of biomass.

Level Analysis

Now the height up to which the stirrer is filled can be calculated according to:

$$180 \text{ Liters} / 0.18 \text{ m}^3 = \Pi * R^2 * H$$

Radius of the stirrer, R= 270mm Therefore height filled is H= 800mm

Stage2 (S2):

We observe gas generation in the digester and about 30-35 liters of gas gets collected in about 30-40 days. Now the gas needs to be tested. For this a suitable burner is fixed to the gas cock provided to the digester.

15 Kgs of cow dung + 5 Kgs of kitchen waste + 40 Liters of water = 60 Liters of biomass.

We need to prepare the same amount of feed for the next 3 days. We observe that the gas starts collecting in the digester after 52 hours.

Stages					
Stage1 (S1)	Days	Amount of Biomass	Temperature (°C)	pH	Pressure Developed (kg/cm²)
	Day1	45 Liters	25-30	7.52	0.8
	Day2	90 Liters	28-32	7.02	1.1
	Day3	135 Liters	35-45	6.5	1.3
	Day4	180 Liters	45-55	6.78	1.5
Stage2 (S2)	Day	Amount of Biomass	Temperature (°C)	pH	Pressure Developed (kg/cm²)
	Day1	60 Liters	28-33	6.7	1.15
	Day2	120 Liters	35-45	7.25	1.35
	Day3	180 Liters	50-55	7.56	1.55

Fig 3: Observations

Stages	Amount of gas produced/ Day (grams)								Average amount of gas/ Day (grams)
	Day1	Day2	Day3	Day4	Day5	Day6	Day7	Day8	
Stage1	120	224	358	326	490	548	556	525	303
Stage2	185	256	400	535	765	837	850	935	620



Fig 4: Bio gas plant in our college canteen



Fig 5: Digester with hose pipe

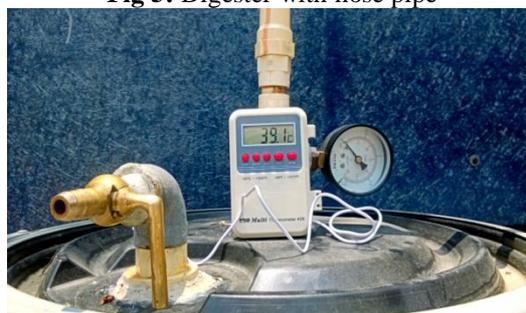


Fig 6: Gas cock, Temperature indicator and pressure gauge attached to the digester

7. CONCLUSION

The requirement of a clean and safe energy has been our interest. Biogas is one the most clean and eco-friendly gas which can be produced in a safer and feasible manner. It can be utilized as cooking gas, IC Engines, Biogas lamps, Radiant Heaters, Refrigerants, Combined Heat and Power Plants.

REFERENCES

- [1]. Karve .A.D. (2007), Compact biogas plant, a low cost digester for biogas from waste starch. <http://www.arti-india.org>.

- [2]. Kale, S.P and Mehele, S.T. kitchen waste based biogas plant.pdf. Nuclear agriculture and Biotechnology/ Division.
- [3]. Cornejo, C. and Wilkie, A.C. (2010). Greenhouse gas emissions and biogas potential from livestock in Ecuador. Energy for Sustainable Development.