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Analysis on Biogas Plant

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ABSTRACT: In our today's life we observed that the environmental problem of our society is continousely increasing due to the much production of municipal solid waste or organic wastes. In many countries and cities, sustainable waste management has become a major political issue, to reduce pollution and greenhouse gas emissions. Dumping of waste is and even controlled landfill disposal, and incrination of organic wastes is no longer acceptable today. As environmental standards here of are increasingly stricter and energy recovery and recycling of nutrients and organic matter is aimed. Biogas is a fuel, produced from by breakdown of organic waste in a close chamber and in the absence of oxygen. Biogas is the best and good source of clean energy
Keywords: Municipal Solid waste,landfill disposal,greeon house gas,pollution.

I. INTRODUCTION:

The biogas also known as Gobar gas in India. The other name are marsh, wet gas and swamp gas. Raw biogas contains about 55-65% methane(CH4),30-45% carbon dioxide (CO2) ,traces of hydrogen sulphide (H2S), and fractions of water vapours. Biogas is having calorific value 4800 to 6900kcal/kg. It is suited for lighting, cooking, drying and fuel for internal combustion engines.The storage and liquefy of biogas is difficult. Biogas can be produced by fermentation through anaerobic digestion of organic material. The container in which digestion takes place known as digester. A Common material used as feedstock is an animal waste, crop residues, urban waste etc. Other material such as sugarcane trash, tobacco waste, cotton dust, fruit and vegetable waste, branches and leaves of trees are used. Any organic cellulose material from animal or plant that is easily biodegradable are potential raw material for biogas production.

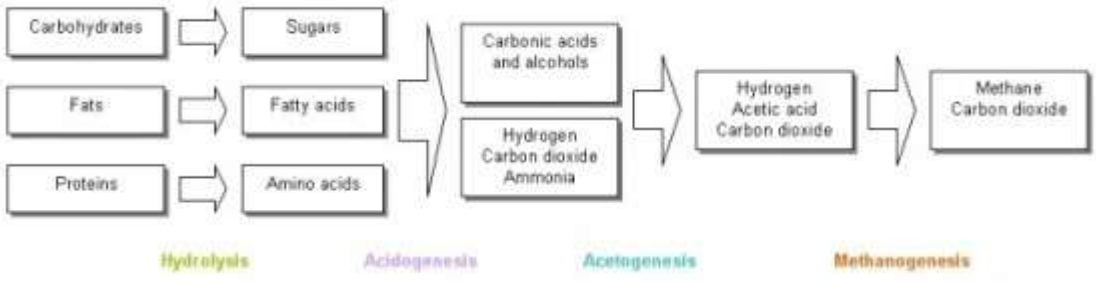

Fig.1 Flow chart of process

When biomass decomposes in open air, it is acted upon aerobic bacteria to produce carbon dioxide and ammonia; thus the total carbon component oxidized to produce carbon dioxide. Biogas is produced from weight biomass with 90% water for the action of anaerobic bacteria. Part of the carbon is oxidized and another part reduced to produce carbon dioxide and methane (CH4). These bacteria live and grow with very less amount of oxygen. The airtight container used for conversion is called digester. The conversion process is called anaerobic fermentation or bio digestion. The soluble nitrogen compounds known as nutrients available in solution and produces good quality fertilizer with methane gas. It is noticed that available energy from the combustion of biogas is 65%- 90% of input dry matter and heat of combustion. Thus, the efficiency of a process is the

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rest between 65% to 90%. For the generation of bio gas, the chemical process mainly occurs in three stages :-

Stage 1. – The biomass feed in a digester in which organic matter containing a complex compound (carbohydrates, proteins, and fats) is broken down in presence of water known as hydrolysis .The large molecules of polymers are broken down to small molecules of monomers. These operations complete within two days at 25˚C in a digester .

Stage 2. – The anaerobic bacteria that can grow without oxygen are to gather known as acid formers that produced acetic and proponic acids. In this stages, carbon dioxide is also released at this stage takes about one day time at 25˚C.

Stage 3. – In this stage due to anaerobic bacteria reaction, the methane, carbon dioxide and less quantity of hydrogen gas is produced. These processes take about two weeks to complete at 25˚C.

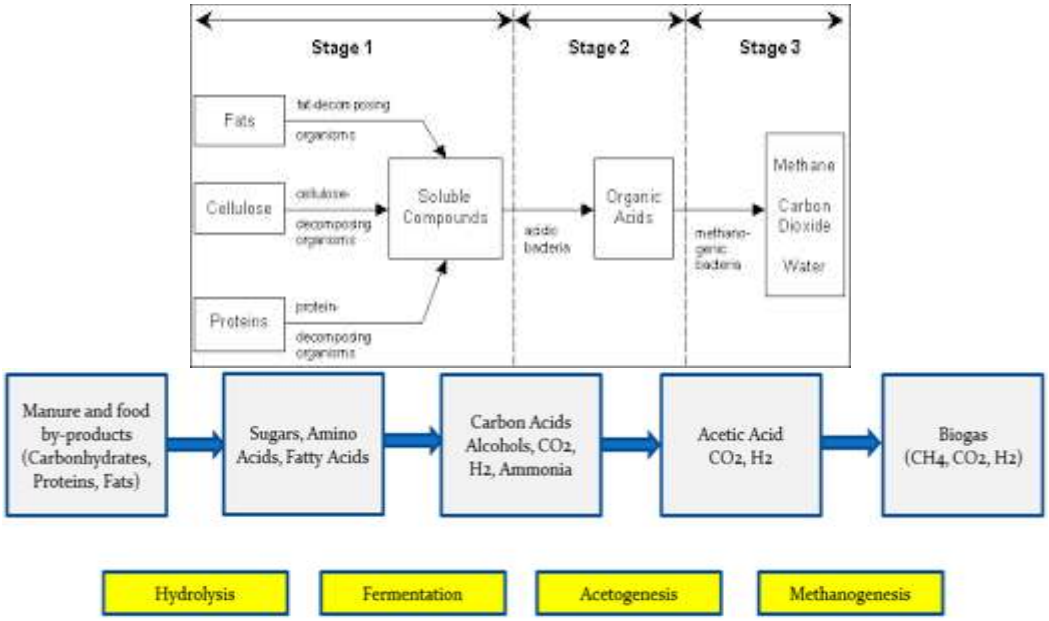

Fig. 2 Stages of anaerobic digestion process

II.PROPERTIES OF BIOGAS AS A FUEL :

(i)Energy density is 22.35 to 24.22 (MJ/m3).
(ii)Octane rating is 110.
(iii)Ignition Temperature is 650˚C.
(iv)For complete combustion, the methane to air ratio (volume) is 1 to 10.
(v)An explosive limit to air is 5 to 10 by volume.
Also, Methane is a key element in biogas. It is also used in internal combustion engine as a fuel but after certain treatment. The raw biogas contains corrosive property that can reduce the life of an engine.

III. ADVANTAGE OF ANAEROBIC DIGESTION:

1. Waste material is used to produce good amount of energy.
2. By anaerobic digestion, two types of products are formed- Fuel in the form of biogas and fertilizers in the form of sludge/slurry.
3. The Energy requirement of industry like dairy farm can be met from anaerobic digestion of the waste.
4. The system is completely enclosed the odors are contained. Digested slurry is odorless.

IV. TYPE'S BIOGAS PLANT

Mainly classified as

1. Batch type Biogas plant.
2. Continous type.
3. Movable type drum plant.

BATCH TYPE BIOGAS PLANT

Batch type biogas plants are appropriate where daily supplies of raw waste materials are difficult to be obtained. A batch loaded digester is filled to capacity sealed and given sufficient retention time in the digester. After completion of the digestion, the residue is emptied and filled again. Gas production is uneven because bacterial digestion starts slowly, peaks and then tapers off with growing consumption of volatile solids. This difficulty can overcome by having minimum

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to digester so that at least one is always in operation. This problem can also minimize by connecting batch loaded digester in series and fed at different times so that adequate biogas is available for daily use.

This type of plant requires feeding in every 50 to 60 days gap. After feeding 8 to 10 days are required to supply the gas and continuously for 40 to 50 days till the process of digestion is completed and after sometimes it is emptied and recharged. The Battery of digesters is charged and emptied one by one to maintain a regular supply of gas through a common gas holder. The installation and operation of these types of plants are capital and labor intensive. They are non-economical unless operated on the large scale. These types of plants are mainly installed in European countries as they do not suit the condition in Indian rural areas.

The salient features of batch-fed type biogas plants are:-

Gas production in batch type is uneven.
(ii) Batch type plants may have several digesters for continuous supply of gas.
(iii) Several digesters occupy more space.
(iv) This type of plants require large volume of digester, therefore, initial cost becomes high.
(v) This plant needs addition of fermented slurry to start the digestion process.

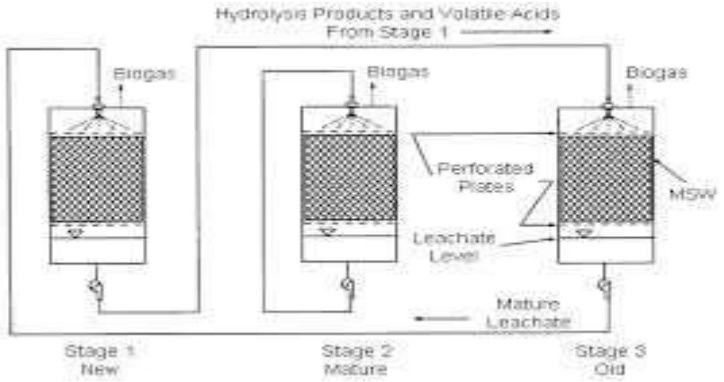

Fig. 3 Batch type biogas plant

CONTINOUS TYPE BIOGASS PLANT

In continuous type biogas plant, the supply of the gas is continuous and the digester is fed with biomass regularly. Continuous biogas plants may be single stage, double stage or multiple stage. Digestion of waste materials in a single chamber or digester is called single stage process, in two chambers or digester is called multi stage process. In double stage process, acidogenic and methanogenic stage are physically separated into two chambers. Thus, the first stage of acid production is carried out in a separate chamber and only diluted acids are fed into the second chamber where biomethanation takes place.

In single stage ,acidogenic and methanogenic stage are carried out in the same chamber without barrier. These plants are economic, simple and easy to operate. these plants are generally for small and medium size biogas plants. However ,the two stage biogas plants are costlier, difficult in operation and maintenance but they produce more gas. These plants are preferred for larger biogas plant system.

This type of plant requires daily feeding with a certain quantity of biomass. The gas is stored in a plant or the separate gas holder and is available for further use. The biomass when slowly passed through digester gets completely digested, and digested slurry is given out through an outlet. The period in which the biomass remains in the digester is known as retention period. This period mainly depends on the type of biomass and operating temperature. The plant is continuously operated and stops only for removal of sludge i.e. undigested biomass residue. The thin dry layer formed at the top of the slurry is known as scum. The function of scum is to prevent the escape of gas from the slurry. The breaking down of layer takes place when the slurry is slowly stirred, and it also helps in digestion process due to better mixing. The feeding pattern of such plants matches with daily waste generation and does not require its storage therefore they are convenient for individual owners. These types of plants are mainly popular in India and China

The important features of continous type biogas plants are:-

(i) Gas production is continuous.
(ii) Retention period is less.
(iii) Less problems as compared to batch type.
(iv) Small digestion chambers are required.

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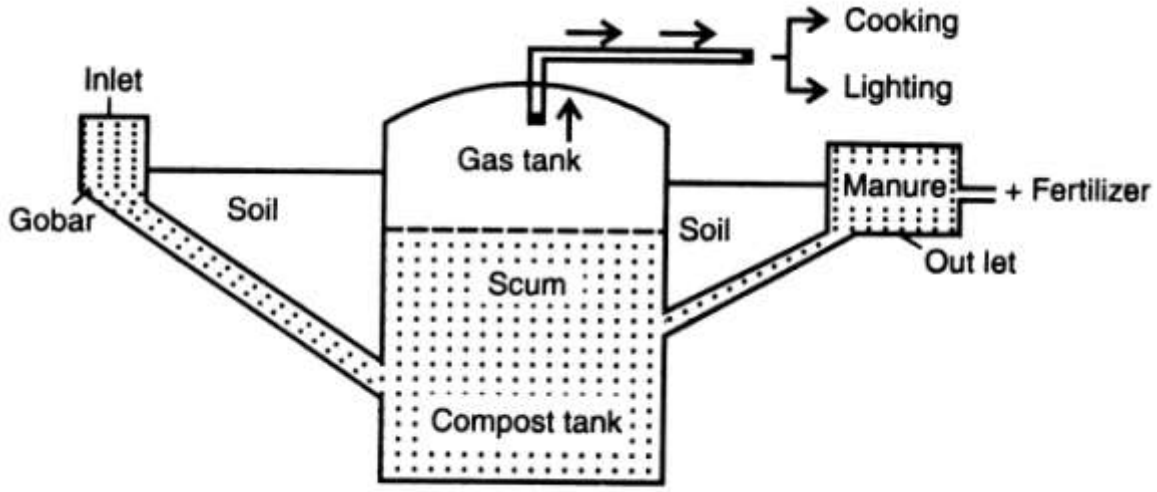

Fig. 4 Continous type biogas plant.

a. Floating drum types biogas plant:

Khadi Village Industries Commission India develops a domestic biogas plant. In this plant, a mild steel drum is used as a gas holder. This drum is most expensive component in this plant and covered by masonry construction with a partitioning wall that creates a required condition for the growth of acid formers and methane formers. This plant produces a good biogas yield.

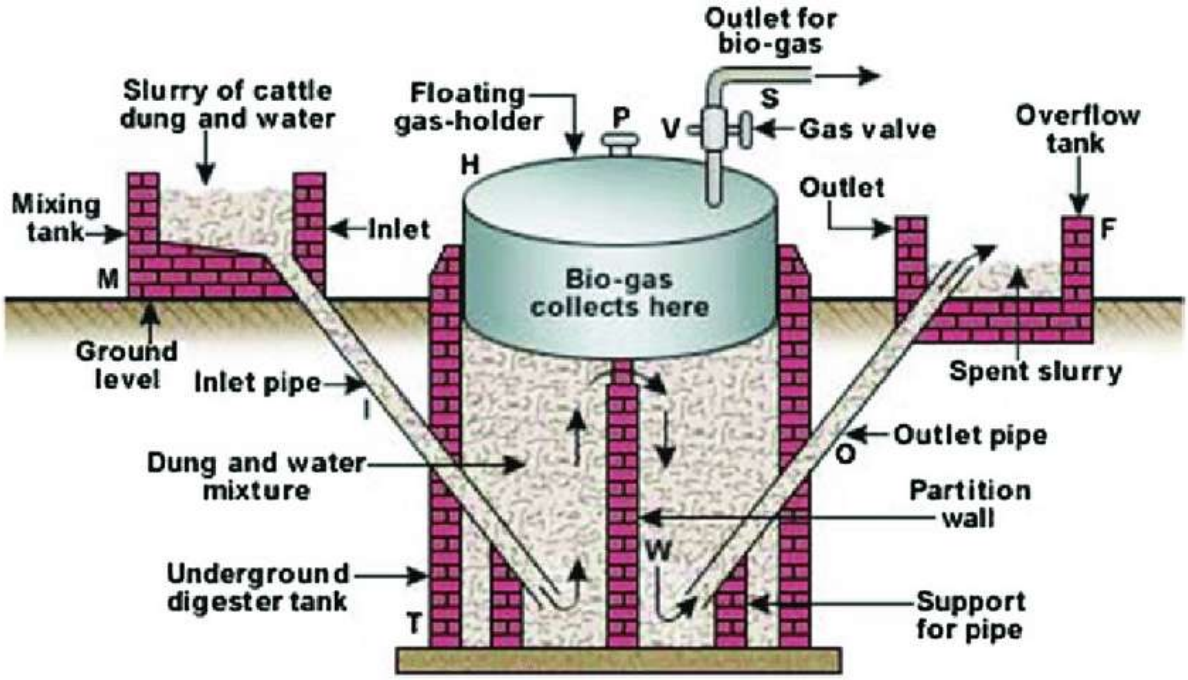

Fig.5 Floating drum type biogas plant.

b. Fixed dome types biogas plant:

This type of plant requires only masonry work that's why it's economical in construction. Pressure in gas varies depending on the production and consumption rate. A dome structure is very strong for outside pressure but weaker for inside pressure. A skilled masonry is required for construction of dome as gas exerts pressure from inside out, the dome structure may be failed. The slurry enters from the inlet, and the digested slurry is collected in displacement tank. If the raw material is crop residue than stirring is required. As

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there is no bifurcation in digester chamber, therefore the gas production is somewhat very low as compared to floating point design. The gas stored in the dome is stored in the dome and displaces liquid in inlets and outlet, sometimes leading gas pressure as high as 100 cm of water. The gas occupies about 10% of the volume of the digester. The complete plant is constructed underground therefore temperature tends to remain constant and is often higher than in winter. Many variations in basic models are developed keeping in view the portability, ease of installation and maintenance, local availability of material and cost.

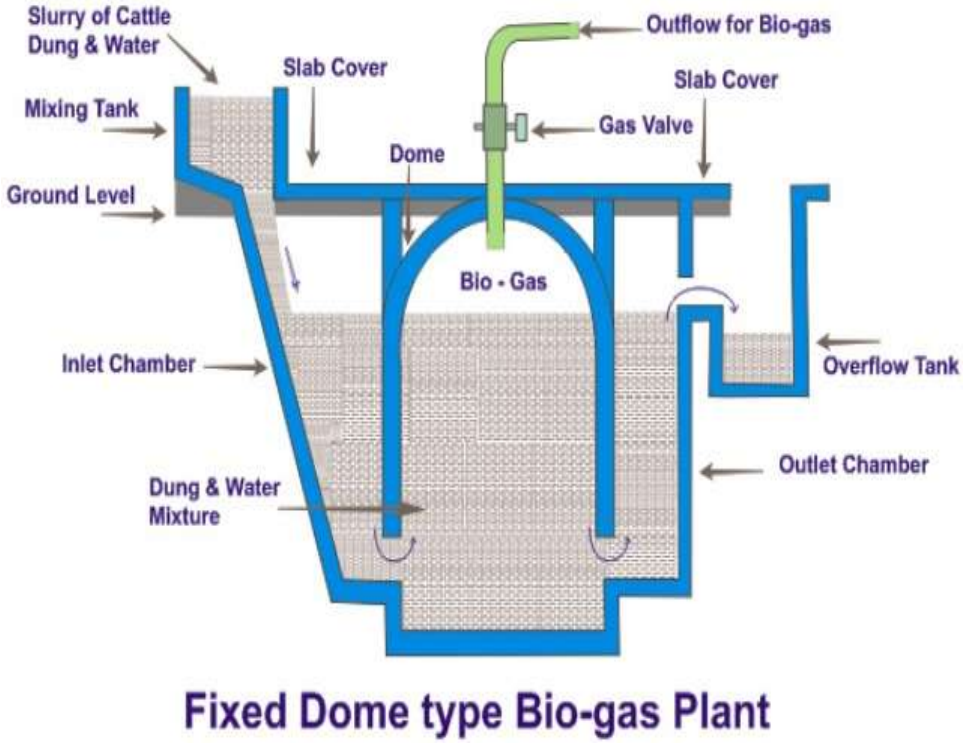

Fig.6 Fixed Dome type Biogas plant

MOVABLE DRUM TYPE PLANTS

This also known as floating dome type biogas plants. The conventional movable drum type comprises a masonry digester with an inlet on one side for feeding slurry and an outlet on the other side for removing digested slurry. The gas collects in a steel gasholder which is inverted over the slurry and moves up and down depending upon accumulation and discharge of gas guided by a central guide pipe. This movable gas holder is made of steel.

The gas holder is painted by anticorrosive painting at least once in year. This plant helps in consistent pressure which can be adjusted by regulating weight. The main drawback of this is that metal cost is large and maintenance cost is also high. To tackle this problem the scientist have created high density polyethylene.

Advantages:
(i) Constant gas pressure.
(ii) No problem of gas leakage.
(iii) Higher gas production.
(iv) Scum problem is less.

V. FACTORS AFFECTING THE BIOGAS DIGESTION PROCESS :

1. Temperature

Methane forming bacteria works best in temperature ranges 20 to 55˚C. Digestions at higher temperature processed more rapidly than at lower temperature, with gas yield in ratesdoubling at about every 5˚C increase in temperature. The gas production decreases sharply at below 20˚C and almost stops at about 10˚C. Raising temperature accelerates the gas production however it's methane content gets relatively decreased.

2. **Pressure**

A minimum pressure of 6 to 10 cm of water column i.e.1.2 bar is considered as ideal for proper functioning of the plant and it should never

exceed 40 to 50 cm of the water column. Excess pressure leads to masonry through microscopes and inhibits gas to release from the slurry.

3. **Solid to moisture ratio in biomass**

The Presence of water is essential for hydrolysis process and activity of extra cellular Enzymes, that helps in better mixing of various constituent of biomass, movement of Bacteria and faster digestion rate. At higher water level, gas production drops but if the water level is too low, more acid accumulation takes place, and it stops fermentation process. Raw cow dung contains 80% by weight, and it is mixed with equal amount of water to minimize solid content up to 15%.

4. **pH Value**

The value of pH during acid forming stage is equal or less than 6. But during methane formation stage pH value goes up to 6.5 to 7.5 .

5. **Feeding Rate**

In the excessive feeding of raw material at a time, an acid will accumulate, and digestion Process stops. A uniform feeding rate in the proper interval of 50 days, amount equal to 0.02 of the volume of the digester should be maintained.

The methane content depends on the feed material. Some typical values are as follows :

Cattle manure -66% Poultry manure -61%
Pig manure- 65%Farmyard manure- 55%
Straw 59% Grass- 70% Leaves- 58%
Kitchen waste- 50%Algae- 63%
Water hyacinths- 52%

6. **Carbon to nitrogen ratio**

Carbon and nitrogen are the major requirements for anaerobic bacteria. For good Microbiological activity, ratio required of C: N = 30:1 .

The fluctuation of this ratio slows down the digestion process.

VI. CONCLUSION:

I observed that the Study about biogas production has shown that municipal waste i.e. available in huge quantity everywhere can be a good source of energy if the government seriously works on it. In this area lot of scope is available for entrepreneur to start the biogas production plant near the industrial area to fulfill the need of energy requirement of industry and residential area and also maintain the city neat and clean.

REFERENCE:

[1]. K. Kaygusuz and A. Kaygusuz, "Renewable energy and sustainable development in Turkey," Renewable Energy, Vol. 25, Issue 3, pp. 431-453, March 2002.
[2]. https://www.sciencedirect.com/topics/engineering/biogas#:~:text=Biogas%20is%20an%20emerging%20renewable,et%20al.%2C%201998
[3]. S. M. Maishanu, M. Musa and A. S. Sambo, "Nigerian Journal of Solar Energy," vol. 9, 183-194, 1990.
[4]. A.V. Buren, "A Chinese Biogas Manual," Intermediate Technology Publications Ltd. 11 24, 1979.
[5]. P. R. Bhat, H. N. Chanakya and N. H. Ravindranath, J. "Energy Sustainable Dev". 1:39 – 41, 2001.
[6]. https://dapsenergyfromwaste.weebly.com/anaerobic.html
[7]. B.H. Khan, "Non-Conventional Energy Resources". 2009 by McGraw Hill Education.
[8]. https://www.indiastudychannel.com/resources/117400varioustypesbiogasplants.aspx#:~:text=Various%20types%20of%20biogas%20plants%201%20Movable%20type,2%20Continuous%20type%20plant%203%20Batch%20type%20plant

links of figures:

https://www.researchgate.net/profile/Anil_Kumar266/publication/283255485/figure/fig3/AS:667840499687446@1536236991989/Batch-type-biogas-plant-4.jpg
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