Biogas Production with Upgraded Design

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***Abstract* - Biogas is a result of anaerobic digest ate of organic matter .Proper or optimum condition with respect to temperature; pressure and PH will control the production rate of the biogas. An attempt have been made here to keep these variable up to the mark with a special design using FRP (fiber reinforced polymer) as the material of digester construction and polypropylene glass was used as a insulator in order to maintain the temperature inside the plant. The outcome of these design were satisfactory. With a glance on the results obtained it is clear that temperature and pressure change was minimum and were successful in maintaining the temperature on mesophilic temperature 35 °C and the pressure of 20-30 cm water column. The yield obtained is 30 – 45 % more yield than the conventional type of biogas which quite satisfactory.**

Keywords: FRP, polypropylene, pressure, temperature

INTRODUCTION

Biogas is a result of anaerobic digestion of the organic matter, such as animal waste (cow dung) containing a high nutritional content, carbohydrate and lignin content. The fast depletion of fossil fuel has led us an option confronts of us to find an alternate source of fuel. Biogas with minimum limitation, food waste is difficult to burn, treat or recycle since it contains high moisture and is mixed with other wastes during collection [1-2]. Major generators of food waste include households, hotels, restaurants, supermarkets, residential blocks, cafeterias, food processing industries, etc. The proportion of food waste in the municipal solid waste is gradually increasing. Hence, a proper food waste management strategy needs to be devised to ensure its eco-friendly and sustainable disposal. Food waste can be recycled via anaerobic digestion, composting and vermin composting. Biomethanation systems already exist in India. However, a large part of these systems are related to farm scale biogas plants and industrial effluents. Ones, availability, production and utilization have scope to replace the depleting fossil fuel [3].

BIOGAS TECHNOLOGY

Biogas is the name given to the mixture of gases generated by the bio-degradation of organic substances under the anaerobic conditions. Sewage and agriculture waste contain organic substances with the proper temperature and humidity conditions, these substances are broken into lower molecular compound material, inorganic matter and gases [3].

BASIC PRINCIPLES OF BIOGAS PRODUCTION

Biogas can be generated from various sources from the biotic as well as abiotic materials such as municipal waste, human and animal waste. Every Organic matters is composed mostly of carbon(C), combined with other elements such as hydrogen (H), oxygen (O), nitrogen (N), sulphur (S) to form organic compounds such as carbohydrates, proteins and lipids. Two type of bacteria's are involved in the biodegradation process, one is acid forming bacteria and the other is methane forming bacterial. Through a digestion process the complex carbon break into smaller substances. The digestion process occurring in presence of oxygen is called aerobic digestion. [1-7]

The digestion process occurring without oxygen is called anaerobic digestion and generates mixtures of gases with main contents as methane (CH_4).

FACTORS AFFECTING YIELD AND PRODUCTION OF BIOGAS

Factors affecting the fermentation process of organic substances under anaerobic Condition are

- The quantity or the amount of feed and nature of organic matter
- The temperature
- Acidity and alkanity (PH value) of substrate
- C : N ratio

During the initial feeding of organic material or after adding new material, small quantities of oxygen as well as aerobic bacteria will enter the digester. These aerobic bacteria, along with some oxygen –tolerant anaerobic bacteria present in the fermented matter will burn the oxygen present and thus help to restore and maintain anaerobic condition. Thus it is important to understand their effects in order to design effective man-made bio-digesters. [4-10]

Properties of biogas

Component	Concentration by volume
Methane	55-60
Carbon dioxide	35-40
Water	2-7
Hydrogen Sulphide	2
Ammonia	0-0.05
Nitrogen	0-2
Oxygen	0-2
Hydrogen	0-1

Methodology
1. Hydrolysis
2. Acidification
3. Methanogenesis

HYDROLYSIS:

In the first step, the organic matter is enzymolysed externally by extracellular enzymes, cellulose, amylase, protease & lipase, and micro organisms. Bacteria decompose long chains of complex carbohydrates, proteins & lipids into small chains. For example, Polysaccharides are converted into monosaccharide. Proteins are split into peptides and amino acids.

ACIDIFICATION:

Acid-producing bacteria, involved in this step, convert the intermediates of fermenting bacteria into acetic acid, hydrogen and carbon dioxide. These bacteria are anaerobic and can grow under acidic conditions. To produce acetic acid, they need oxygen and carbon. For this, they use dissolved O_2 or bounded-oxygen. Here by, the acid-producing bacteria creates anaerobic condition which is essential for the methane producing microorganisms. Also, they reduce the compounds with low molecular weights into alcohols, organic acids, amino acids, carbon dioxide, hydrogen sulphide and traces of methane. From a chemical point of view, this process is partially endergonic (i.e. only possible with energy input), since bacteria alone are not capable of sustaining that type of reaction. [1-8]

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. Under natural conditions, CH_4 producing microorganisms occur to the extent that anaerobic conditions are provided e.g. under water (for example in marine sediments) and in marshes. They are basically anaerobic and very sensitive to environmental changes, if any occurs. The methanogenic bacteria belong to the archaebacter genus i.e. to a group of bacteria with heterogeneous morphology and lot of common biochemical and molecular-biological properties that distinguishes them from other bacteria's. The main difference lies in the make. [1-8]

Types of Biogas Plant

(i) The Fixed dome:

This consists of an airtight container constructed of brick, stone or concrete, the top and bottom being hemispherical. Sealing is achieved by building up several layers of mortar on the digesters inner surface if brick is used for construction. It is relatively cheaper to construct the fixed dome digester than the floating gasholder type.

(ii) The Floating gasholder:

The design of this digester was first developed by Indian's Khadi and Village Industries Commission (IKVIC) and consists of a cylindrical container, the height to diameter ratio being in the order of 2.5 –4.1:1, constructed of brick or concrete reinforced with chicken wire. The cover is usually constructed of mild steel. Cost, corrosion and maintenance of the cover have been the main problem of this design. However, the mild steel cover is gradually been replaced by plastic gasholder.

(iii) The Bag digester:

This type of digester comprises of a long cylinder, either polyvinyl chloride (PVC) or a material known as red mud, plastic – developed in 1974 from the residues of bauxites smelted in aluminum production plants. Incorporated in the Bag are inlet and outlet pipes for the feedstock and slurry and a gas outlet pipe. Gas produced is stored in the bag under a flexible membrane. A complete 50 m^3 can be easily installed in a shallow trench. This type of digester is not popular. [1-8]

Scope:

Biogas is eco friendly, easily available and is a result of the anaerobic digestion of waste material. A developing country like India is facing major problem in decomposing and disputing it. As the moisture content is more in vegetable waste, food waste compared to other biomass resulting a very tough job in handling it. A biogas plant is a perfect solution for decomposing and even getting useful fuel and it have proved an initiative step for being a good source of alternative fuel. Demographical study is showing the fast growth rate of population and as a result of it sewage waste and municipal waste is also bulking itself and is predicted up to 3000-5000 tons in the metropolitan city. Till now many organization and Government organizations have taken steps and have implemented schemes in waste handling and reusing as a source of alternative energy.

Design:

Keeping in focus of required conditions, the design was made with following dimensions.

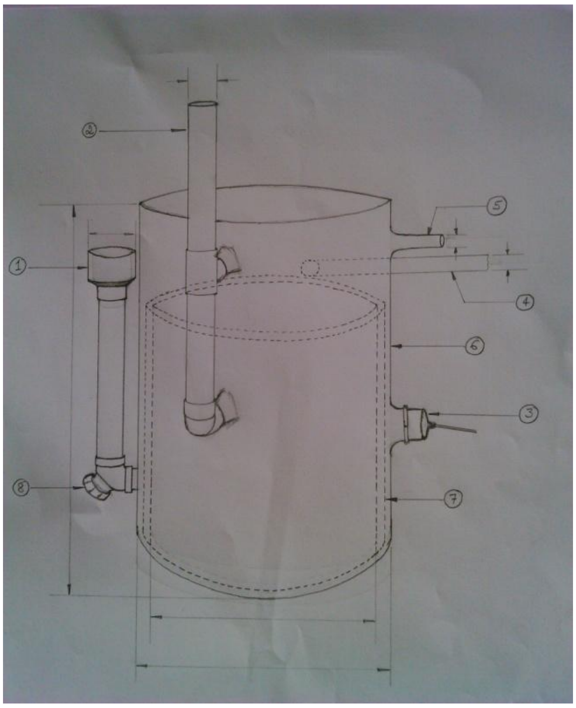

Fig 1.Brief outlet of Biogas plant

Table 1.physical characteristics of biogas plant

S.no	Part	Material	Dimension (mm) length/Dia	Range /Capacity
1	Inlet pipe	PVC	90	
2	Pressure balance pipe	PVC	45	
3	Thermocouple	digital	Pocket size	-5°to 300°C
4	Gas outlet Ball valve	Cast iron	25	
5	Pressure balance pipe	PVC	25	
6	Digester &air holder tank	FRP	1066 x 609	300ltrs
7	Insulator sheet	Polypropylene	3x900	
8	Cleaning outlet pipe	PVC	90	

Design consideration

In order to maintain the appropriate condition for biogas following design considerations were made

Mechanical Strength:

The failure of a biogas plant due to mechanical rupture an due to the material used for the construction of plant were overcome by using the FRP (Fiber Reinforced polymer) with binding material or the resin used was unsaturated polyester resin (source material safety data sheet). FRP being light in weight will not add to the total weight of the plant but will provide the required mechanical strength.

Pressure Maintenance

Biogas yield depend upon the various variable in which pressure plays a major role. The plant in operation is of constant volume, in order to maintain the pressure to the safe mark, a clearance volume is provided above the gas holder. When the outlet valve of the plant is closed, the pressure inside the plant (reactor) goes on increasing, as a result will lead to bursting of the plant. in order to relieve this pressure rise this mechanism is used .

Temperature maintenance

Temperature is also being one of the important parameter in biogas production. It needs to be maintained in between 30°-40°C. An insulator made up of polypropylene glass was used to maintain temperature as well as to reduce the corrosive property of the slurry in the plant due to formation of H_2S.

Preparation of the incolumn:

Cow dung is used as in column for the reactor. Initially cow dung was fed with 80 ltr water in the ratio of 1:2 and was left over for degradation with proper inspection and made sure of not having any leakage.


Food waste collection and Preparation: The sample food waste was collected from the college canteen and pulverized in a mixer grinder to form proper slurry. The plant can be fed up to the maximum of 5kg.

Results and discussion:

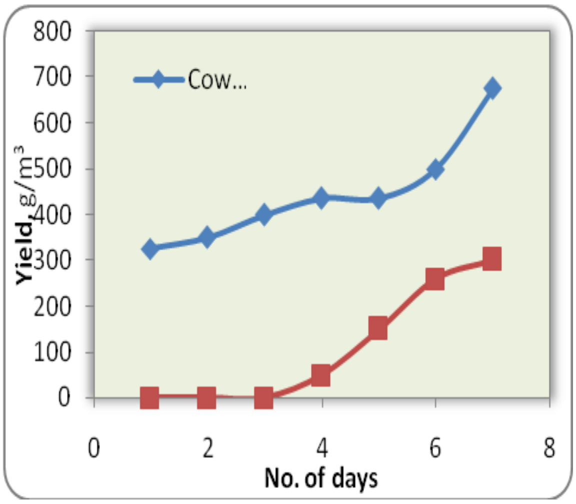

Figure 1: Variation of yield of biogas with no. of days

The figure 1 shows the daily increase in biogas production which highlights the increase in microbial activity resulting the production of biogas. The very first day of feed the carbon producing bacteria's get accumitised and hydrolysis process takes place .the production was seen from the 4th day of the reaction, still containing less amount of biogas, the complete biogas production was started on the 7 day.

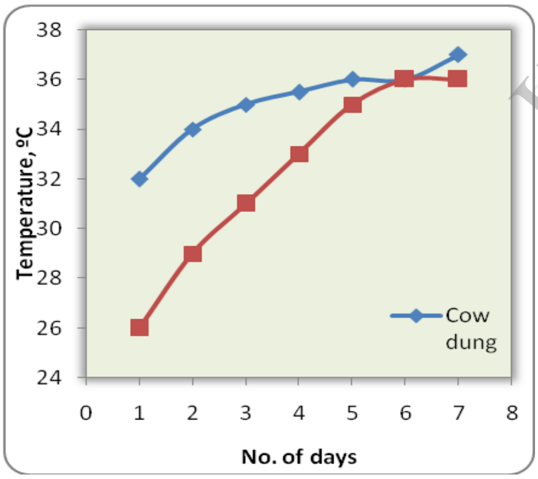

Figure 1: Variation of temperature of biogas with no. of days

Figure 2 shows about the temperature rise in the plant due to maximum moisture content in the feed. The temperature was 29 ºC on the first day as the microbial activity begins the temperature also rises. Temperature inside the reactor was not affected by the surrounding due to the polypropylene sheet. Hence we conclude that the optimum conditions were obtained by the design proving it worthy enough and appropriate for biogas production.

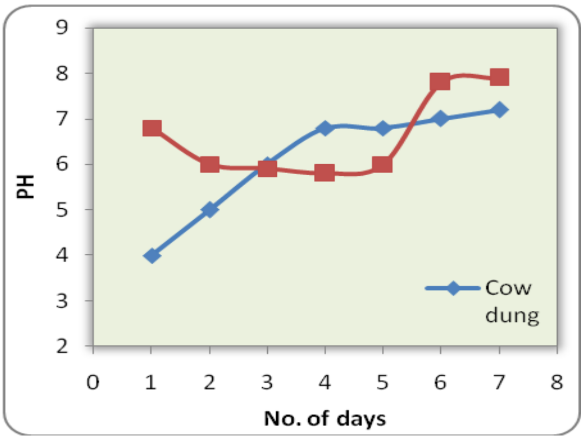

Figure 3: Variation of PH value of biogas with no. of days

Figure 3 shows the pressure variation of both the cow dung and kitchen waste. From the observations made highlights that the nuetrality of cowdung and kitchen waste will be affected and gets reduced thus showing the production of gas.

CONCLUSIONS

With a glance on the results obtained it is clear that temperature and pressure change was minimum and were successful in maintaining the temperature on mesophilic temperature 35 °C and the pressure on 20 -30 cm water column. The yield was satisfactory with a 30 – 45 % more yield than the conventional type of biogas.

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