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# Implementation and Optimizing Methane Content in Biogas for the Production of Electricity

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***Abstract*—At present the world is facing an acute crunch of energy as the population increases day by day. It is expected that there will be about 50% increase in the demand of energy by 2025. Due to limited stock of petroleum and coal in the earth bed as well as the problems faced due to their combustion it lead to research indifferent corner to get access of new source of energy like renewable energy resources. Unlike of the traditional renewable sources of energy like solar energy, wind energy. Kitchen waste and chicken bit are most economical and easily available as well as have great potential for the electricity generation.**

**Methane is the main important component under the aspect of using biogas as fuel. In the present paper we have made an attempt to optimize the methane content in biogas from biogas reactor for the electricity production. Hostel Mess is used as feedstock for our reactor which works as anaerobic digester system to produce biogas energy. The aim of the study is to bring down the energy cost, utilizing food waste to produce biofuel and manure.**

***Keywords— Energy; Methane yield; Electricity production; Kitchen Waste; Slurry***

## INTRODUCTION --

Biomass is one altogether the foremost promising renewable energy resources on earth that's used at intervals the vary of solid, liquid and vaporous fuels. The demand for bio-energy systems in very little or no scale trade is increasing at faster rate due to its lower investment value. Presently bio-energy that is the second largest industrial renewable energy provide. Current total biomass energy usage ranges around music of world total primary energy consumption, primarily in ancient applications like preparation in developing nations like land.

Electrical energy is to boot a awfully necessary kind of energy at intervals the planet recently. Use of Bio power plants unit of activity attending to be a vital inductive issue towards this energy crisis at intervals the planet. Engineers measure unit of implementing property [1] system several programmatically than planners. So renewable energy resources for generation of power got to be compelled to be exploited to the utmost extent.

The goal of renewable energy integration is to advance system approach, planning, and operation of the electrical grid to:

**1**. Deflate carbon emissions and emissions completely different of various air pollutants through raised use of renewable energy and different clean distributed generation

**2.** Increase quality use through integration of distributed systems and shopper plenty to chop back peak load and thus lower the costs of electricity

**3.** Support accomplishment of renewable portfolio standards for renewable energy and energy efficiency

**4.** Enhance responsibility, security, and resiliency from little grid applications in

A survey is made through that area where waste offered on daily basis is being analyzed. The waste data disclosed the particular incontrovertible fact that around one to a combine of metric weight unit of waste offered in each house where 4-6 members of the family unit residing. This waste consists of le1ftover food, wheat bread, vegetable wastes, used tea leaves, fruits waste etc. Some leftover item of veg and non-veg nature. It is assumed that the similar quantity would be generated at fully totally different college canteens or even further and now this waste is not being used for any useful purpose but merely drop among the trash bin then at land fill area of city.

*A. What is Anaerobic Digestion ?*

It is a multistep biological activity that is helpful not only for waste management but place along economical in energy production.Large organic polymers that frame Biomass are broken into littler easier molecules by the action of anaerobic tiny organisms. Upon completion of the strategy, Biogas is obtained that primarily contains CH4 and greenhouse emission. At the aspect of the Biogas, solid Digestive and waste water is likewise obtained.

Why Anaerobic Digestion?

a. Waste management.
b. Production of "Saleable products".
c. Biogas and manure
d. Hygienic and Low maintenance and labor.

*B.* Biological processes involved in Anaerobic Digestion

1. Hydrolysis:
   Breakdown of water into $H^+$ and $OH^-$ ions. Large organic polymers such as proteins, fats and carbohydrates are broken into smaller molecules such as amino acids, fatty acids and simple sugars.
2. Acidogenesis :
   Fermentative bacterias develop an acidic environment, producing ammonia, $H_2$ , $CO_2$ , $H_2S$, shorter volatile fatty acids, carbonic acids, alcohols etc.
3. Acetogenesis:
   The acetogenic microorganisms catabolize the products of Acidogenesis into $CO_2$, $H_2$ and acetate (acetic acid derivative).
4. Methanogenesis:
   Finally, Methanogenic microorganisms act upon the products and produce methane and $CO_2$ from acetic acid and other intermediate products.

$$CH_3COOH \rightarrow CH_4 + CO_2$$

*C. Factors affecting the Digestion Process:-*

1. Total solid content
   30% solid waste + 70% water
   There are three different ranges of solid content: low solid (LS) AD systems contain less than 10% Total Solid (TS), medium solid (MS) from 15-20% and high solid systems(HS)range from 22-40%. When increasing the total solid content, the volume of the digester decreases, due to lower water requirements. The advantages of both wet and dry digesters will be discussed later on, as well as their suitability for different Feed stocks [ref. 12, 13].
2. Temperature
   The optimum temperature requirements are
   i. 20-450 C
   ii. Normally 350 C
   iii. Maintained relatively constant
3. Retention Time
   The time needed to15-30 days
4. pH value
   6.4 to 7.2 pH
   The methane producing bacteria have best suitable pH range from neutral to slightly alkaline. If the value drops below 6.2, methanogens will start dying.
5. C:N ratio
   10 to 20
   Various organisms need different ratio of carbon and nitrogen accumulation in their metabolism. Methanogenic bacterias show approx 10 to 20 CN ratio optimization in their metabolic activity.
6. Mixing
   For high level production of bio gas, the solid substrate should be properly mixed to avoid formation of scum, layering of digestive, and to maintain uniformity of bacteria in digester.
7. Volatile solid loading rate
   per day V.S. (volatile solid) Input
   after complete combustion of any waste, we calculate its volatile solid content by taking the difference of the waste before the combustion and the ash content after the complete combustion.
8. Seeding
   30% [cow dung + water] of the digester
9. Uniform feeding
   Uniform slurry input per day and output slurry
10. Diameter to Depth ratio
    The diameter to depth ratio of the digester tank should be (0.6 to 1.00)

*D. Composition of Biogas:-*

Biogas is formed from methanogenic phase in the anaerobic digestion. The composition of biogas is a parameter for analyzing the circumstances in the digester. Methane and carbon dioxide are the main compositions of the biogas, there are also small amount of hydrogen sulfide, nitrogen, ammonia, oxygen and hydrogen. TABLE 1 shows the general composition of biogas. [6] The biogas generally contains 50-75% CH4, 25-45% CO2, 10 to 10000 ppm H2S and small amounts of N2, O2, H2 and NH3. [9] [10]

Table 1:Theoretical Biogas Composition:-

*E. The BUSWELL and MUELLER (1952) formula State:-*

$$C_cH_hO_oN_nS_s + \left(C - \frac{h}{4} - \frac{O}{2} + \frac{3n}{4} + \frac{S}{2}\right)H_2O \rightarrow \left(\frac{C}{2} + \frac{h}{8} - \frac{o}{4} - \frac{3n}{8} - \frac{s}{4}\right)CH_4 + \left(\frac{c}{2} - \frac{h}{8} + \frac{o}{4} + \frac{3n}{8} + \frac{s}{4}\right)\text{co2} + nNH_3 + sH_2S$$

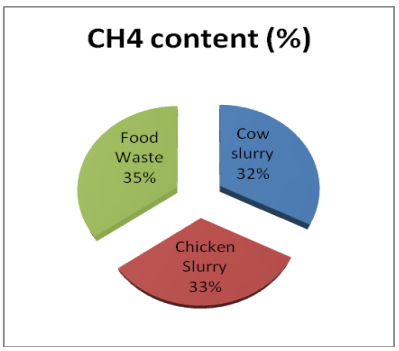
Table 1:

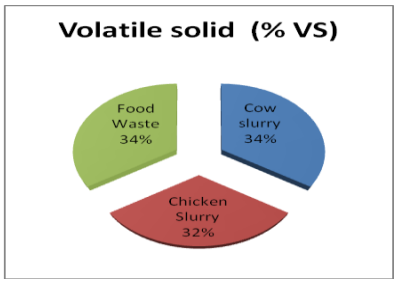
| | |
|---|---|
| Methane $CH_4$ | 50 - 75% |
| Carbon dioxide $CO_2$ | 25-45% |
| Oxygen | 0-2% |
| Nitrogen $N_2$ | 0-2% |
| Hydrogen sulphide $H_2S$ | ~500ppm(parts per million) |
| Ammonia $NH_3$ | ~100ppm(parts per million) |

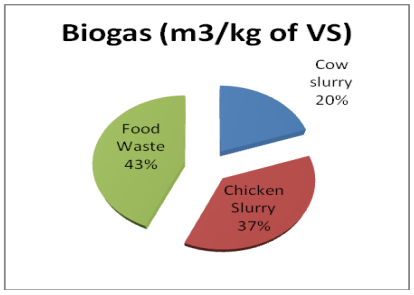
Table 2:

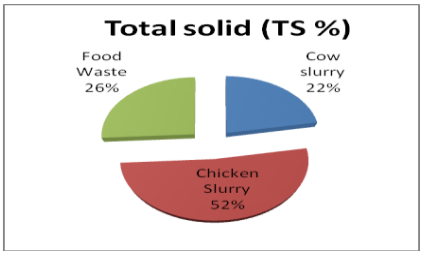
| Feed stock | Total solid (TS %) | Volatile solid VS (% of TS) | Biogas ($m^3$/kg of VS) | CH4 content (%) |
|---|---|---|---|---|
| Cow slurry | 5-12 | 75-85 | 0.20-0.30 | 55-85 |
| Chicken Slurry | 10-30 | 70-80 | 0.35-0.60 | 60-80 |
| Food Waste | 10 | 80 | 0.50-0.60 | 70-80 |

Pie chart 1: For different contents

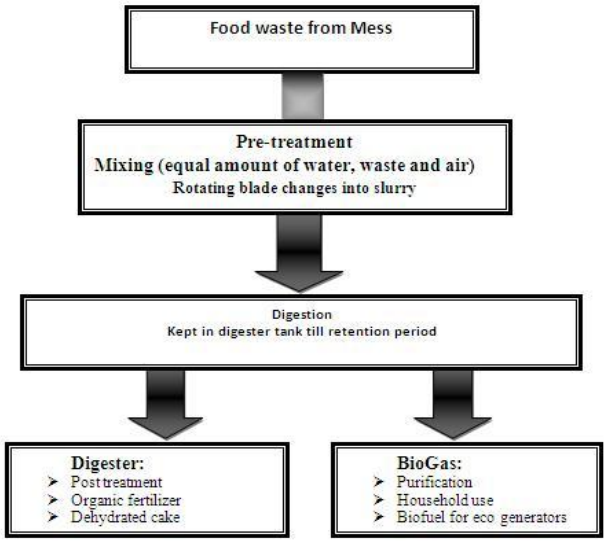



*F. Flowchart II: - General procedure for Bio-Plant*



*G. Figures and Tables*

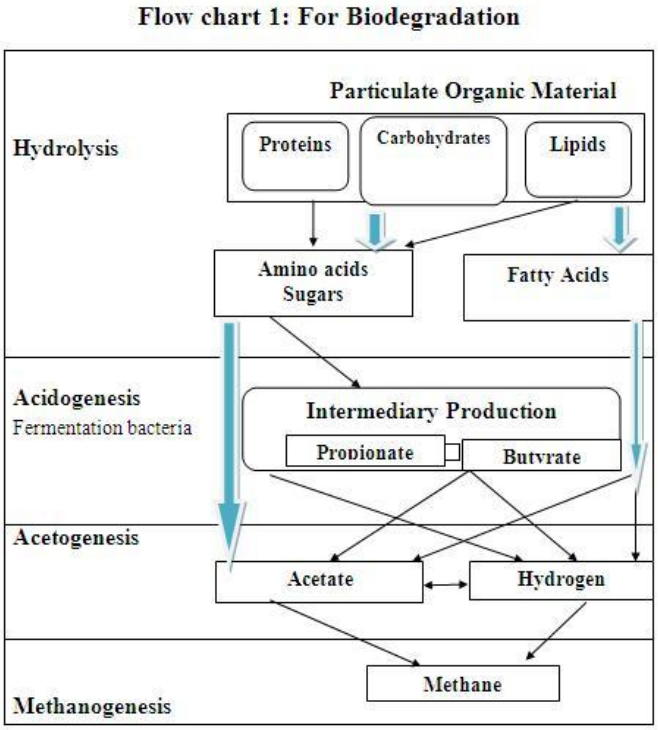



Fig. Flow chart of anaerobic digestion

In our institute we have three hostels with a central mess, where daily a large amount of kitchen waste is obtained which can be utilized for better purposes. Biogas production requires anaerobic digestion. Project is to be 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 Mess

Mess as feedstock for our reactor which works as anaerobic digester system to produce biogas energy. 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. For this reactor we have prepared our Inoculums than we installed batch reactors, to which inoculums of previous cow dung slurry along with the kitchen waste was added to develop our own Inoculums. A combination of these mixed inoculums was used for biogas production at 37°C in laboratory(small scale) reactor (220L capacity) 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.

In the present paper we have made an attempt to optimize the methane content in biogas for the electricity production. The aim of the study is to bring down the energy cost, utilizing food waste to produce biofuel and manure.

## CONCLUSION

AD contributes to reducing the greenhouse gases. A well managed AD system will aim to maximize methane production, but not release any gases to the atmosphere, thereby reducing overall emissions. AD also provides a source of energy with no net increase in atmospheric carbon which contributes to climate change. On a financial aspect, the advantage of AD is to convert residues into potentially saleable products: biogas, soil conditioner, liquid fertilizer. It can also contribute to the economic viability of farms by keeping costs and benefits within the farm if the products are used on-site.

AD projects, as with many developments, will create some risks and have some potential negative environmental impact. These need to be removed wherever possible or at least minimized. About health and safety, there may be some risks to human health with the pathogenic content of the feedstock but it can be avoided with an appropriate plant design and feedstock handling procedures. There may also be some risks of fire and explosion, although no greater than for natural gas installation.

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