Comparative Study of Biogas Production Using Kitchen Waste and Poultry Waste

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Abstract : Due to scarcity of petroleum and coal it threatens supply of fuel throughout the world also problem of their combustion leads to research in different corners to get acces the new sources of energy, like renewable energy resources. Solar energy, wind energy, different thermal and hydro sources of energy, biogas are all renewable energy resources. But, biogas is distinct from other renewable energies because of its characteristics of using, controlling and collecting organic wastes and at the same time producing fertilizer and water for use in agricultural irrigation. Biogas does not have any geographical limitations nor does it requires advanced technology for producing energy, also it is very simple to use and apply.

Kitchen waste is organic material having the high calorific value and nutritive value to microbes, that's why efficiency of methane production can be increased by several orders of magnitude as said earlier. It means higher efficiency and size of reactor and cost of biogas production is reduced. Also in most of cities and places, kitchen waste is disposed in landfill or discarded which causes the public health hazards and diseases like malaria, cholera, typhoid.

This paper mainly brings out the journey identifies and evaluate the economic feasibility to produce biogas from poultry waste and kitchen waste. It has been concluded that biogas can be generated with a huge probability of energy for use in households as well as industrial use which can also cut the supply of non-conventional fuels and balancing the environment aspects using poultry waste digestion.

***IndexTerms* - Biogas, kitchen waste, poultry waste, natural resources.**

I. Introduction

Deforestation is a very big problem in developing countries like India, most of the part depends on charcoal and fuel-wood for fuel supply which requires cutting of forest in other words deforestation. It leads to decrease the fertility of land by soil erosion.Use of dung, firewood asenergy 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 poultry industry is growing day by day concentrated within the urban as well as rural community. The intent of this project is to show that the chicken waste used as feed material to produce biogas can tap additional energy from the otherwise wasted energy and make the poultry industry co-exist with the environment of the neighbours.

The kitchen wastes containing high carbohydrates are amenable to anaerobic digestion process and the maximum gas production was observed.

1.1A brief history

Scientific interest in the gases produced by the natural the seventeenth century by Robert Boyle and Stephen Hale, who noted that flammable gas was released by disturbing the sediment of streams and lakes. In 1808, Sir Humphrey Davy determined that methane was present in the gases produced by cattle manure.

In 1907, in Germany, a patent was issued for the Imhoff tank, an early form of digester. Through scientific research, anaerobic digestion gained academic recognition in the 1930s. This research led to the discovery of anaerobic bacteria, the microorganisms that facilitate the process. Further research was carried out to investigate the conditions under which methanogenic bacteria were able to grow and reproduce. This work was developed during World War II where in both Germany and France there was an increasein the application of anaerobic digestion for the treatment of manure (Wikipedia).

1.2 Growth and advancement in India

The first anaerobic digester was built by a leper colony in Bombay, India in 1859. In 1895, the technology was developed in Exeter, England, where a septic tank was used to generate gas for street lighting.
Biogas production by anaerobic digestion has a tremendous potential in India. India is a pioneer in the field of anaerobic digestion of animal waste which is being practiced since 50 years. Over past 25 years, anaerobic digestionprocesses have been applied to wide array of industrial and agricultural wastes. India being an agricultural based country, it was estimated that there were about 330 thousand biogas plants by 1985-86. Most of the biogas plants are almost fed with cow dung, mixture of human night soil, pig dung, stacks of feed grasses, etc

II. DEFINITION OF BIOGAS

Biogas is produced by bacteria through the bio-degradation of organic material under anaerobic conditions. Natural generation of biogas is an important part of bio-geochemical carbon cycle. It can be used both in rural and urban areas.

2.1 Chemical Compositions

Different sources of production lead to different specific compositions. The presence of H_2S, CO_2 and water vapor make biogas very corrosive and require the use of adapted materials. The composition of a gas issued from a digester depends on the substrate, its organic matter load, and the feeding rate of the digester.

Table 2.1: Chemical Composition of biogas

Components	**Household waste**	**Wastewater treatment plant sludge**	**Agricultural waste**	**Waste of Agri-food industry**
CH_4 % vol	50-60	60-75	60-75	68
CO_2 % vol	38-34	33-19	33-19	26
N_2 %vol	5-0	1-0	1-0	-
O_2 % vol	1-0	<0.5	<0.5	-
H_2O % vol at 40 ^{0} C	6	6	6	6
Total % vol	100	100	100	100
H_2S, mg/m^3	100-900	1000-4000	3000-10,000	400

2.2 Physical Characteristics

According to its composition, biogas presents characteristics interesting to comparewith natural gasand propane. Biogas is a gas appreciably lighter than air which produces twice as fewer calories by combustion with equal volume of natural gas

Table 2.2: Physical Characteristics of Biogas

Components	Biogas from house hold waste	Biogas from agri-food industry	Natural gas
Composition	60% CH_4 33% CO_2 1% N_2 0% O_2 6% H_2O	68% CH_4 26% CO_2 1% N_2 0% O_2 6% H_2O	97.0% CH_4 2.2% C_2 0.3 % C_3 0.1% C_4 0.4% N_2
Density	0.93	0.85	0.57
Mass (Kg/m^3)	1.21	1.11	0.73

2.3 Properties of Biogas

- Change in volume as a function of temperature and pressure.
- Change in calorific value as function of temperature, pressure and water vapour content.
- Change in water vapour as a function of temperature and pressure.

III. BENEFITS OF BIOGAS TECHNOLOGY

- Production of energy
- Transformation of organic wastes to very high quality fertilizer.
- Improvement of hygienic conditions through reduction of pathogens.
- Environmental advantages through protection of soil, water, air etc.
- Micro-economical benefits by energy and fertilizer substitutes.

3.1 Principles For Production Of Biogas

There are four key biological and chemical stages of anaerobic digestion:

1. Hydrolysis.

2. Acidogenesis.

3. Acetogenesis.

4. Methanogenesis.

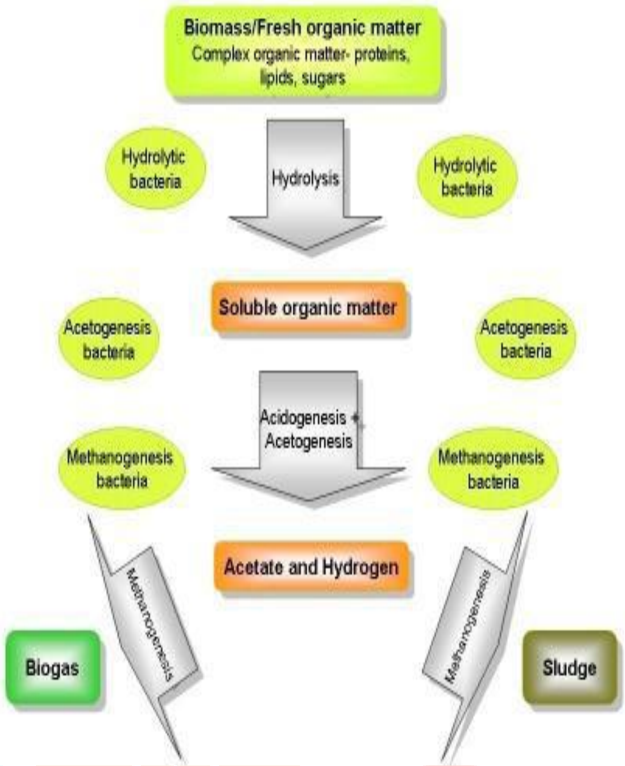

Fig.1: Biological and chemical stages of anaerobic digestion

VI. PRODUCTION OF BIOGAS FROM POULTRY AND KITCHEN WASTE

4.1 Poultry Waste

The poultry litter used in this work is distributed on the floor of sheds that serves for the birds. For this application it can be used various materials such as: wood shavings, peanut hulls, rice hulls, coffee hulls, dry grass and chopped corn cobs. The quantities produced and the characteristics of poultry litter depend on the base material used, the time of year, the creation time and the bird population density.

Fig.2: Poultry Waste

4.2 Kitchen Waste

The waste used in this study is collected from Devanahalli village were generation rate of kitchen waste is 10-15 kg per day. Initially we collected a waste of 5kg and later on 2kg per day. Waste contains the cooked rice, vegetables and non-used vegetables waste. This waste is crushed bymixer grinder and slurry was prepared mixing with water.

A separate container for coconut shells, egg shells, peels and chicken mutton bones. These will be crushed separately by mixer grinders.

Different containers of volumes 5liter to collect the wet waste, stale cooked food, waste milk products. The vegetables refuse like peels, rotten potatoes coriander leaves collected in bags.

Fig.3: Kitchen Waste

V. EXPERIMENTAL SETUP AND PROCESS

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- Cow dung was used to make inoculum which was just one day old.3 kgs of cow dung were mixed with three litres of water.
- The inoculum was fed in to the digester through inlet chamber.
- Food waste was brought from Devanahalli village in a plastic container.
- Fresh feed material (food waste) was collected every week. The preparation included homogenization in a kitchen blender, diluting with water and sampling for further analysis.
- The samples were taken from the homogenized slurry for the further analysis.

5.1 Construction material

- 120ltr Capacity Plastic Drum – Bio-digestion Tank
- 25ltr Water Storage Cans – Inlet Chamber
- 2” CPVC Pipe – Waste Flow
- ½” CPVC Pipe – Gas Collection
- Air Pillows – Collection Unit
- Funnel – Feeding Mechanism
- 2” Control Valve – Sludge Removal

Fig.4: Digestion tank with air pillows.

VI. COW DUNG AS FERMENTABLE MATERIAL

Cow dung, coming from a rumen animal is known to contain the native microbial flora that aids in faster biogas production. It has also been reported severally that cow dung is a very good starter for poor producing feed stocks. The average temperature of the digester was about 32ºC. It shows that the hydraulic retention time for cow dung is 15 days and gas production starts at the 5th day. Maximum gas is produced at the 15th day which is 0.0263 m3.

6.1 Poultry Waste as Fermentable Material

The gas production from poultry waste. The average digester temperature was about 30 ºC.It shows thatthe hydraulic retention time for poultry waste is about 45 days and gas production starts at the 1st day.
Maximum gas is produced at the 8thday which is 0.026 m3. The gas production from poultry waste in four slots of hydraulic retention time. In first slot from 0-10 day's maximum amount of gas about 25% is produced.

VII. RESULTS

The amount of gas produced was monitored by measuring its volume and the average temperature daily.

- The digester temperature remained in the range of 26 to 36^{0}C thought out the period of operation.
- The results obtained shows that the volume of biogas generated from first day to the sixth day changes repeatedly.
- Gas generated for the first three days was quite low though an increase in production was observed daily.
- There was a gradual reduction in the volume of gas produced after it has reached the peak value of gas production. This is due to the fact that the microorganisms responsible for biogas production have consumed a large amount of the substrate and hence subsequent drop in activity.
- The p^H of the digester remains considerably within range of 6.5-6.9, this would have contributed to the lower volume of gas generated

Table 7.1: P^H Values of Various Wastes

Sl.no	Parameter	Fresh cow dung	Fresh food waste	Fresh poultry waste
1	pH	6.6	6.1	6.35

Table 7.2:Various BIOGASES From Poultry Waste For 0-15 Days

Sl no	Parameter	constituents
1	Methane (CH_4)	25.3
2	Carbon Dioxide (CO_2)	10.2
3	Nitrogen (N_2)	1.8
4	Hydrogen (H_2)	0.7
5	Hydrogen sulfide (H_2S)	0.9
6	Carbon mono oxide (CO)	0.1

Table 7.3:Various BIOGAS From Kitchen Waste For 0-15 Days

Sl no	Parameter	constituents
1	Methane (CH_4)	13.17
2	Carbon Dioxide (CO_2)	6.1
3	Nitrogen (N_2)	1.3
4	Hydrogen (H_2)	0.3
5	Hydrogen sulfide (H_2S)	0.7
6	Carbon mono oxide (CO)	0

VIII. CONCLUSIONS

Based on the investigation, observations made and results obtained from the raw and digested kitchen waste, the following conclusions are drawn.

The study revealed further that cow dung and poultry waste as animal waste has great potentials for generation of biogas and its use should be encouraged due to its early retention time and high volume of biogas yields. Also in this study, it has been found that temperature variation, pH and concentration of total solid etc., are some of the factors that affected the volume yield of biogas . Biogas technology can be a viable development option for developing countries for energy production and substitution if properly managed and marketed.

- It was observed that cow dung acts as a seeding agent that increases the rate of biodegradation and quantity of biogas generation.
- It was found that the generation of biogas used to take place after 10 to15 days from the day of loading the digester.
- It was observed that the cow dung gas which more in 6 – 10 days was up to 35% gas is produced.
- As compared to kitchen waste the methane gas which is obtained more in poultry waste up to 48.13%.
- The an aerobically digested waste is rich in nutrient content and can serve as very good manure for crops. Hence it will help in the organic farming process.
- The waste even after degradation has not lost its calorific value and thus, it can be used as an energy source by adopting incineration process.
- It is an economical method as its reuse of kitchen waste and poultry waste, saves the amount that has to be spent on LPG.

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