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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 access 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.

KEYWORDS: Biogas, Kitchen Waste, Poultry Waste, Natural Resources

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 as energy is also harmful for the health of the masses due to the smoke arising from themCausing air pollution. We need an ecofriendly 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 neighbors.

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

A 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 increase in the application of anaerobic digestion for the treatment of manure (Wikipedia).

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 digestion processes have been applied to wide array of industrial and agricultural wastes. Indiabeing 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

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.

Chemical Compositions

Different sources of production lead to different specific compositions. The presence of H2S, CO2 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 [3]

Components	Household waste	Wastewatertreatmentplantsludge	Agriculturalwaste	Wasteofagri-Foodindustry
CH4% vol	50-60	60-75	60-75	68
CO2% vol	38-34	33-19	33-19	26
N2%vol	5-0	1-0	1-0	-
O2% vol	1-0	<0.5	<0.5	-

Table 2.1: Cond				
H_2O% volat40^0C	6	6	6	6
Total%vol	100	100	100	100
H_2S, mg/m^3	100-900	1000-4000	3000-10,000	400
NH_3, mg/m^3	-	-	50-100	-
Aromatic,mg/m^3	0-200	-	-	-

Physical Characteristics

According to its composition, biogas presents characteristics interesting to compare with natural gas and propane. Biogas is a gas appreciably lighter than air which produces twice as fewer calories by combustion with equal volume of natural gas [3]

Table 2.2: Physical Characteristics of Biogas [3]

Components	Biogas From House Hold Waste	Biogas From Agri- Food Industry	Natural Gas
Composition	60% CH_4	68% CH_4	97.0%
	33% CO_2	26% CO_2	CH_4
	1% N_2	1% N_2	2.2% C2
	0% O_2	0% O_2	0.3 % C3
	6% H_2O	6% H_2O	0.1% C4
			0.4% N_2
Density	0.93	0.85	0.57
Mass (Kg/m3)	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 vapor content.
- Change in water vapour as a function of temperature and pressure.

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.

Principles for Production of Biogas

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

- Hydrolysis.
- Acidogenesis.
- Acetogenesis.

4. Methanogenesis

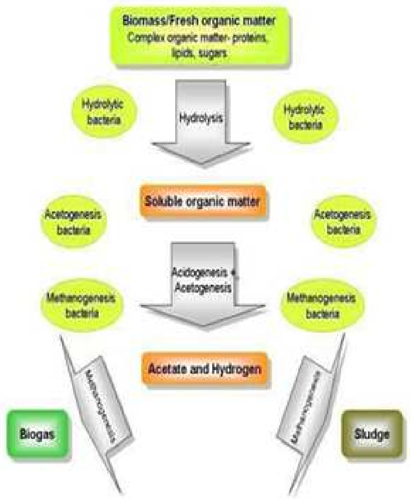

Figure 1

PRODUCTION OF BIOGAS FROM POULTRY AND KITCHEN WASTE

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

Figure 2: Poultry Waste

Kitchen Waste

The waste used in this study is collected from Devanhalli village were generation rate of kitchen waste is10-15 kgper day. Initially we collected a waste of 5kgandlateron2kgperday.Waste contains the cooke drice,vegetablesandnon-used vegetables waste. This waste is crushed by mixer grinder and slurrywa speared mixing with water.

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

Differentcontainersofvolumes5litertocollectthewetwaste,stalecookedfood, wastemilkproducts.Thevegetablesrefuselikepeels,rottenpotatoescorianderleavescollectedinbags.

Figure 3: Kitchen Waste

EXPERIMENTALSETUPANDPROCESS

Cowdungwasusedtomakeinoculumwhichwasjustonedayold.3kgsofcowdungweremixedwiththreelitresofwater

- Cowdungwasusedtomakeinoculumwhichwasjustonedayold.3kgsofcowdungweremixedwiththreelitresofwater.
- Theinoculum wasfed intothe digester throughinletchamber.
- FoodwastewasbroughtfromDevanahallivillageinaplasticcontainer.
- Freshfeedmaterial(foodwaste)wascollectedeveryweek.Thepreparationincludedhomogenizationinakitchenblend er,dilutingwithwaterandsamplingforfurtheranalysis.
- Thesamplesweretakenfromthehomogenizedslurryforthefurtheranalysis.
-

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

Plate5.1: Digestion Tank with Air Pillows

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.

Poultry Waste as Fermentable Material

The gas production from poultry waste. The average digester temperature was about 30 ºC. It shows that thehydraulic 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.

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 360C 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 pH 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: PH Values of Various Wastes

Sl.No	Parameter	Freshcow dung	Freshfo odwaste	Freshpoul trywaste
1	pH	6.6	6.1	6.35

Table 7.2: Various Biogases from Poultry Waste for 0-15 Days

Slno	Parameter	Constituents
1	Methane(CH_4)	25.3
2	CarbonDioxide(CO_2)	10.2
3	Nitrogen(N_2)	1.8
4	Hydrogen(H_2)	0.7
5	Hydrogensulfide(H_2S)	0.9
6	Carbonmonooxide(CO)	0.1

Table7.3: variousbiogasfromkitchenwastefor0-15Days

Slno	Parameter	Constituents
1	Methane(CH_4)	13.17
2	CarbonDioxide(CO_2)	6.1
3	Nitrogen(N_2)	1.3

Table7.3:Cond		
4	Hydrogen(H_2)	0.3
5	Hydrogen sulfide(H_2S)	0.7
6	Carbon monooxide(CO)	0

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 been courage due to its early retention time and high volume of biogas yields. Alsointhisstudy,ithasbeenfoundthattemperaturevariation,pHandconcentrationoftotalsolidetc.,aresomeofthefactorsthataffectedthevolumeyieldofbiogasproduction.Biogastechnologycanbeaviabledevelopmentoptionfordevelopingcountriesforenergyproductionandsubstitutionifproperlymanagedandmarketed.

- It was observed that cow dung acts as a seeding agent that increases the rate of bio degradeationand quantity of biogas generation.
- Itwasfoundthatthegenerationofbiogasusedtotakeplaceafter10to15daysfromthe day of loading the digester.
- It was observed that the cow dung gas which morein6–10days was upto35%gasisproduced.
- Ascomparedtokitchenwastethemethanegaswhichisobtainedmoreinpoultrywasteupto48.13%.
- Theanaerobicallydigestedwasteisrichinnutrientcontentandcanserveasverygood manure for crops. Hence it will help in the organic farming process.
- The wasteevenafterdegradationhasnotlostitscalorificvalueandthus,itcanbeusedasanenergysourcebyadoptingincineration process.
- Itisaneconomicalmethodasitsreuseofkitchenwasteandpoultrywaste,savestheamountthathastobespentonLPG.

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