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Co Digestion Food Waste with Cow Manure for Efficient Biogas Generation

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I. Introduction

In the present day energy has become a resource of primary importance. With the constant increase of fossil fuel prices and the growing evidence of environmental damage caused by their use, a lot of research has been focused on finding alternate sources of energy. No matter which kind of renewable energy that can replace fossil energy sources, fact remains; the future energy demands will increase. The energy debates during the past century have as a result of this brought on an increased awareness about the potential in recirculation of organic waste into power or fuel by using anaerobic digestion in a biogas plant. The advantages are many but the major need for disposal of waste, especially in development countries, has been in focus. The low proportion of waste collection and waste management structure causes the waste streams to become a visible problem in the highly populated areas. An important waste management technique includes biogas production that along with the production of biogas results in a residue that can be recycled to farmland as fertilizer.

Many public health hazards and diseases like malaria, cholera, typhoid etc. are caused by open disposal of food waste in many cities. There are many hazardous consequences of insufficient management of waste.

Food wastes are generally biodegraded in the process of anaerobic digestion to produce biogases. The process in which

biodegradable organic matter is broken down by microorganisms in the absence of
oxygen into biogas which consists of methane (CH_4), carbon dioxide (CO_2) is called anaerobic digestion (AD) [1]**.** A major technique for the management of municipal waste is anaerobic digestion [2]**.** Only in the past decade has the technology become a recognized method for processing solid organic waste from residential and commercial sources. The benefit of an AD process is that it is a net generator of energy which can be sold in the form of heat, steam or electricity.

This problem can be handled by humans with the help of methane , however still we are lacking in it, because of ignorance of basic sciences – like output of work is dependent on energy available for doing that work.

2. Materials and Method

This work is conducted in small scale in plastic tank.

2.1 Food Waste Collection

The waste used in this study is collected from Vikram boy's hostel in Govt. Model Science College, Jabalpur of and strength approximate 300. The following are the prominent ingredient of wastes: vegetables and non-used vegetables waste, cooked rice. The slurry was then prepared by mixing the waste in water.

We use containers of 15 litres volume for the collection of wet waste, stale cooked food,water and waste milk products. We use Poly Bags are used to collect refuse like peels, rotten potatoes, coriander leaves.

2.2 Materials for designing and development of digester

i) Digester: Two batch type airtight digester, Capacity - 20 litres container (used for drinking water storage).

ii) Gas Container: one 2- 10 liter High-density glass container for contains the biogas.

iii) Substrates: The substrates used as feed stock materials for the generation of biogas in the mess of hostel.

iv) Inoculums: The pilot scale mesophilic anaerobic treatment plant based on cow dung were used to collect the inoculums for mesophilic incubations.

v) Plastic cap to make the container air tight.

vi) Pipe made of polyvinyl chloride 0.5'' (length ~ 1 m)

vii) Funnel (for feed input)

viii) Cape 0.5" (to seal effluent pipe)

ix) Pipe (for gas output, I was used level pipe) (3-5 m)

x) Bucket (15-20 litter)

xi) Solid tape

xii) M – seal

a) pH meter

2.3 Analytical Methods

The schematic diagram of the overall process is shown in Fig 2. The process reactor had total Volume of 20 liters batch type. When the hydraulic Retention time (HRT) of the reactor was 4-5 days, and solid retention time (SRT) was 20-40 Days, the organic loading rate (OLR) from 16 kg with seeding with 1 liter fresh digested sludge of Cow manure [3]. The reactor, an anaerobic batch type, pH value of acidogenic reactor was 5-6 and methanogenic rector was 7.5-8.0.

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At temperatures of reactor were maintained at 35°C-45°C. pH value measures of acidified effluent, and final effluent were taken from the experimental setup. Gas production and pH value were monitored daily. Gas composition was determined with an infra-red gas analyzer (GA 94A) and gas detector (GASTEC, Japan) at pariat biogas plant, Jabalpur; concentrations of CH_4, CO_2, and H_2S were monitored Experiments were carried out in 20 liters cylindrical anaerobic digester and 2 liter High-density glass type tightly container.

Table 4: Experimental setup feed preparation

Reactor	Food Waste (%)	Cow manure (%)
Experimental setup 1	**50 (1)**	**50 (1)**
Experimental setup 2	**66.7 (2)**	**33.4 (1)**

The substrate filled 80% of the container 20% left for gas collection, from 20% active inoculums (refer materials in methodology section) was used for all reactors for the total feedstock input.

2.4 Anaerobic digestion Process

A single sealed reactor or holding tank is responsible for the entire digestion in a digestion system. Construction cost is reduced due to use of single stage, but results in less control of the reactions. Methanogenic bacteria operate in a strictly defined pH range.

Single stage process have one reactor for both acidogenic and methanogenic phase. These can be low solid (LS) or high solid (HS) depending on total solid (TS) content in a reactor [4].

A series of biochemical transformation give rise to the process of biomethanization of organic wastes, which can be roughly separated into a first step where acidification liquefaction and hydrolysis take place and a second step where hydrogen, carbon dioxide and acetate are transformed into methane.

2.5 Operation of the Reactor

Feeding unit: When the size of food waste was reduced to a certain extent then it was feeded onto the reactor and then mixed with water to form a slurry, the reactor was kept for seven and half days for hydrolysis.

2.6 Experimental Setup 1

Experiments were carried out in one 20 liters airtight cylindrical anaerobic digester at ambient temperature and 1 liters High-density glass container tightly insulated to keep the temperature at ambient state to determine biogas production from cow manure (CM). In Experimental setup 1 Food waste and cow manure (CM) (1:1) feed in digester. The hydrolysis, acidogenesis, acetogenesis and methanogenesis process is done. The feeding materials are 4 kg fresh cow dung, 4 kg food waste and mixed with8 liter water thoroughly by hand and poured into 20 lit. Digester and add 1 kg inoculums. After some days food waste was added for checking gas production.

2.7 Experimental Setup 2

In Experimental setup 2 the feeding ratio is (2:1) of FW (food waste) and CM (cow manure) in digester .The hydrolysis, acidogenesis, acetogenesis and methanogenesis process is done.2 kg food waste, 1 kg cow manure, 1 kg fresh inoculums and 12 litres water.

2.8 Gas Production

A calibrated collector vessel operating by water displacement is used to off-take gas from each reactor. The pressure create through the balloon at one end of the pressure glass tube and gas container collect the gas at the other end of the glass tube. All sides around the digester seal through the M-seal and air-tide liquid [5].

Gas sampling points are located at all strategic points around the reactors. Non-return valves and liquid seal are included in the process. Gas compositions are measured directly from the reactors gas sampling hose using gas analyzer (SR2-Bio) at Pariat biogas plant, Jabalpur.

2.9 Discussions

From the result it has been seen that in experimental 2 which contain food waste produces more gas, compare to experimental 1. In experimental 2 with food waste produces average more gas than experimental. From results it has been seen that pH reduces as the process going on as the bacteria produces fatty acids. It is a rate limiting step in reaction due to methanogens bacteria which utilize the fatty acids.

In experimental 2 there is a rapid increase in pH due to presence of food waste due to fast hydrolysis and acidogenesis reaction. And total solid decreases more in experimental 2.

2.10 Food waste in Jabalpur city

One of the four major cities of Madhya Pradesh is Jabalpur with a population of approximately above 24 lacks produces 1, 59,826 tonnes per annum and 450 tonnes per day of MSW. 30 % Food waste in MSW. The current waste was dumped at Ranital dumping site.

3. Results And Discussion

This chapter deals with the results obtained on the experimental scale of AD of food wastes. The characteristics of the wastes are presented. Results reveal the AD process as an efficient technique for food waste with Cow Manure.

The results obtained on the experimental scale of AD of solid wastes. The characteristics of the wastes are presented. The result shows the AD process as an efficient technology for the FW with CM (Cow manure) co-substrate. The different subtracts of FW and CM use for biogas production from the anaerobic digestion in different ratio.

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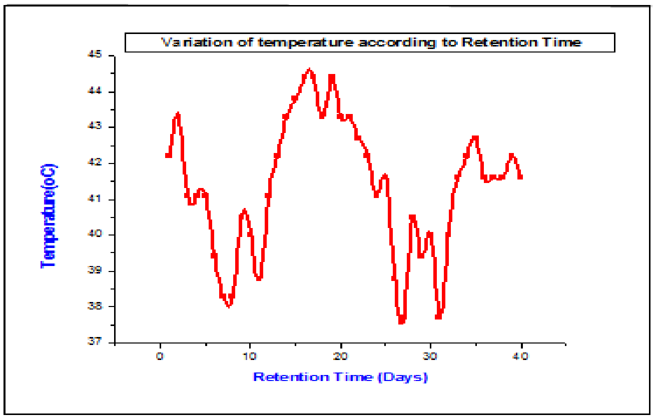


Figure 3 Show the variation of Temperature w.r.t. Retention Time. The Temperature Fluctuation in different days in summer seasons duration 01/05/2016 to 05/06/2016.

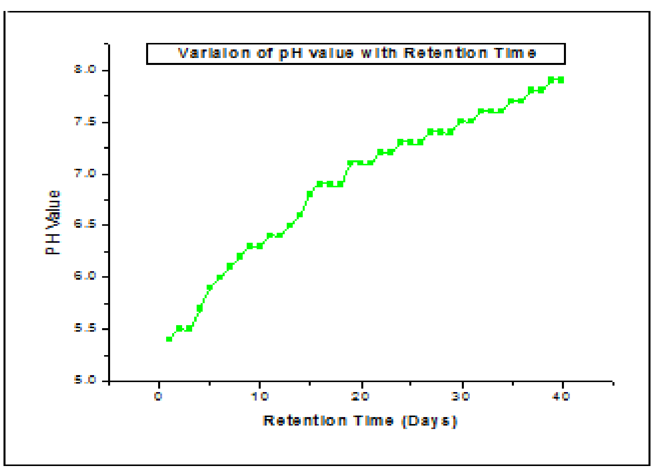


Figure 4: Variation of pH value w.r.t. Retention Time

Figure 4 Show that the variation of pH value with respect to Retention Time. The figure reveals that at initial stage pH was less than 5.5 and increases sharply up to 20th day of RT and later little variation with slow increases were noticed. It may be because of in the later stage maximum acid formation have been takes place and methogens were active.

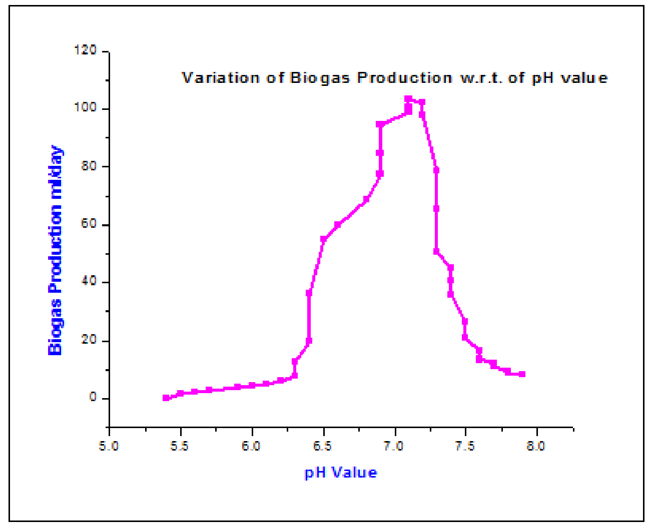
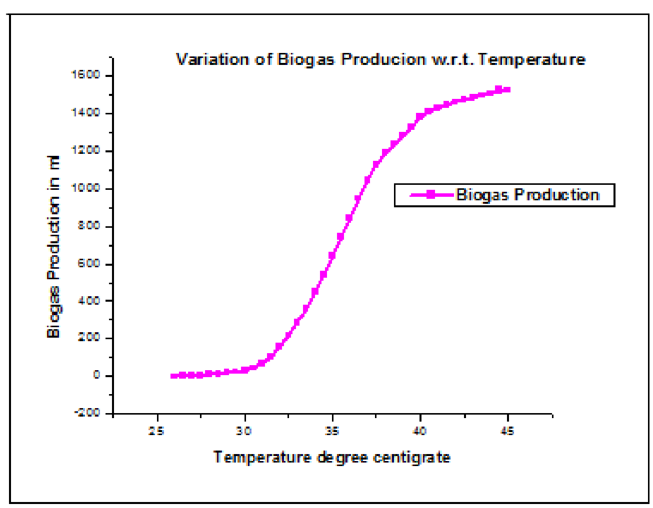


Figure 5 suggests that pH value is responsible for the variation of biogas production. The digestion is affected by the degrading capability of microorganism ,biodegradability of substance, and the environmental conditions like pH. Primarily the biogas production very slow at the value of pH between the 5.5-6.0 and biogas production constantly grow at pH value between 6-7 but biogas production is rapidly grow at utmost rating the pH value between 7-8. The Highest biogas Production at the value of pH is 7.2.



The above figure demonstrates that Mesophilic temperature (25-45^oC) is best for biogas production in AD. Initial temperature between 25-35^oC, the biogas yield is less and in the range of 40^oC plus the biogas production increasing rapidly because methanogens grow quickly.

4. Conclusion

The production of biogas from FW and methane composition of batch type experimental setup was carried out. In this experimental work the biodegradability of the FW organic fraction has been studied with cow manure at mesophilic temperature zone in AD. The variation of biogas production with respect to Retention Time (RT), pH value, and temperature in co-substance mix ratio FW: CM (2:1) and FW: CM (1:1). . It was observed that at the end of 40-day, the experimental (2), FW: CM (2:1) produced the highest biogas production potential 120.4 ml at a maximum biogas production rate of 55.02 ml/day. Experimental setup (1), FW: CM (1:1) had biogas production potential estimated to be 103.3 ml at a maximum biogas production rate of 38.25 ml/day. The total biogas production in experimental setup (1) is 1530 ml and in experimental setup (2) are 2201 ml. The gas yield was 0.18-0.21 m^3/ Kg of Volatile solid (VS) however present study reveals that biogas yield was 1530 ml/kg of VS and 2201 ml/kg of VS in experimental setup (1) and (2) respectively, which is less than the previous research it may be because of variation are process parameters such as Temperature, pH value, C/N ratio, N,P, K (Nutrients) etc. and experimental setup error such as leakage of biogas, suitable pressure for replacement of biogas etc.

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