

Performance Evaluation of Anaerobic Digestion of food waste

Mrs. A.N. Gonjari¹, Mrs. L.K. More², Mr. J.K. Patil³, Mr. S.D. Wani⁴

^{1,2,3,4}Department of Civil Engineering, JSPM's, RSCOE, II nd Shift Polytechnic Tathawade Pune-033, Pune, Maharashtra, India.

Abstract: The Municipal Solid Waste (MSW) consist of food and organic waste followed by plastic, paper, textile, glass, metal, wood etc. food and organic waste has contribute to high moisture content. Among these the food waste affects on the environment it mostly consists of uneaten food and food preparation waste from residence, restaurants, hostel, canteen etc

The necessity of the anaerobic digestion are the minimizing the quantity of solid waste. For improving adverse effects on environment, air quality and nutrient management, for producing organic fertilizer, for generating the methane gas which is use as a fuel. It becomes the alternative for the use of fossil fuel

Keywords: Anaerobic Digestion, Metane

1. INTRODUCTION

Anaerobic digestion process

The anaerobic digestion of organic matter is a complex process, which falls into for degradation steps. The specific microorganisms that take part in the process have different requirements on environmental conditions and moreover coexist in synergetic interactions.

Biogas digester systems provides a residue organic waste, after its Anaerobic Digestion(AD) that has superior nutrient qualities over normal organic fertilizer, as it is in the form of ammonia and can be used as manure. Anaerobic biogas digesters also function as waste disposal systems, particularly for human wastes, and can, therefore, prevent potential sources of environmental contamination and the spread of pathogens and disease causing bacteria. Biogas technology is particularly valuable in agricultural residual treatment of animal excreta and kitchen refuse (residuals). (Suyog, 2010)The composition of biogas varies depending upon the origin of the anaerobic digestion process.

Table No.1 Concentration of Biogas

Component	Concentration (by volume)
Methane (CH ₄)	55-60 %

Carbon dioxide (CO ₂)	35-40 %
Water (H ₂ O)	2-7 %
Hydrogen sulphide (H ₂ S)	20-20,000 ppm (2%)
Ammonia (NH ₃)	0-0.05 %
Nitrogen (N)	0-2 %
Oxygen (O ₂)	0-2 %
Hydrogen (H ₂)	0-1 %

2. METHODOLOGY

3.1 Material and Methods

3.1.1 Digester composition

1. 20 L capacity digester
2. Cow dung+ inoculums+ water
3. Cow dung- 2.5 L
4. Inoculum- 3.8 L
5. Water- 13.5 L

3.1.2 Collection of waste

Kitchen waste (cooked food) was collected from Hostel. It grind by using the grinder and mixed with distilled water in 1:4 proportion for maintained the pH neutral.

Experimental Set up

Batch digester is the common system used to assess the Anaerobic Digestion (AD) of different materials. This system is simple both in design and operation. Batch AD test carried out 20 L air tight cylinder known as digester. It was made up of plastic material. The inlet and outlet connection to the well-shaped digester have been located at its bottom which are opposite to each other for feeding and discharging of slurry respectively. Firstly, fresh cow dung was collected and mixed with water and inoculum was as sewage it mixed thoroughly and poured into 20 L digester. After a period of 30 days initial startup, the digester was fed with continuous feeding and the complete evaluation of the various inlet and outlet parameters were carried out.

For the collection of gas a 2.5 L glass bottle was used. Gas was measured by water displacement method through calibration on the glass bottle. The bottle is filled with water and kept in inverted position on tripod stand. The neck of bottle is closed by rubber cork. Cork has two holes in which two glass pipes are inserted. Glass pipe was connected with gas outlet of dome of digester through rubber pipe. While another glass pipe was dipped into the water bucket. When the continuous feeding was start the gas production rate was high the 2.5 L glass bottle was not sufficient for the collection of gas so we used 5 L glass bottle for the collection of gas.



Figure: Anaerobic Digester

Analytical Method

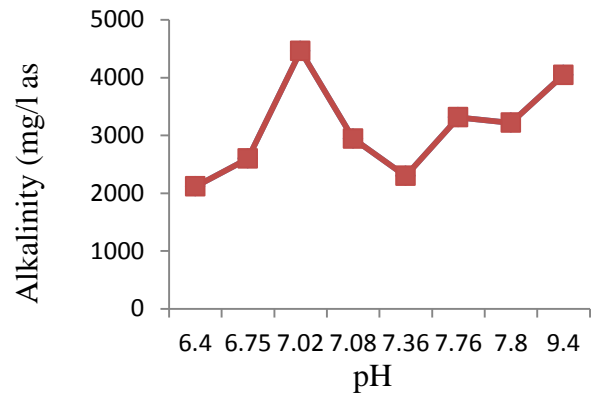
Continuous feeding to the digester was carried out from VSS loading of 0.5 to 1.5 the analysis of various inlet and outlet parameters were analyzed for PH, temperature, VFA, alkalinity, COD, VSS

Parameters	Methods
PH	PH meter
VFA	Distillation method
COD	Reflux method
Alkalinity	Titration method
VSS	Pyrolysis method
Gas	Water displacement

4. Results and Discussion

Figure: pH Vs Alkalinity

Figure shows the alkalinity variation with respect to pH. The pH was observed from the 6.4 to 9.4. When the pH



was 6.4 the alkalinity was observed minimum that is 2116 mg/l as CaCo3 and at pH 7.02 the alkalinity was observed maximum that is 4462 mg/l as CaCo3. The favorable range of pH for digester is 7 to 7.50. Hence, it is observed that in this range the alkalinity was varied from 4462 mg/l as CaCo₃ to 2300 mg/l as Caco₃

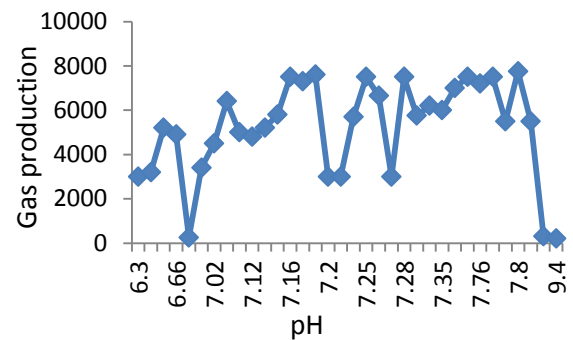


Figure: pH Vs Gas Production

Figure shows the gas production with respect to pH. The pH was observed from 6.3 to 9.4. The maximum gas production that is 7750 ml/day was observed at pH 7.8, which is nearer to operating range of anaerobic digestion process that is 7 to 7.5 at temperature 30oC. And the minimum gas production was 200 ml/day at pH 9.4. Because, of the initial stage of digestion the gas production was 200,250,300 ml/day at the pH 9.4, 6.75 and 8.86 respectively. This is attributed due to initial start-up period of the digester.

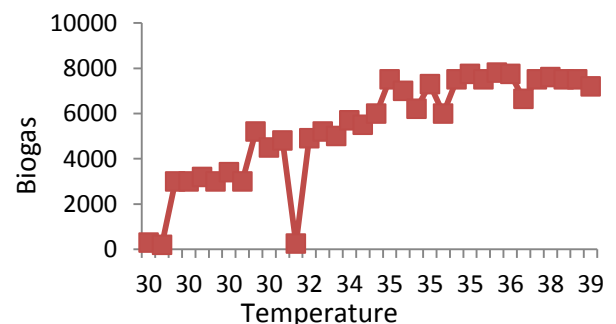


Figure: Temperature Vs Gas Production

Figure shows the biogas production with respect to temperature. It is observed that throughout the experiment temperature achieved were 30 to 38°C. In the month of February up to March the temperature was observed 30 to 34°C. The biogas production during this period was 200 to 7000 ml/day. Later for a period a temperature range varying from 35 to 38°C, the biogas production increased that is from 7000 to 7750 ml/day. This shows that the temperature is an important factor affecting anaerobic digestion

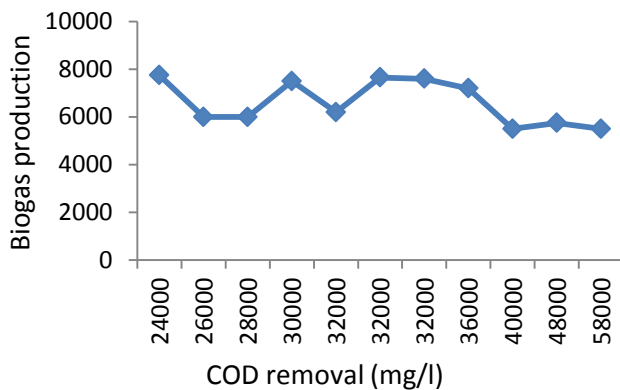


Figure: COD Removal Vs Gas Production

Figure shows COD removal with respect to biogas production. The COD (outlet) was ranged from 24000 to 58000 mg/l. At minimum COD (outlet) reduction of 24000 mg/l the gas production was 7750 ml/day. At maximum COD (outlet) 58000 mg/l the gas production was 40000 ml/day. Thus when the COD (outlet) was decreased the gas production was increased.

5. Conclusions

1. Start up period for Anaerobic Digestion Process was 25 days.
2. Generally VFA to Alkalinity ratio is 1:2. Maximum VFA was 2136mg/L at an alkalinity 4462mg/L and minimum VFA was 864mg/L at an alkalinity 2600mg/L. It shows the VFA to alkalinity ratio was 1:2.
3. The recorded for the first day i.e. 44th day of loading the COD was 58000 mg/L and last day i.e. 78th day of loading the COD was 24000 mg/L.
4. Biogas production recorded at organic loading 0.5 g.VSS/ L.day was 6167 mL/day.
5. Biogas production recorded at organic loading 1.0 g.VSS/ L.day was 7490 mL/day. Biogas production recorded at organic loading 1.5 g.VSS/ L.day was 7420 mL/day.
6. The maximum Biogas production was achieved at organic loading of 1.0 gm.VSS/L.day.

Average daily biogas production was 2093.58 mL/day.

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