Comparative Study on Biogas Generation from Municipal Solid Waste using Different Inoculums

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Abstract **- Treatment of solid waste by anaerobic digestion is a promising process of recovering and saving energy. Present study aims to estimate the mesophilic digestion of municipal solid waste by using batch scale laboratory reactors (acrylic bottle) having each bottle capacity 20 L for 90 days at room temperature, with two different inoculum sources such as Cow dung slurry and sewage sludge. Proportion of inoculum used for acidogenic fermentation of organic waste is about 30 % of operating volume of substrate. Cumulative biogas production achieved for the reactor with sewage sludge as inoculum was 457 ml/gVS and for cow dung as inoculum was 487 ml/gVS.**

Index Terms **- Anaerobic Digestion, Biogas Inoculum, Municipal Solid Waste**

IINTRODUCTION

Solid waste management is gaining importance both in developed and developing countries because of its pollution potential, nuisance, unsightly, unhygienic conditions. As a result of the steady population increment, industrialization and urbanization, in the last decade the generation of municipal solid waste increased [1]. The volume of waste generated is projected to increase from 64-72 million tons at present to 125 million tons by 2031 [2]. In various zones of India, composition of municipal solid waste ranged from 50-75% organic solids, 28-31% inert waste, 16-19% recyclable solids, 45-51% moisture content and calorific value varies between 6.8-9.8 MJ/kg [3]. More waste is generated at the source and less of this waste is treated efficiently in recycling, treatment and disposal. As a result, waste generated is filled in landfills without classification. This is neither economic nor environment friendly, coupled with the problem of land acquisition [4]. For the treatment of municipal solid waste, anaerobic digestion is promising process of recovering and saving energy [5]. The biogas production from anaerobic digestion from digestible organic waste, sludge and manure converts the substrates into renewable energy and also provides natural fertilizer for agriculture. Biogas is defined as gas mainly composed of methane (CH4) and carbon dioxide (CO2) produced by the biological process of anaerobic digestion, which can be burned to produce heat and electricity or can be converted into transport fuels and renewable natural gas [3]. Anaerobic digestion technology has immense use in future for sustainability, for agriculture and environmental, as it represents efficient and feasible waste stabilization method for converting diluted solid waste into sustainable energy with organic fertilizers. Objective of this study was to compare quantity of biogas generated when solid waste is treated anaerobically by using cow dung slurry and sewage sludge as inoculum. For production of biogas anaerobically, substrates were treated and analysed for Total solids (TS), pH, Volatile solids (VS), COD. Analysis of mention parameters will be useful for establishing a biogas system with the use of various types of available food waste and substrates for production of biogas.

II. MATERIALS AND METHODOLOGY

A. Sample Collection

Organic fraction of municipal solid waste was collected from Avaragolla landfill site and food waste was collected from UBDT Boys Hostel, and were mixed, shredded and filled in the reactor. Sludge was collected from Davanagere sewage treatment plant (STP).

B. Fabrication of Batch Reactors

Present experimentation was carried out using batch scale laboratory reactors (acrylic bottle) having each bottle capacity 20 L. The reactors were made by acrylic sheet with sampling outlet at bottom. These bottles were enclosed by rubber stopper equipped with glass bottles for collection of gas and to adjust pH. The glass bottle was filled with water and from the bottom the pipe was collected to another bottle for the collection of displaced water (fig.1).

C. Inoculum

Study has been carried out with two various inoculum sources such as Cow dung slurry and sewage sludge. Proportion of inoculum used for acidogenic fermentation of organic waste is about 30 % of operating volume of substrate.

D. Preparation of Feedstock

A fresh organic Municipal Solid Waste (MSW) has been used as feed for biological reactor. Organic MS W includes food waste, fruit waste, vegetable waste from the Avaragolla land fill site and food waste from UBDT boys hostel. Wastes were sorted and shredded and mixed number of times in laboratory. Both reactors were filled with raw materials supply and seeded separately with Cow dung slurry and Sewage sludge. Water was added to achieve preferred total solids concentration.

E. Experimental Procedure

Study is programed to estimate the mesophilic digestion of MSW using two inoculums. Substrate concentration expressed as weight of solids/total volume of water plus solids, assuming that density of solids is nearly equal to density of water. Two reactors of volume 20 liters and effective volume of 15 liters were operated under continuous state with inoculum concentration of 30% of solid weight. Both reactors were fed with municipal solid waste and tap water. One reactor was inoculated with Cow dung slurry and other is inoculated with sewage sludge as starter in reactors. Liquid samples were periodically taken from the reactors and analyzed for pH, TS, VS and COD. pH was maintained in range of 6.8 to 7.3 using 2N Sodium Hydroxide solution which promotes optimal for the growth of methanogens. Biogas generation was measured by the water displacement method. Substrate was mixed once in a day, at gas measurement time to keep intimate contact between substrate and microorganisms. Experimentation was carried out for 90 days at room temperature. Through water displacement method, biogas generations from the reactors were monitored every day. Volume of water displaced from bottle was equivalent to volume of gas generated.

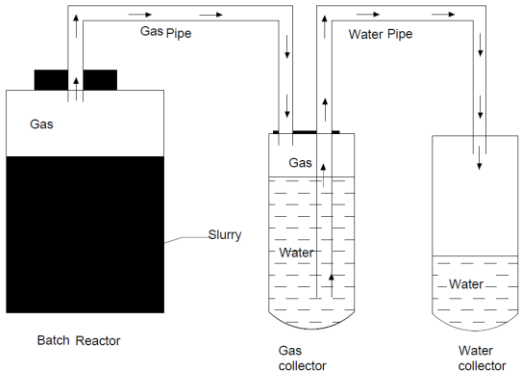

Fig. 1: Schematic Representation of Experimental Setup

III. RESULTS AND DISCUSSION

A. Optimization of the Biogas Production

The degradation of the substrate started slowly and progressed without any problems in the reactors maintained at room temperature. The initiation of biogas production lasted between 15-20 days. A cumulative biogas production for two different inoculum and total solids concentration was observed at room temperature.

B. Performance of Batch Reactor with Cow Dung as Inoculum

The reactor was operated with inoculum concentration of 30% of the substrate weight. Initially the pH was low in both the reactors due to acidic fermentation thereby reducing the biogas production. Fig.2 and fig.3 shows variation in total solids, volatile solids and COD for slurry with cow dung as inoculum. At the beginning stage COD of the slurry increases to some extent due to acid fermentation and acid regression, later due to alkaline fermentation it falls down rapidly after 45th day. The cumulative biogas production achieved for the reactor was 487 ml/gVS in 90th day. Production of biogas was decreased after 70th day due to the lack of amount of substrate to degrade.

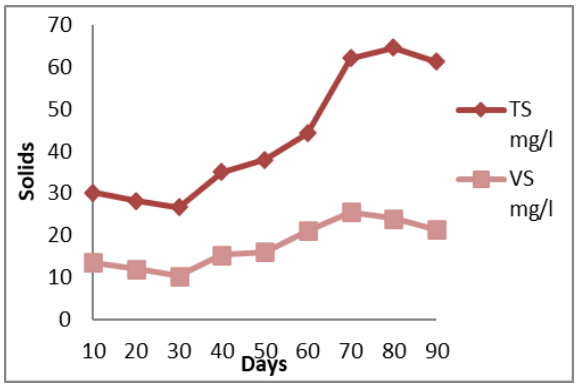

Fig. 2: Variation of TS & VS for Cow dung as Inoculum

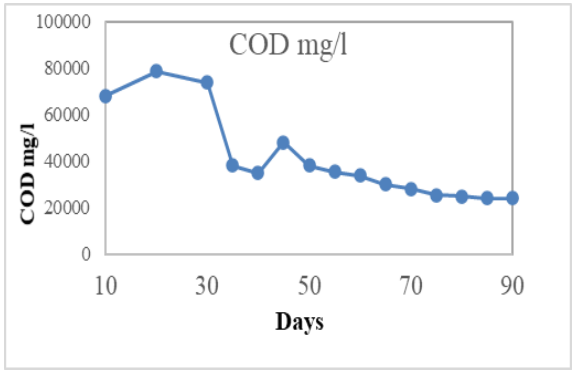

Fig. 3: Variation of COD for Cow dung as Inoculum

C. Performance of Batch Reactor with Sewage Sludge as Inoculum

Fig.4 and fig.5 shows the variation of total solids, volatile solids and COD for slurry with sewage sludge as inoculum. COD falls down rapidly after 40th day due to alkaline fermentation. Cumulative biogas production achieved for the reactor was 457 ml/gVS in 90th day.

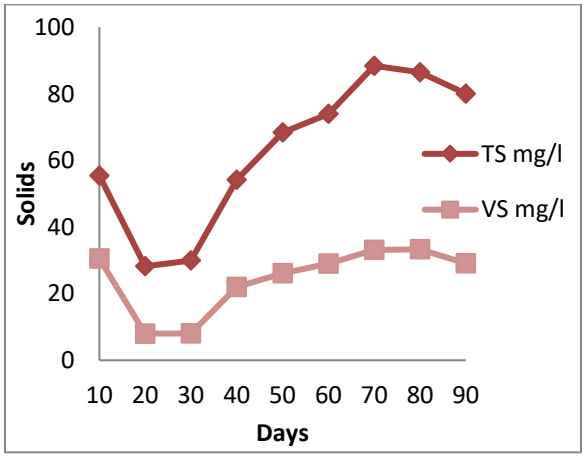

Fig. 3: Variation of TS & VS for Sewage sludge as Inoculum

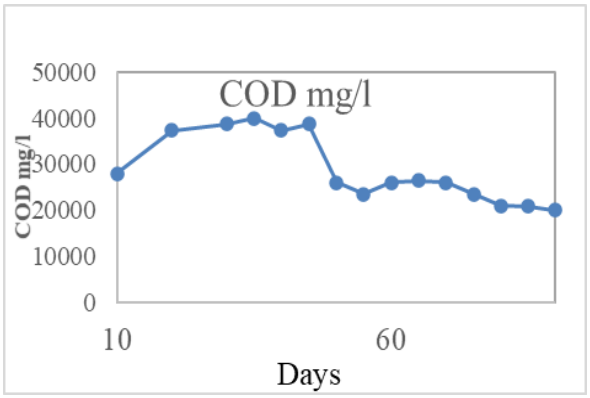

Fig. 4: Variation of COD for Sewage Sludge as Inoculum

D. Comparison Study

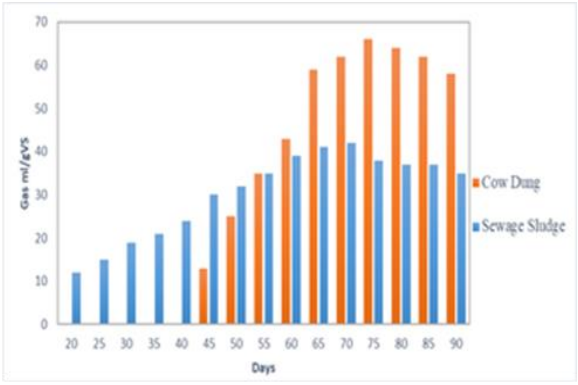

Fig. 5: Comparison of Biogas Production in the Reactor with Sewage Sludge and Cow Dung as Inoculum

Fig. 5 shows the comparison between amount of biogas generated from MSW with sewage sludge and cow dung as inoculum. Biogas production at the beginning was low due to the lag phase. From the above figure, it can be observed that the degradation of substrate takes place after the 20th day for sewage sludge as inoculum whereas degradation of the substrate takes place after the 45th day for cow dung as inoculum. The gas produced in the reactor with cow dung as inoculum rapidly increases from 60th day onwards whereas, in the reactor with sewage sludge as inoculum is comparatively less.

IV CONCLUSIONS

After studying the various quantities of biogas generation from MSW with two inoculums and characteristics of slurry generated from the reactor, the following conclusions were drawn.

- Biogas production was more in cow dung slurry as inoculum than the sewage sludge.
- The study found that gas generation is directly dependent on inoculum concentration and initial substrate characteristics like pH, organic loading rate, hydraulic retention time etc.
- The maximum level of biogas can be attained by the maximum reduction of COD in the reactor.
- As the total solids (TS) increases production of biogas also increases.
- By neutralizing the pH there is a maximum yield of biogas generation, hence the pH is maintained between the range of 6.8 - 7.8.

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