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Comparison of Various Inocula for Efficient Anaerobic Digestion of Municipal Solid Waste

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***Abstract*— Anaerobic digestion of municipal solid waste was carried out in this study for 60 days at room temperature in batch reactors with various inocula at different inoculum percentages. Inocula used were cow dung and domestic sewage. The digestion was carried out in laboratory scale. The characteristics of the MSW, cow dung, and domestic sewage were analyzed. The daily biogas production from the reactors was measured. At the end of the study, the biogas yield from the reactors R1, R2, R3, R4, R5, R6, and R7 was 24.88 L, 64.45 L, 79.74 L, 109.18 L, 47.06 L, 63.18 L, and 80.71 L respectively. The percentage of methane in the biogas produced with cow dung as inoculum was found to be 70%, and percentage of methane in the biogas produced with domestic sewage as inoculum was found to be 63%.**

***Index Terms*— Anaerobic digestion, batch reactor, biogas, municipal solid waste.**

I. INTRODUCTION

Solid wastes are the useless and unwanted materials in the solid state which are produced by individuals, households or organizations. Hence they are of various types like food wastes, garden wastes, papers, textiles, rubber, plastics, glass, ceramics, metals, wood wastes, construction wastes etc.

Municipal Solid Waste (MSW) contains organic as well as inorganic matter. The latent energy present in its organic fraction can be recovered for gainful utilisation through adoption of suitable Waste Processing and Treatment technologies. Disposal of municipal solid waste generates biogas, which include methane (CH4), biogenic carbon dioxide (CO2) and non-methane volatile organic compounds. Some lesser generated gases are nitrous oxide (N2O), nitrogen oxides (NOx) and carbon monoxide (CO).

Conversion of biomass into methane is popular in recent times. Recovery of energy from solid waste also has some notable benefits which include waste reduction by 60%, reduction of demand for land, for open dumping or for land filling, reduction in cost of transportation, improved efficiency in solid waste management. Therefore, every effort should be made to minimize waste generation to recycle and reuse the item. Many research works are being carried out for treating various types of organic solid wastes using anaerobic digestion process. It has become a major focus of interest in waste management throughout the world.

The objective of this study is to characterize the municipal solid waste and the inocula and, to compare various inocula for efficient anaerobic digestion of municipal solid waste under room temperature by conducting experiment in the laboratory.

II. MATERIALS AND METHODS

A. *Inocula*

Fresh cow dung and domestic sewage were used as inocula in this study. They contained all the required microbes essential for the anaerobic digestion process. The inocula were characterized for moisture content, total solids, volatile solids, total carbon, total nitrogen, COD etc. using methods recommended in bureau of Indian standards.

B. *Preparation of feedstock*

The municipal solid waste was collected from the waste disposal site at Chidambaram. Shredded MSW was characterized for moisture content, total solids, volatile solids, total carbon, and total nitrogen; COD etc. using methods recommended in bureau of Indian standards. The substrate was mixed with the inocula. The mixture was used in the batch reactor for anaerobic digestion process.

III. EXPERIMENTAL SET-UP

Batch reactors with total capacity of 20 L were used in this experiment. The reactors were made of acrylic fibre. The reactors were set up with suitable provisions for feeding, gas collection and draining of residues.

Fig 1. Experimental set-up of the reactors

This study was programmed to evaluate the anaerobic digestion of MSW using different inocula at various inoculum percentages. The inocula used were cow dung and domestic sewage. Seven reactors of 20 L capacity were used; the reactors were named as R1, R2, R3, R4, R5, R6, and R7. The reactor R1 was kept as blank, which means it was not filled with any inoculum. The reactors R2, R3, and R4 were filled with cow dung as inoculum at the percentage of 10, 20, and 30. The reactors R5, R6, and R7 were filled with domestic sewage as inoculum at the percentage of 10, 20, and 30 respectively. Water displacement method was adopted to observe the biogas production. Each reactor was provided with the gas collection system separately.

IV. RESULTS AND DISCUSSION

The characteristics of the substrate and the characteristics of the inocula are shown in Table 1, Table 2, and Table 3.

The graph gives a vivid picture that biogas production in R1 which was low in the beginning, was gradually increasing. In the reactors R2, R3 and R4 production of biogas was higher than the reactors R5, R6, and R7. Production of biogas reached the maximum level when cow dung was used as inoculum, whereas in the case of domestic sewage it was considerably low. And also, biogas production was higher in the reactors with higher percentage of inoculum. Therefore, in R4 the biogas produced was comparatively higher than the biogas produced in other reactors. As the result of decomposition, volume reduction of the feedstock occurred. Mesophilic bacteria were formed and they caused the biogas production. pH increased during the digestion at 7 days. NAOH was added to neutralize the pH value so as to regulate the digestion.

Table 1. Characteristics of the substrate (MSW)

S. No	Parameters	Value
1.	Moisture (%)	30.2
2.	pH	5.13
3.	Total solids (mg/L)	19.5
4.	Total volatile solids(mg/L)	90.3
5.	Ash content (%)	12.55
6.	Total organic carbon (%)	20.35
7.	Total nitrogen (%)	1.03
8.	Chemical oxygen demand (mg/L)	3952

Table 2. Characteristics of the inoculum no. 1 (Cow dung)

S. No	Parameters	Value
1.	Moisture (%)	50.02
2.	pH	6.64
3.	Total solids(mg/L)	8.6
4.	Total volatile solids(mg/L)	88.29
5.	Ash content (%)	11.23
6.	Total organic carbon (%)	12.44
7.	Total nitrogen (%)	0.85
8.	Chemical oxygen demand (mg/L)	2419

Table 3. Characteristics of the inoculum no. 2 (Domestic sewage)

S. No	Parameters	Value
1.	Moisture (%)	74.8
2.	pH	7.24
3.	Total solids (mg/L)	6.5
4.	Total volatile solids(mg/L)	73.3
5.	Ash content (%)	9.51
6.	Total organic carbon (%)	10.28
7.	Total nitrogen (%)	0.57
8.	Chemical oxygen demand (mg/L)	995

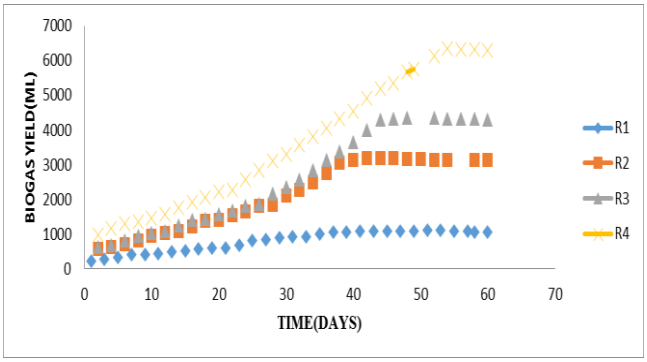

Fig 2. Variations of biogas production versus days for R1, R2, R3, R4

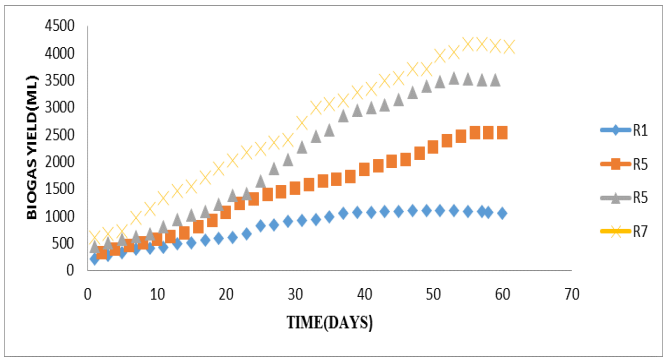

Fig 3. Variations of biogas production versus days for R1, R5, R6, R7

V. CONCLUSION

From the results obtained, it can be concluded that maximum biogas production was observed in the reactors which contained cow dung as the inoculum than the reactors which contained domestic sewage as the inoculum comparatively, and the reactors with higher concentration of inoculum resulted in production of maximum biogas. At the end of 60 days of digestion, the biogas yield from the reactors R1, R2, R3, R4, R5, R6, and R7 was 24.88 L, 64.45 L, 79.74 L, 109.18 L, 47.06 L, 63.18 L, and 80.71 L respectively. The amount of methane in the biogas was found to be 70% in the reactors using cow dung as the inoculum, and 63% in the reactors using domestic sewage as the inoculum.

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