International Journal of Research in Advent Technology, Vol.4, No.5, May 2016
E-ISSN: 2321-9637
Available online at www.ijrat.org

Study of Biomass Configuration on the Behaviour of Anaerobic Batch Reactor in Dairy Wastewater

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Abstract- Anaerobic treatment is one of the best choices to convert dairy wastewater into biogas. The purpose of this research work was to study the biogas production and COD removal efficiency from dairy wastewater in batch mode anaerobic digestion. Biogas, a clean and renewable form of energy could very well substitute for conventional sources of energy. In this work, different concentrations of initial COD such as 1120, 1840, 2960, 3560, 4240mg/l was used as feed for producing biogas. The important parameters like temperature, initial COD concentrations and hydraulic retention time (HRT) were used to enhance the gas production rate from substrates under mesophilic condition with temperature ranging from 28°C to 36°C. Five closed type portable digesters (batch mode) were used for this work. The results indicated that dairy wastewater could be treated anaerobically with maximum COD removal efficiency of 81.08% and 2020ml of biogas production.

1. INTRODUCTION

Dairy plant wastewater is generally high strength wastes containing soluble, colloidal and suspended solids with high concentration of Biochemical Oxygen Demand Backman,*et al*.,(1983). Anaerobic digestion of organic matter results in the production of methane and carbon dioxide. The volume of biogas produced and it`s methane content depends on the nature and quality of bio polymers present in the organic matter and group of microorganism active there in. the waste rich in fat and protein has potential to yield higher volume of biogas than that rich in cellulose ligninRaghunathan*et al*.,(2008). The anaerobic digestion of waste organic materials has two advantages, i.e. treating waste and generating biogas which can be used as alternative energy source. In the anaerobic digestion, organic materials will be discharged directly into the river, so the treatment of converted by bacteria into the biogas through four major phases i.e. hydrolysis, acidonegesis, acetonegesismethanogenesisBatstone, et al.,(2002). In the hydrolysis phase: complex organics (carbohydrate, protein, fat) are converted into simple organics (sugar, amino acid, LVFA); the acidonegesis phase: simple organics are converted into organic acids; the acidogenesis phase: organic acids are converted into acetic acid; the methanogenesis phase: acetic acid is converted into CH_4 and CO_2. Biogas contains 50-75% CH_4, 25-48% CO_2 and other gases in small amount Karellas et al., (2010). Due to its low operating cost and reduced generation of sludge, the anaerobic reactors are placed in a prominent position for the treatment of wastewater from agro-industries, as these systems provide the organic matter removal and methane generation, and this sub-product can be harnessed for power generation, mainlyin tropical and sub-tropical regions where the temperature favors the anaerobic digestion process. Studies on the anaerobic sequencing batch intensified from the study by Dague et al. (1992), treating dairy wastewater. The authors observed high degradation of organic matter, good flocculating characteristics of the sludge and efficient separation of solids, enabling high retention times of cellular factors that confer good stability to the process. This reactor configuration has been receiving increasing attention in recent years, with applications in the treatment of dairy wastewater in bench scale studiesRatuznei et al. (2003). The major advantages are the high degree of waste stabilization achieved in very little production, maximum amount of bio degradable fraction can be converted to useful end product in the form of methane and high strength can be employed because oxygen transfer is not a limiting factor. The bench scale studies are useful to determine effects of various process parameters and to suggest controls promoting optimum purification. Applicability of laboratory results for scale up results depends on the input, and on experimental designing, simulating anticipated operating conditions as field condition, etc. by Sridhar et al.,(2001).However, most of the lab research and engineering project only stay on the two kind's wastewater mixed fermentation. Under

mesophilic condition (37±1℃), a bench-scale experiment based on anaerobic co-digestion process was conducted in batch reactors. The biogas production performance and the reasonable material ratio were analyzed in order to provide the basis of the design and operation of anaerobic co-digestion process with dairy wastewater and municipal wastewater. The present study aimed to analyze the study of biomass configuration on the behavior of anaerobic batch reactor.

2. MATERIALS AND METHODS

Anaerobic digester was constructed by polypropylenebottle which have a volume of 1liters. The bottle was plugged with rubber plug and it was equipped with valve for biogas measurement. Anaerobic digester was operated in batch mode at room temperature. A gas-tight rubber pipe transported the biogas generated in the digesters to the graduated cylinders. By this action, the water was pressed out of the graduated cylinders into the water tank. Biogas generated was measured by the liquid displacement method.

Fig.1. Photographic view of the Experimental Set up

The photographic view of the experimental set up is shown in Fig 1. It consists of 1litre jar as digesters and 1litre graduated cylinder as biogas collector (Totally five numbers). In this study, dairy wastewater and domestic wastewater were tested. Dairy wastewater was collected from dairy industry in Aavin Chills Ltd, Thalaivasal, Salem District, Tamil Nadu. Municipal wastewater was collected from the treatment unit at Chidambaram.

Table 1. The characteristics of dairy waste water

1	pH	7.06
2	Chlorides	216 mg/l
3	Hardness	196 mg/l
4	COD	4160 mg/l
5	BOD_5	1950 mg/l
6	D.O	1.4 mg/l
7	Total solids	3900 mg/l
8	Dissolved solids	2900 mg/l
9	Suspended solids	1000 mg/l
10	Sulphates	174 mg/l
11	Sodium	107.6 mg/l
12	Potassium	7.18 mg/l
13	Calcium	17.38 mg/l
14	Lithium	0.22 mg/l
15	EC	12.19(milli mho)

The batch test set-up as shown in Fig.1 consists of 1L jars as digesters and 1L graduated cylinders as biogas collectors. Anaerobic digester was operated in batch mode at room temperature. A gas-tight rubber pipe transported the biogas generated in the digesters to the graduated cylinders. By this action, the water was pressed out of the graduated cylinders into the water tank. The volume of the headspace of the graduated cylinders represents the volume of the biogas generated in the digesters.

3. RESULTS AND DISCUSSION

The performance study of the batch reactor with five different influent COD reduction was analyzed.

Effect of pH

In an anaerobic system, pH places an important role, which may affect the activity of the mixed consortia. The increase level of pH may be due to the accumulation of bicarbonate or decrease the pH due to the formation of volatile fatty acids. In the entire experimental study the level of pH was from 6.88 to 7.82 which is optimum condition for anaerobic activity.

Performance of COD removal efficiency

The efficiency of any anaerobic process is generally explained with reduction in terms of COD. The overall efficiency of the batch process is shown in Figure .2. The COD reduction was achieved from 17.85 to 81.08% in Batch reactor (BR) 1 to 5. Maximum COD removal efficiency was attained 81.08% for an influent COD of 2960 mg/l at a HRT of 120hr.

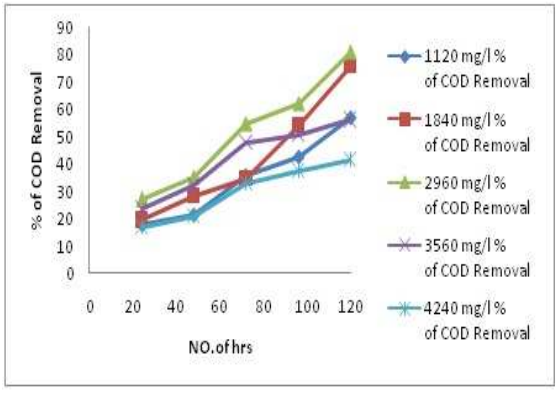

Fig.2 Performance of HRT in days with respect to % COD removal efficiency

Performance of Biogas generation

The gas collection from the reactors was analyzed by the method of water displacement. Fig.3 shows the biogas production from anaerobic batchreactor (BR) from the experimental study. The highest biogas generation was obtained from the 3rd reactor around 2020ml, which may be due to the addition of municipal wastewater was acted as an inoculum in the reactor actively.

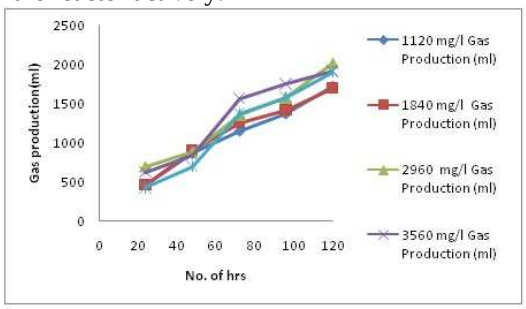

Fig.3. Performance of HRT in days with respect to Gas generation

4. CONCLUSIONS

In this study, anaerobic batch reactor experiments were conducted to investigate the COD removal efficiency and biogas production from dairy wastewater with the addition of municipal wastewater.

Five concentrations of influent COD such as 1120, 1840, 2960, 3560 and 4240mg/l was allowed in the Batch mode reactors for efficient COD removal and biogas production.

The experiments were experimented at room temperature varies from 25-37°C.

Results revealed that the maximum gas production was found in the BR 3 with an influent COD of 2960mg/l.

The maximum COD removal efficiency was attained at 81.08% with 2020ml of gas generated from the 3rdreactor.

By considering the vast and cheap availability of various wastewaters the biogas process could be used to fulfill the future energy demand in eco-friendly manner.

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