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Treatability Studies of Dairy Wastewater by Upflow Anaerobic Sludge Blanket Reactor

R.Thenmozhi*, R.N.Uma
Department of Civil Engineering, Sri Ramakrishna Institute of Technology
* thenmozhir2008@yahoo.in

Abstract

In any dairy plant, the quantity and characteristics of effluent is depending upon the extent of production activities, pasteurization of several milk products. The anaerobic digesters are used in the first phase of treatment, which is followed by high rate aerobic treatment. It remains as the most common effluent treatment scheme for dairy plants. The Indian dairy industry is stated to have the growth at more than 15% and waste water is poised to cross 150 million tones / annum. The requirement for milk and milk products is keep growing in steady state, making a significant impact on the Indian agriculture domain. The dairy industries require large quantity of water for the purpose of washing of cans, machinery and floor, the liquid waste in a dairy originates from manufacturing process, utilities and service section. So there is every need to reuse the waste water generated with proper and efficient treatment methods. Biological wastewater treatment has been performed in many different ways .In order to overcome the limitations of suspended and attached growth systems. Upflow Anaerobic Sludge Blanket reactors are designed. UASB is a hybrid type of reactor, involving both suspended and attached growth process. This study involves the treatment of dairy industry wastewater by UASB reactor by varying the retention times in days for a particular organic loading rate . This has effectively removed BOD, COD and other parameters because of the combined suspended and attached growth processes

Keywords: UASB reactor, COD removal, biogas production.

1. Introduction

The focus of wastewater treatment extended from physical treatment to engineered systems of biological treatment. Many efforts have been made for the biological treatment of wastewater. It has been performed in many different ways since 1974Lettinga and Vanvelsen [1] developed a simple and inexpensive and efficient anaerobic process known as UASB. In this process micro organisms use the organics in waste water as a food supply and convert them into biomass.

The controlled anaerobic treatment process is being considered today as one of the best possible means of recovering energy in the form of methane gas while at the same time reducing the organic load in the waste water. The UASB reactor is a high-capacity methane bioreactor with a sludge bed, or blanket of settled microorganisms through which the wastewater flows upwards). The main advantage of the UASB process is that no support material is required for retention of the high density anaerobic sludge [2].However, the absence of carriers necessitates the availability and maintenance of highly settleable biomass, either as flocs or as dense granules (0.5-2.5 mm in size) (3). The simple design of UASB reactors ensures a uniform distribution of incoming wastewater around the base of the digester, sufficient cross section top revent excessive biomass entrapment, and effective separation of gas, biomass and liquid(4). A three-phase separator, (biogas, liquid and biomass) serves to separate the biogas on the one hand, and the bacterial mass, which is returned into the active lower zone of the reactor, on the other hand. The UASB does not require the expense and energy consumption of pumps for recirculation of effluent (5) is less and hence economical. In practice, the UASB reactor distinguishes itself by being highly reliable under constantly varying conditions. The dense structure and high settleability of the sludge (60-80 m/h), allow upflow anaerobic reactors to be operated at very high upflow liquid velocities

The parameters of dairy wastewater such as colour, pH, Total solids, BOD, COD were measured using

standard methods before and after treatment. The reactor has multiple gas hoods for the separation of biogas. As a result the extremely large gas/water interfaces in the reactor greatly reduce turbulence, making relatively high loading rates of 10 – 15 kg/m^3.d possible. Separation in the UASB reactor requires only 1.0 meter of height, which prevents flotation effects and, consequently, floating layers. Generally, during the treatment of UASB reactor, the substrate passes through an expanded sludge bed which containing a high concentration of biomass first. After that, the remaining part of substrate passes through a less dense biomass which named the sludge blanket.

2. Materials and Methods

The feed stock for the reactor was collected from Aavin dairy industry, pachapalayam coimbatore Tamil nadu, India. Cow dung slurry is used as seed material for the reactor.

2.1 Reactor set up

The UASB reactor was fabricated using plexi glass pipe of 100mm diameter and 61cm height having an effective volume of 4.32 L.PVC rings were used as packing material and to serve as a supporting media for microorganisms in the reactor. The feed was supplied from the bottom of the reactor. The reactor set up is shown in the Figure.1

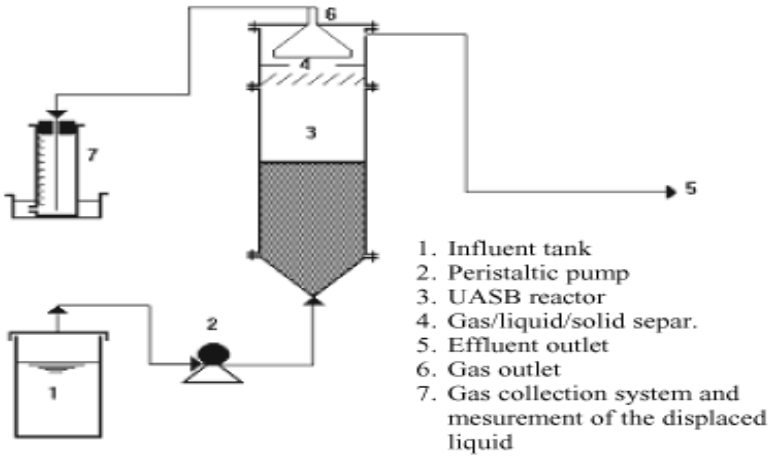

Figure 1: Schematic diagram of the laboratory UASB reaction system.

2.2 Gas Production

Gas production in the UASB reactor was measured by water displacement method. The outlet of the gas port of the reactor was connected to the inlet of measuring collector,

2.3 Start up process.

The UASB reactor was acclimatized by feeding; cow dung slurry for 2weeks.During this period the reactor was operated in batch mode. After acclimatization period, the reactor was operated in a continuous mode and dairy waste water was then gradually introduced.

2.4 Process Investigation

The operating parameters under which the performance of the reactor was monitored are given in Table.1.The performance of the UASB was investigated for treatment of dairy waste water through experiments at particular COD concentration with varying Hydraulic retention time (HRT).the COD removal was evaluated. The organic loading rate was 2.5g COD/m3/d.

Table 1: Operating parameters

Parameters	Range
Hydraulic retention time (HRT)(days)	1-43
Organic Loading Rate(g cod/m3 /d)	2.5
Temperature	27-35

2.5 Analysis Techniques

The organic strength of waste water was determined by the COD method. The analyses were conducted in duplicates and in some cases in triplicates and the influent and effluent parameters were analyzed as per standard methods.

3. Results and Discussion

The characteristics of dairy waste water has been numerated in Table 2. During this investigation the dairy waste was diluted to obtain the required COD concentrations. The process performance was monitored and the COD removal efficiency of the reactor under different hydraulic retention time. Experiments were conducted at room temperature (27-35 c)

Table 2: Characteristics of the dairy effluent

Parameters	Value
Colour	Pale white
pH	9.18
BOD	1250 g/L
COD	5240 g/L
Sulphates	119 g/L
Total solids	3015 g/L
Total dissolved solids	681 g/L

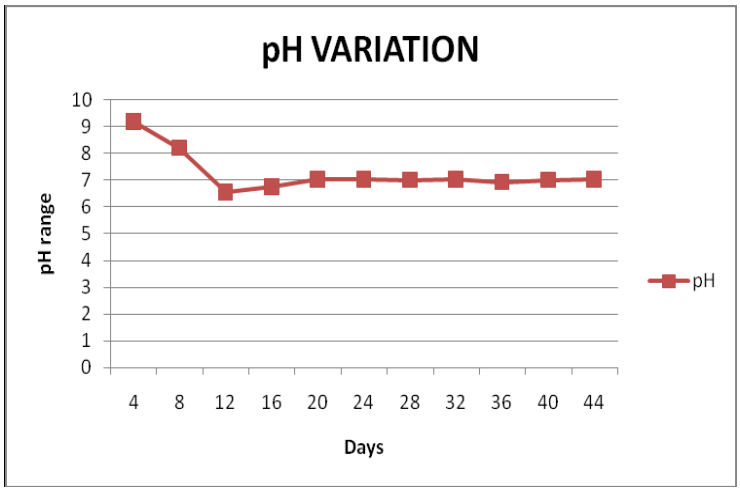

Figure 2: PH Variation

The pH values of the influent and effluent samples were measured at different HRT and COD concentrations. The pH value of the influent was high compared to that of effluent. The alkaline nature of the sample acts as a efficient buffer in the anaerobic biological treatment process. The pH values decreases and become neutral after treatment

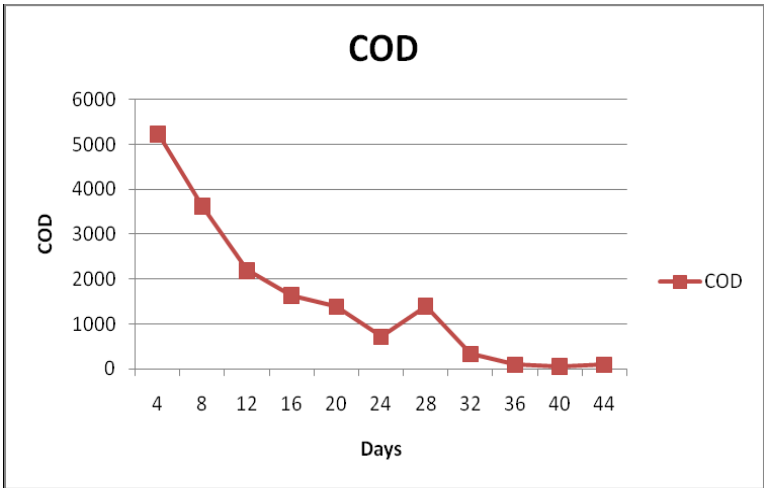

Figure.3. Effect of HRT on COD removal

The effect of influent COD concentration on COD removal was studied keeping HRT as a parameter. It was observed that COD removal percentage increased with increase in hydraulic retention time.komasu10.The present study also confirms this observation because the longer the HRT, the greater the efficiency of COD removal from dairy waste water. The maximum COD removal efficiency was 78%

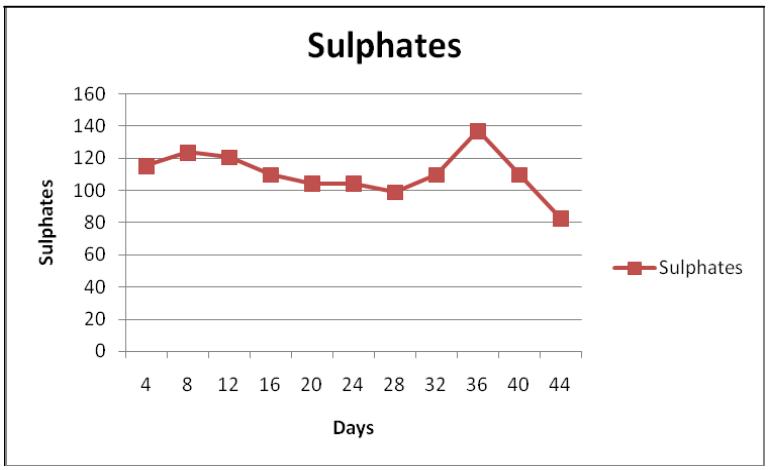

Figure 4 Effect of HRT on sulphates

The effect of sulphates is important in the treatment of dairy waste water. The percentage removal of sulphates ranges 45-50%.The sulphates removal increases with increase in HRT.

Further in the case of gas collection which is important in anaerobic digestion is measured by water displacement method. The gas collection increases with increase in HRT. At the end of 43 days the gas collection was maximum for OLR of 2.5g/L/day.

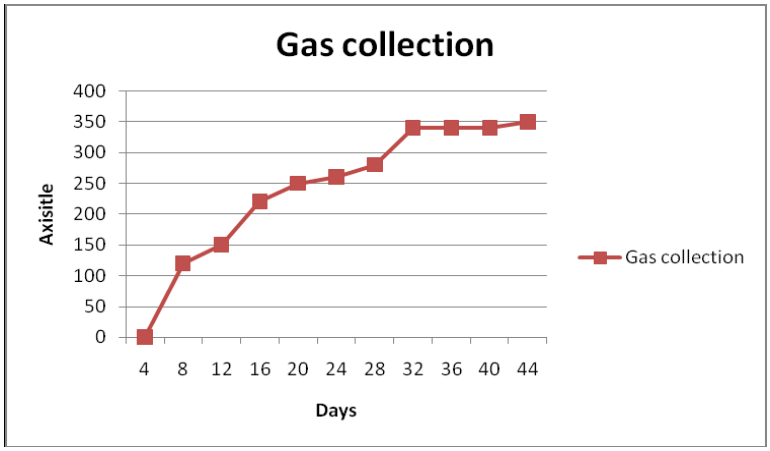

Figure 5 Effect of HRT on Gas collection

4. Conclusion

From the results observed the UASB reactor is suitable method to treat the dairy waste water. It is studied that operating temperature, pH of waste water, microbial population, presence of ammonia based materials affected the performance of the reactor. The reactor study shows about 78% COD removal when the

influent COD rate was 2.5 g /L/ day. Biogas generated from the reactor was 350ml when it was operated for43days

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APHA-Standard methods for examination of water and waste water.