Treatment of Canteen Waste Water Using Up-Flow Anaerobic Sludge Blanket Reactor

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Abstract--- Due to increase in population urbanization there is a significant increase in the production of waste water. The treatment of wastewater with good operational reliability is now in demand all over the world. Because of the varying characteristics of waste water, its treatment and disposal are posing serious problems. Among many anaerobic technologies UASBR technology is an upcoming one. It is simple compact and easy to operate at the laboratory scale model. With this background an experimental study was conducted to determine the feasibility of UASBR process to treat canteen waste water for a period of 35 days, as it is one of the most extensively applied technologies in the world. The performance of the reactor was evaluated for a flow rate of 100ml/min with average loading of 3.08 kg of BOD/m²d. The maximum of 94% COD removal and of 92% BOD removal was observed after stabilization period. Variation of pH was between 6.5 to 7.8 and no adjustment was required for the process. An increase in gas production is observed wherever there is an increase in the organic loading rate.

Keywords--- Anaerobic Treatment, UASBR, BOD, COD

I. INTRODUCTION

• General

ANAEROBIC granular sludge bed technology refers to a special kind reactor concept for the high rate anaerobic treatment of waste water. The concept was initiated with upward flow anaerobic sludge blanket reactor. The average supply of water in India is approximately to be 100 to 120 lpd. The consumption of water & production of waste water varies due to the seasons of the year, weather conditions, and day of the week & time of the day. Hence numerous wastewater treatment technologies were developed to produce effluent suitable for the survival of flora and fauna. There are various waste water treatment technologies, of which UASBR has more benefits such as high loading rates, no artificial mixing, low load requirement for installation no energy input, simple for operation and maintenance and recovery of energy.

A. Need of the Study

• Shortage of Water

Due to rapid growth of population people in large numbers migrate to city for better income, leads to shortage of water in urban areas. Due to less option for better quality of water in urban areas, it is necessary for development of treatment methods for waste water.

0. Waste Water Treatment

Waste water generated in millions of litters per day in quantity every year in India and disposal of these waste water is a difficult task. The criteria in selection of waste water treatment technology should be to provide sufficient treatment efficiency for the removal of various pollutants.

• Objectives of the Study

The objectives of the study are:

1. To study the variation of PH and its suitability to UASBR process.
2. To study the variation in production of alkalinity during biodegradation process.
3. To study the percentage removal of BOD and COD.
4. To study the rate of gas production.

II. LITERATURE REVIEW

Lettinga and his co-workers popularised an innovative method of anaerobic treatment called Anaerobic Sludge Blanket process. This is now being used for the treatment of waste water in many countries, including India. Upflow anaerobic sludge blanket process offers a simple technique of accumulation and concentration of a large population of bacteria in the form of granulated sludge, which has a high settle ability and bioactivity.

As per Frag H.H.P and Chui H. K(1993) successful operation of lab scale upflow anaerobic sludge blanket reactor has been reported even for short hydraulic retention time of two hours.

Lettinga et.al (1979) treated sugar beet waste in a upflow anaerobic sludge blanket reactor at 20 -25 kg COD/m²d organic loading rate and obtained 92% - 95% COD removal efficiencies at 28–32°C and 4 day hydraulic retention time.

Yue-Gen Yan et.al (1996) used COD of 2030mg/l and BOD of 1150mg/l as substrate ,and anaerobic digested sludge as inoculums. After granulation system performed stably with soluble COD and BOD removal efficiencies of 89.1%under the volumetric loading rate of 12.2gCOD/lit d and hydraulic retention time of 4 hours.

He Yan-Ling et.al (1995) used Two lab -scale UASBR to treat black liquor of Pulp and paper industry. Granulation was achieved in both the reactors. Low influent concentration was also essential for granulation. 40% -46% of influent COD and 56% -65% of BOD could be
removed by application of loading of 10kg COD/m3d. The specific yield of biogas was 510lit/kg COD removed.

Nearly 35 UASBR plants already exists in India as per BalA.S et.al (2001) to treat the waste water from Distilleries, dairies, Pharmaceutical units, Tanneries, and Housees.

III. METHODS AND MATERIALS

A. Materials

In UASB process the waste water enters the reactor from the bottom and flows upwards through relatively dense sludge bed and blanket of sludge particles. The substrate comes in contact with the sludge gets digested. The gas produced pass through the bed brings contact between the biomass and substrate.

The reactor is a circular column, made up of mild steel and has been fabricated as shown in the fig.1. An inlet and outlet were provided for the influent and effluent at the bottom and at 20cm below from the top respectively. Three taps are fixed on the column at a distance of 0.33m apart from the bottom [for sampling].

![Diagram of UASBR](image)

Figure 1: Schematic Diagram of UASBR

The reactor is divided into three distinct zones like sludge bed, sludge blanket, gas-solid liquid separator. The sludge is kept in dynamic motion by two factors. First by controlling the waste water flow in the upward direction at the bottom and secondly by the produced biogas in sludge able to push up sludge particles in upward direction.

At the gas-solid-liquid separator point that is at 1.0m from the bottom a, funnel made up of sheet metal was provided. A gap of 5mm is maintained between the funnel and column. The produced gas passes through the funnel and is collected in the gas collection jar by water displacement method. A 50lts plastic drum which was used to store waste water was placed above the column with a control valve to control the flow of influent into the reactor.

B. Methods of Analysis

Parameters like $P_H$, COD, BOD and alkalinity were analyzed for both influent and effluent and the change were studied. The lab scale UASBR model was operated in batch mode, which was operated for 6hrs/day. The flow adopted was 100ml/min with an average BOD loading of 9.56 kg BOD/m3 day in terms of COD is 15kg COD/m3 day. The efficiency of reactor with respect to the BOD removal, COD removal were monitored. These efficiencies were compared with the standard performance efficiency with respect to the organic loading and performance efficiencies of some high rate anaerobic reactor.

IV. RESULTS AND DISCUSSIONS

A. Variation of $P_H$

Variation of influent and effluent $P_H$ with respect to time at a constant flow rate during the study is as shown in the fig.2. During the study period $P_H$ of influent varied between 6.5 to 7.8 and that of effluent 7.0 to 8.9 pH of influent is suitable for the operation of UASB reactor. There is a very good control of $P_H$ range during the biodegradation of organic matter within the reactor and external $P_H$ adjustment is not required for the process control. This will reduce the initial investment cost, simplification of operation and maintenance of the system.

![Variation of PH](image)

Figure 2: Variation of PH

B. Variation of Alkalinity

The variation of influent and effluent alkalinity with respect to time is as shown in the fig.2. The alkalinity varies from 200 to 850 mg/lit of CaCo3 in the influent and varies from 500 to 1440 mg/liter of CaCO3 in the effluent. Higher effluent alkalinity is resulted from the formation of bicarbonate due to the reaction of OH with CO2 produced during anaerobic degradation and complete reaction of volatile acids. As the process operates over a wide range of volatile acid concentrations, alkalinity requirements also increases according to a system of operation and type of wastewater. Hence the increase of volatile fatty acid has contributed to the drop in the alkalinity of effluent as compared to the influent alkalinity.
The variation of influent and effluent BOD with respect to time is as shown in the fig.4. BOD of influent varies from 490 to 1820mg/lit and that of effluent varies from 20 to 780mg/lit. The BOD removal efficiency is 77% to 92% at temp of 35°C to 37°C of the blanket. With respect to time BOD removal is increased. During the stabilization period, BOD removal was varying in initial 15 days & then became constant.

D. Variation of COD

The variation of COD with respect to time of influent & effluent is as shown in the fig.5. After stabilization period of 15 days COD of influent varies from 1224-4280mg/lit and effluent varies from 80-1982mg/lit. COD as organic loading varies a minimum of 6.52 Kg COD /m³ day and maximum of 22.01 Kg COD /m³ day. This variation of this organic loading is due to varying characteristics of influent. The percentage removal is in the range of 82% to 94%. During batch mode operation, biomass is kept at starved condition without supply of food and during the beginning of the supply F/m ratio will be very less resulting in the increased percentage of COD removal.

V. CONCLUSIONS

Based on the experimental investigations the following results are drawn:

1. The P_{H} of the influent is suitable for Treatment using UASBR process.
2. There is an increase in the alkalinity during biodegradation process during the study period, which is due to the reaction of hydroxyl ions and co2 produced.
3. The study indicates a maximum of 97.3% BOD removal and a minimum of 30.61%.
4. The percentage removal of COD varies from minimum 27.28% to a maximum 93%.
5. UASBR is an efficient process in terms of BOD, COD removal and PH control. Therefore batch mode of operation can be adopted for treating canteen wastewater. During the study period there was a continuous increase in the gas production which is a good source of energy.

ACKNOWLEDGEMENTS

The authors are extremely grateful to Management, authorities and students of MSRIT, Bangalore, for the whole hearted support and encouragement provided by them during the course of investigations.

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