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Research Article

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Treatment of Sugar Waste Using Upflow Anaerobic Sludge Blanket

Smita M Honnannavar*, Jiffan, Dipika and Sucheta

Department of Civil Engineering, Shaikh College of Engineering and Technology, Belgaum, Karnataka, India

ABSTRACT

A laboratory scale upflow anaerobic sludge blanket (UASB) reactor was designed for treating sugar effluent under ambient condition. Anaerobic sludge and sugar effluent was used as seed and substrate in the reactor. UASB was used to treat sugar effluent at a HRT of 48 hrs and at different OLRs. During the process it was observed that COD removal efficiency and biogas production rates increased with increase in OLR and the average COD removal efficiency of 80% and maximum biogas production of 70% was achieved. From the present study it was concluded that UASB could be used for the efficient treatment of sugar effluent under ambient conditions. Production of bio gas, rich in methane can be used as renewable energy source was additional benefit of the treatment.

Keywords: Upflow anaerobic sludge blanket; OLR; Effluent; HRT; Sugar effluent

INTRODUCTION

Rapid urbanization and industrialization in the developing countries like India pose severe problems in collection, treatment and disposal of effluent. This situation leads to serious public health problems. Increasing discharge of domestic and industrial wastewater in receiving bodies and simultaneously increased withdrawal of fresh water, make it impossible to relay on the self-purifying capacity of the receiving water bodies. The current practices adopted in India for the disposal of industrial wastewater include discharge into public sewers, river streams and on land with little or no treatment. Most of the developing countries suffer from severe environmental problems, shortage of energy and resources. These countries urgently need simple and in expensive and integrated environmental protection systems, which combine wastewater treatment with recovery and reuse. Hence adequate treatment prior to disposal to obtain a desirable quality is 'must' further with increased environment awareness among the public and stricter implementation effluent standards by regulatory authorities the treatment of wastewater has become a challenging task [1-7].

MATERIALS AND METHODS

Effluent

The study was carried out by using sugar effluent collected from the nearby sugar industry. Characterization of the wastewater was carried out as per the standard methods for examination of water and effluent. These characteristic are given in Table 1 for lower organic rates the effluent was diluted with the addition of tap water. The pH of feed was maintained around 7.2 ± 0.2. The COD: N: P ratio was maintained around 100:3:1 by adding required quantity of urea and KH_2PO_4.

Upflow Anaerobic Sludge Blanket (UASB) Reactor

A laboratory unit upflow anaerobic sludge blanket (UASB) is made up of tube of Perspex material and the internal diameter of l0 cm and height of 100 cm. In the upper part of the reactor, a three-phase gas solid separator (GSS) was provided to capture the evolved gas and to allow the settling of suspended solids. Just beneath the GSS device deflector was provided on the rector wall to guide the gas bubbles into the separators. Reactor was provided with feed inlet at the bottom and effluent draw-off pipe at top. Effluent pipe was bent in u-shape to act as a seal for biogas through the effluent pipe. The inlet pipe was provided with T-shape to evenly distribute the influent. Sampling ports are provided at every 20 cm of the reactor. An outlet is provided at the top of the GSS for letting out the biogas generated. Gas production was measured by allowing the gas to pass through arrangement wet gas flow meter. The reactor was fed with sugar waste (molasses diluted with water) from a specific height to maintain a sufficient pressure. The reactor was fed with sludge from satisfactorily working septic tank. The effective volume of the reactor was 7.81. All the loading rates were calculated on effective volume basis (Figure 1 and Table 2).

Table 1: Characteristics of sugar effluent

Parameter	Range
pH	3.8-5.10
Total suspended solid (TSS)	890-3400
Volatile suspended solid(CSS)	390-2010
Total kjeldahl nitrogen (TKN)	15-45
Phosphorous (as po4)	1-2.5
Chemical oxygen demand (COD)	800-4890
Biochemical oxygen demand (BOD)	70-2140

Table 2: Specification of the reactor

Parameter	Values
Internal diameter, cm	10
Effective height, cm	100
Total height, cm	105
Effective volume, liters	7.8
Number of sampling ports	3

After pumping 4litres of anaerobic sludge (3% VSS), the reactor was started with feeding of the diluted- effluent of COD 1000 mg/l at an HRT of 2 days. This gave an initial sludge loading rate (SLR) of 0.03 kg COD/kg VSS. These experiences have shown that concentration lower than 2000mg COD/I and initial SLR lower than 0.1 kg COD/kg VSS. This will speed up the startup higher concentrations are difficult for anaerobic microorganisms to acclimatize. Keeping feed concentration constant the HRT was decreased stepwise to get stepwise increase in loading. The combined loading pattern is shown in. However while changing the HRT care was taken that volatile fatty acids (VFA) are less than 250 mg/l as acetic acid, such a procedure is essential for better acclimatization and speedy start-up. The period preceding this steady state situation is called start-up period. In present study 20 days were required to reach steady state condition.

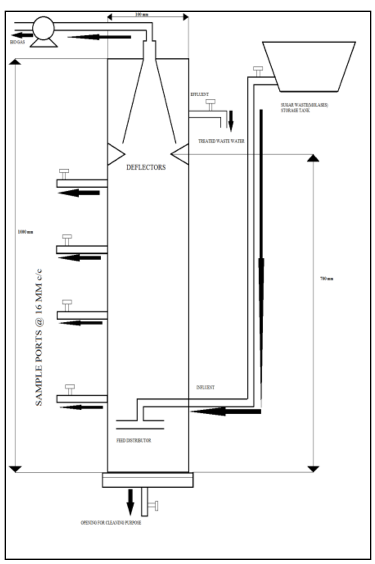

Figure 1: Mechanism of UASB

RESULTS AND DISCUSSION

After pumping 4litres of anaerobic sludge (3% VSS), the reactor was started with feeding of the diluted- effluent of COD 1000 mg/l at an HRT of 2 days. This gave an initial sludge loading rate (SLR) of 0.03 kg COD/kg VSS.d. experiences have shown that concentration lower than 2000mg COD/I and initial SLR lower than 0.1 kg COD/kg VSS.d will speed up the startup higher concentrations are difficult for anaerobic microorganisms to acclimatize. Keeping feed concentration constant the HRT was decreased stepwise (Table 3) to get stepwise increase in loading (Table 4). The combined loading pattern is shown in (Table 3). However while changing the HRT care was taken that volatile fatty acids (VFA) are less than 250 mg/l as acetic acid, such a procedure is essential for better acclimatization and speedy start-up. The period preceding this steady state situation is called start-up period. In present study 20 days were required to reach steady state condition. After successful startup, the loading of the reactor was increased in COD/m^3.d. To obtain these constant at 0.5 day and feed COD concentrations were increased by 3456 mg/l was achieved. However, the last increment was only concentration 3456 mg/I. From the graph it can be observed that there was decrease in COD reduction whenever the OLRs were increased. It can be attributes to the fact that after start up increase in OLR is obtained by increase in feed concentration, which inhibited the very sensitive methanogenic bacteria temporarily. However after few days the improvement in performance was observed as expected. At target concentration of 3456 mg COD/I high reduction of 83% was obtained indicates feasibility of UASB sugar effluent. The biogas production rates also increased along with operating days.

Table 3: Operational parameter and performance result during the study

Operating period (days)	HRT(hrs)	Feed conc. (mgCOD/L)	OLR (KgCOD/m^3.d)	COD removal efficiency (%)	Effluent conc. (mgCOD/L)	Biogas production rate(l/d)	Methane (%)	Ph of effluent
1	48	1000	0.5	-	-	0	-	7.4
2	48	1000	0.5	15.5	845.5	0	-	7.2
3	48	1000	0.5	-	-	0	-	7.4
4	48	1000	0.5	20	800	0.04	-	7
5	48	1000	0.5	-	-	0.045	--	6.8
6	48	1000	0.5	-	-	0.045	-	6.8
7	48	1000	0.5	10.5	897	0.085	-	6.8
8	48	1000	0.5	-	-	0.15	-	6.8
9	48	1000	0.5	18.5	815.5	0.22	-	6.9
10	48	1000	0.5	25	750	0.15	-	7

Table 4: Operational parameter and performance result during the study

Operating period (days)	HRT(hours)	Feed conc. (mgCOD/L)	OLR (KgCOD/m3.d)	Effluent conc. (mgCOD/L)	COD removal efficiency (%)	Biogas production rate(l/d)	Methane (%)	Ph of effluent
11	36	1500	1	803.4	46.24	0.17	-	7.3
12	36	1500	1	-	-	-	-	7.3
13	36	1500	1	787.5	47.52	0.18	-	7.3
14	36	1500	1	-	-	-	-	7.6
15	36	1500	1	740	50.6	0.3	-	7.5
16	36	1500	1	-	-	-	-	7.6
17	36	1500	1	681.3	57.9	0.8	65	7.5
18	36	1500	1	-	-	-	-	7.8
19	36	1500	1	628	58.13	1.3	70	7.7
20	36	1500	1	-	-	-	-	7.8
21	36	1500	1	-	-	-	-	7.8
22	36	1500	1	610	59.33	1.55	-	7.8
23	36	1500	1	-	-	-	-	7.8
24	36	1500	1	560	62.6	1.88	69	7.6
25	36	1500	1	-	-	-	-	7.8
26	36	1500	1	478	68.13	2	-	7.9
27	36	1500	1	-	-	-	-	7.8
28	36	1500	1	300			73	7.8
29	36	1500	1	281			-	7.8
30	36	1500	1	250			75	7.9

It was mainly due increased loading and increased activity of the biomass (both attached and suspended).however at each change of loading rate marginal decrease in gas production rate is observed. Maximum biogas of 9.41/d was obtained at an OLR of 5.6-kg COD/m^3.d. Unlike during start-up the variations in the methane content after start-up negligible this was mainly because of development granular sludge inside the reactor. Similarly pH variations were minimum because of development sufficient buffering capacity inside the reactor.

CONCLUSION

From the results of the present project work it can be concluded that cane sugar mill waste water can be treated efficiently by upflow anaerobic sludge blanket process. Conservation of energy is possible by capturing by product methane starting from poor quality seed sludge, granular sludge of good settling characteristics and high activity can be developed on these effluents. The high loading rated make the reactors small and compact necessitating small land requirements. Biomass yield of the process is very small. Tentative cost analysis has indicated that sugar mill can earn substantial amount of profit from the utilization of biogas. The bio gas can be alternative source of energy for the mill.

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