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Consequence of Hydraulic Retention Time on Fixed Film Reactor using Sugar Mill Wastewater

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Abstract: ***The utilization of large quantity of fresh water and the production of organic compounds as liquid effluents are major environmental problems in sugar cane processing industry. The endeavour of this learning is to treat the sugar mill wastewater by laboratory-scale up flow anaerobic fixed film reactor with a working volume of 13.0 litres. Which retains a high concentration of accumulated biomass in the form of fixed film supported by a carrier, has been developed to treat sugar mill wastewater. The effects of major process variables such as hydraulic retention time, chemical oxidation demand, volatile suspended solids, and biogas yield performances of the reactor were evaluated. The technology ensures the retention of the active methanogenic biomass within the reactor, independent of the HRT, of 3.00, 1.50, 1.00, 0.75 and 0.60 days. A sufficient amount of granular sludge was cultivated so that the reactor could accept the design loading within three months of operation. The maximum organic removal efficiency was achieved 86% at an OLR of 0.288kg COD/m^3/day with a HRT of 3 days.***

Keywords: Biogas, Chemical Oxidation Demand, Fixed film reactor, Hydraulic Retention Time, Organic Loading Rate, Volatile Suspended Solids

1. Introduction

Sugar is one of the significant agricultural products and industries processing sugar are vital support in Indian economy. Sugar industry is one of the important agro-based industries in India. The industry has created significant socio-economic impact on rural agro-based economy in particular and Indian economy in general. The residues from Sugar are part of the natural products. All the industries consume huge quantity of water and throw back almost an equal quantity of effluent which contains highly toxic materials in dissolved or suspended form. If this water is properly used or it is purified to recycled, a part of water shortage will surely be solved.

The problem of environmental pollution on account of essential industrial growth is, due to the problem of disposal of industrial waste as well, whether solid, liquid or gaseous. Polluted water, in addition to other effects, directly affects soil not only in industrial areas but also in agricultural fields and river beds, thereby creating secondary source of pollution *(Kisku et al., 2000;Barman et al., 2000).*These effluents not only increase the nutrient level, but also excess tolerance limits and cause toxicity *(Mishra et al., 1999).*

India is the largest producer of sugar in the world. The sugar industry with crushing capacity of 5000 tons per day requires 10000m^3/day of water. The sugar mill generates the wastewater in the ratios of 1:2.The sugar mill effluents are having higher amount of suspended solids, dissolved solids, Biological Oxidation Demand, Chemical Oxidation Demand. According to the permissible limit suggested by BIS and CPCB the characteristics of sugar mill effluents of the study showed in general exceed the limits. In the recent era great concern has been given throughout the universe regarding the environmental pollution from so many aspects since of rapid industrialization and subsequent urbanization *(RA Sail et al., 2006).*However, effluents containing various types of metallic and non-metallic elements act as nutrients but at the higher concentration they may show toxic nature on seed germination and seedling growth, ultimately adversely affecting plant growth and yield in agricultural field *(YM Avasnet al., 2000).*A significant large amount of waste water is generated during the manufacture of sugar and contains a high amount of production load particularly in items of suspended solids, organic matters, press-mud, and bagasses and air pollution. *(Bevan, 1971, Hendrickson et.al.1971).*The polluted water directly or indirectly affects the lives of flora and fauna which are situated nearby the water sources not only in the industrial area but also in agricultural fields, river and river beds *(K Nathet al., 2005).*Biological treatment processes are economical and most efficient methods that can be used in treating wastewater in sugar mill industry. The effect of HRT on the biodegradability of textile wastewater in an anaerobic baffled reactor was investigated by *Bhuvaneswari. A and Asha, B(2015)* and attained a maximum COD removal 91.67% with a HRT of 1.7days. The sugar-beet wastewater, treated for efficiency of UASB and FBR was found that the FBR offers good efficiency despite very high loading rate and low HRT(*lza et.al.,1990).* The behaviour of anaerobic fixed-bed reactors treating sugar-mill wastewater for four hydraulic retention times was found that organic matter removal increased with the hydraulic retention time and decreased with the influent concentration *(Sanchez. E,Borja. R. and Travieso.L.1994).* Sugar mill effluent reported that more than 90% COD could be removed at lower loadings upto 13kg.COD/m^3.day and about 80% COD up to 25 kg.COD/m^3.day HRT ranging from 4-24hours *(Pathe et. al., 1995).* Upflow anaerobic fixed-film reactor, treating distillery wastewater (wine vinasses) in thermophilic conditions. The results obtained showed that the pH influent influences the performance of the biodegradation process *(Perez-Garcia et. al., 2005).* The effect of the support material used for biomass attachment and bed porosity on the potential generation of hydrogen gas in an anaerobic

bioreactor treating low-strength wastewater. (*Fernandes et.al., 2013).*Granules were once again seen within a very short period of 14 day. The COD removal efficiency obtained ranged from 80 to 96 %. *(Tanksali 2013).* The wastewater is distributed from above/below the media. fixed film reactors offer the advantages of simplicity of construction, elimination of mechanical mixing, better stability at higher loading rates, and capability to withstand large toxic shock loads *(Van den Berg et.al 1985)* and organic shock loads *(Kennedy JL, and Droste RL1985)*. The reactors can recover very quickly after a period of starvation *(Van den Berg et.al 1985)*. This research article discussed about the effect of hydraulic retention time with respect to Chemical oxidation demand in an anaerobic fixed film reactor for treating sugar mill wastewater.

2. Materials and Method

The Sugar mill effluent was collected from M/S. EID Parry India Limited. Nellikkuppam, Cuddalore District, TamilNadu. The characteristics were analyzed for the sugar mill effluents(Table.1.)as per the procedure detailed in **"**Standard Methods**"**(APHA, 2005). The reactor was fabricated with acrylic materials with an effective volume of 13litre capacity and packed with spijino spiral special made by Japan; the reactor was hermetically sealed to avoid any air entrapment to maintain anaerobic conditions. The ambient room temperature during the study period was between 29 and 33 °C. Start-up period required by the reactor was 3 weeks. Initially a hydraulic retention time (HRT) of 48 h was set, HRT was decreased when the reactor reached steady state.

Table 1: Characteristics of Sugar Mill Effluent

Sl. No.	Parameters	valves
1	pH	6. 27
2	Total Suspended Solids, mg/1	640
3	Total Dissolved Solids, mg/1	2420
4	Total Volatile Solids, mg/1	910
5	Total Fixed Solids, mg/1	840
6	Total Solids, mg/l	1620
7	BOD_5@20°C, mg/l	800
8	COD, mg/l	3540
9	Nitrogen, [as N] mg/l	18.47
10	Phosphorus[as P] mg/l	6.20

A reactor configuration has been used to investigate treatability in terms of COD reduction in under different streams of sugar mill waste water. The Laboratory model consists of anaerobic biofilm reactor having a working volume of 13.0 litres (Figure.1.). The reactor was made up of clear acrylic Plexiglas which was sealed to avoid any air entrapment and filled with the solid support media, consisting of PVC rings namely *Fugino spirals*. The rings were of 19mm outer diameter, 1mm thickness and 15mm height, which were randomly packed. And they were light, durable inexpensive and easy to install, and their high porosity to prevented any clogging by the increased bio mass. The material was packed in the reactor to avoid flow tortousity and other physical factors at a height of 50cm. The reactor was continuously fed with real time sugar mill wastewater at an influent flow rate of 0.18, 0.36, 0.54, 0.72, 0.90 l/day by means of Peristaltic Pump with varied Hydraulic Retention Time (HRT). The % COD reduction and gas production are continuously measured from the reactor.

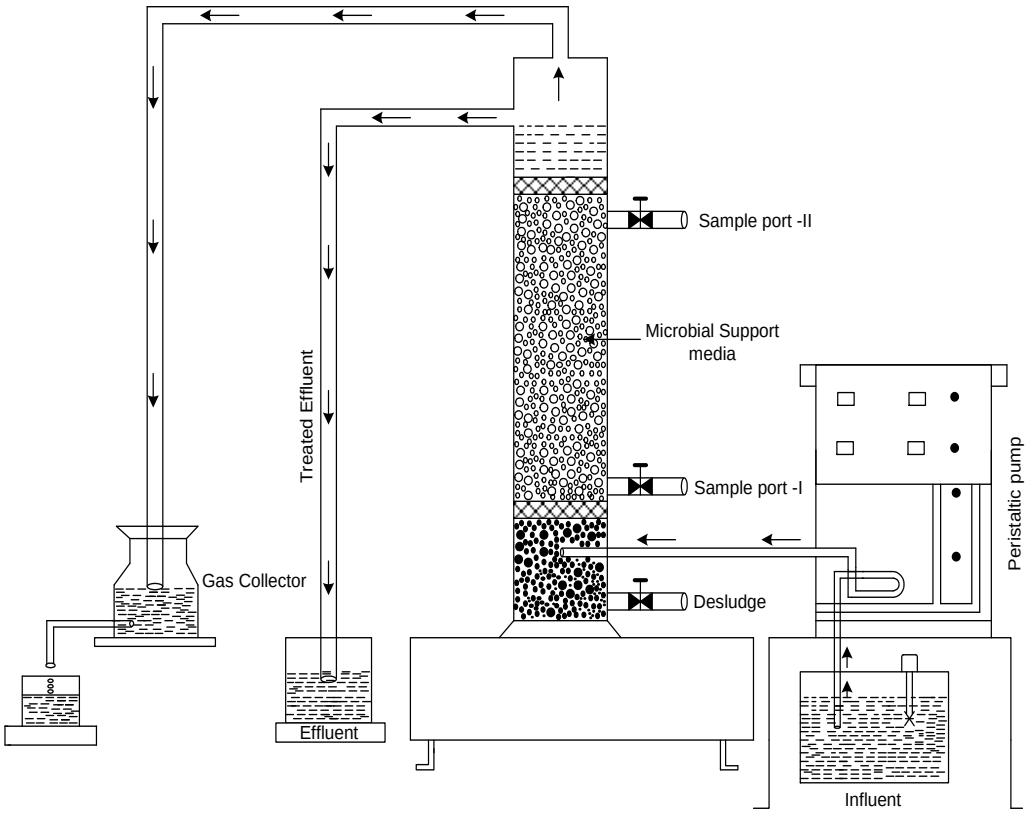

Figure 1: Schematics of Laboratory Model of an Anaerobic Bio- Film Reactor

3. Results and Discussion

The reactor was activated on sugar mill wastewater at an influent average COD loading of 2044, 2472, 3184, 3560 and 4032 mg/l which corresponded to Organic Loading Rates was varied from0.031to 0.2880 KgCOD/m^3/day. The effective studies of the entire experimental were presented. The anaerobic fixed film reactor was continuously fed by using peristaltic pump with five ranges of Sugar mill effluent at an influent flow rate of 0.18, 0.36, 0.54, 0.72, 0.90 l/day with varying hydraulic retention time HRT of 3.00, 1.50, 1.00, 0.75 and 0.60 days. The maximum % COD removal efficiency of 86% for the sugar mill wastewater at 3.0 days Hydraulic Retention Time with an influent COD concentration of 3960 mg/l was obtained as shown in Figure.2.It was concluded that the influence of COD reduction was increase to increases the HRT.

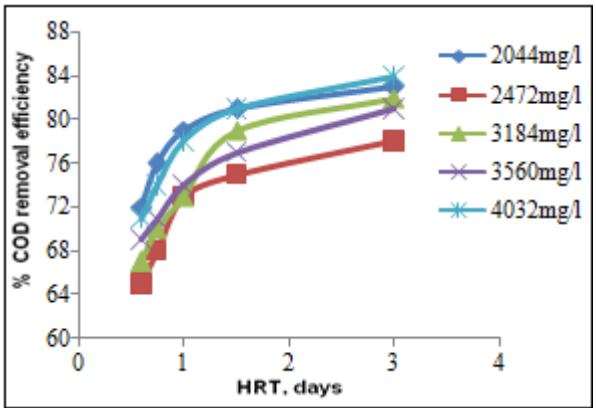

Figure 2: HRT, days VsCOD, mg/l

The pH variations are observed for the different operating conditions of Hydraulic Retention Time as shown in the Figure 2. The pH values got decreased while increasing HRT in sugar effluents. The pH of the wastewater plays an important role in anaerobic systems as shown in Figure 3.

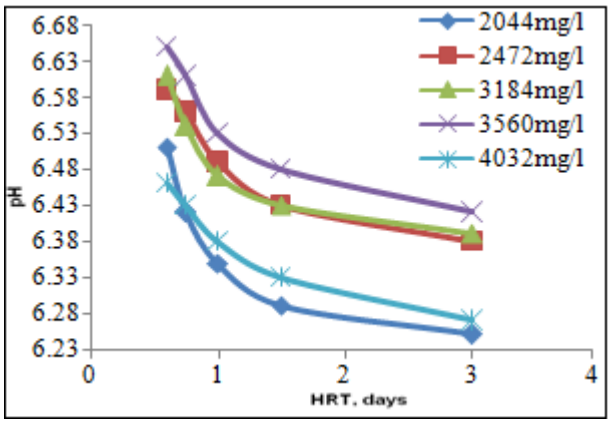

Figure 3: HRT, days Vs pH

4. Conclusion

The consequence of hydraulic retention time was created considerably affect the performance of the fixed film reactor. It can be accomplished from the result of the experimentation that the 3 days of HRT are found very optimal and feasible as they collectively present the system performance of overall COD removal at 86% at an influent COD deliberation of 3960 mg/l. The treated effluents of sugar industry are not highly polluted and they satisfy the BIS Indian standard values.

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