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Research Paper

Use of Geotextiles Baffle Contact Method for Biomass Development in Treatment of Domestic Wastewater

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Abstract: *Use of geotextile baffles as biofilm attachment media for wastewater treatment has been carried out in the present study. This Geotextile Baffle Contact System (GBCS) reactor was operated at different Hydraulic Retention Time (HRT) of 24hr, 18hr, 12hr, 8hr and 6hr in room temperature. The removal of Chemical Oxygen Demand (COD) was monitored for different Hydraulic Retention Time (HRT) and Organic Loading Rates (OLR). For Hydraulic Retention Time (HRT) of 24hr and OLR of 0.31 COD/m^3/day, 84% COD removal efficiency has been achieved. For Hydraulic Retention Time (HRT) of 18hr and OLR of 0.41 COD/m^3/day, 82% COD removal efficiency has been obtained. As Organic Loading Rates (OLR) increases the COD removal efficiency decreases. Overall the Geotextile Baffle Contact System (GBCS) system is an efficient tool for wastewater treatment.*

Keywords: Geotextile Baffle Contact System Reactor, Mixed Liquor Suspended Solids, COD, OLR, Water treatment.

Introduction

Water is an essential element for economic development and political stability and limited water resources are recognized as the most important obstacle to the development of the agricultural sector [1]. But the level of purity of the water being consumed is very crucial since it has a direct effect on health [2]. Waterborne diseases are one of the main problems in developing countries, about 1.6 million people are compelled to use contaminated water and more than a million people (of which two million are children) die from diarrhea each year [3]. The treatment of drinking water provides multiple barriers to protect public health by removing microorganisms and chemicals that may cause illness to consumers [4]. Wastewater treatment methods include precipitation, coagulation/flotation, sedimentation, filtration, membrane process, electrochemical techniques, ion exchange, biological process, and chemical reactions have its own merits and limitations in applications because of their cost [5]. So the treatment of water with low cost method is very important nowadays.

Attached growth process is one of efficient biological method in water and wastewater treatment. The advantages of the attached growth systems over conventional activated sludge process include better oxygen transfer, high nitrification rate and biomass concentrations, more effective organic removal, and relatively shorter HRT [6-7]. The present study aims to use geotextile baffles as an attaching media for biomass for the treatment of domestic wastewater. Geotextiles are thin durable pervious fabrics manufactured from polypropylene or polyester films or fibers in a variety of structures [8]. Geotextiles are used in subsurface applications as filters, drains, separators, or reinforcements [9]. GBCS reactor has been reported as an efficient tool for wastewater treatment [8]. COD removal from the municipal wastewater using geotextile baffles as an attaching medium has been carried out in present study. Effect of HRT and OLR on COD was carried out. pH variation in GBCS also monitored during the study.

Material and Methods

Sample Collection: Wastewater used for the experimental study was collected from National Institute of Technology Tiruchirapalli.

Characteristics of wastewater: The characteristics such as COD, pH, TS etc of wastewater were analyzed according to standard methods [10]. The characteristics of wastewater are shown in Table 1.

Influent Substrate

A synthetic substrate consisting of glucose, peptone as organic source was used as substrate throughout the period to ensure a consistent quality of influent to the reactor [11]. The synthetic wastewater used in this study simulates municipal wastewater. It has been designed to provide all the inorganics and micronutrients, as well as nitrogen, phosphorous for the development of the biomass [12]. The detailed composition of the synthetic substrate is shown in Table 2. Concentrated feed (300 mg/l COD) solution was prepared and stored in the refrigerator at 4 ^{0}C for a maximum period of ten days. Influent feed concentration of desired for the studies. Table 3 shows the general characteristics of the synthetic substrate strength in terms of COD was then prepared by diluting the concentrated feed with tap water. The influent substrate concentration varied from 300 mg/l COD to 310 mg/l COD. The influent was continuously supplied to the reactor in order to match with the permeate flow rate by keeping the water level constant in the reactor.

Experimental Setup

The schematic diagram of GBCS reactor is shown in Figure 1. It consists of rectangular Perspex box that was maintained in room temperature. The baffles divided the reactor into 4 discrete compartments with a total working volume of 15 liters. The influent was pumped by using peristaltic pump to the inlet of the reactor. The wastewater passes through the sludge bed is composed of microorganisms which have settling velocity and thus resist wash out even at high hydraulic loads. Glass strips were attached on the bottom part of the geotextile samples and secured with plastic ties to prevent floating and keep the geotextiles in alignment. The same plastics were also used to hang the geotextiles to hangers. The specifications of the reactor are shown in Table 4. No metal was exposed to the wastewater in the fish tanks. The Organic Loading Rate (OLR), velocity of the feed and Hydraulic Retention Time (HRT) is varied. The performance of the reactor is evaluated at different HRT and organic OLR, and the feasibility of adopting the GBCS for domestic wastewater treatment studied. Photographic views of fresh and aged baffles are given in Figure 2 and 3 respectively.

Table 1
Characteristics of Sewage waste

S. No.	Parameter	Value
1	pH	7.89
2	Chemical Oxygen Demand (COD)	240 mg/l
3	Biological Oxygen Demand (BOD)	180 mg/l
4	Total Solids (TS)	1480 mg/l
5	Total Suspended Solids (TSS)	330 mg/l
6	Total Fixed Solids (TFS)	490 mg/l
7	Total Volatile Solids (TVS)	660 mg/l

Table 2
Composition of Synthetic wastewater

Chemicals	Quantity (mg/l)
Dextrose **De**	300 **/l 3**
$(NH_4)_2SO_4$	75
$MgSo_4.7H_2O$	10
K_2HPO_4	18
$MnSo_4.H_2O$	1
$CaCl_2$	0.26
$FeCl_3.6H_2O$	0.05

Table 3
General Characteristic of Synthetic Water

S. No.	Constituent	Concentration
1	pH	7.0
2	Suspended Solids	< 1 mg/l
3	Mixed Liquor Suspended Solids (MLSS)	0 mg/l
4	Chemical Oxygen Demand (COD)	300 – 310 mg/l

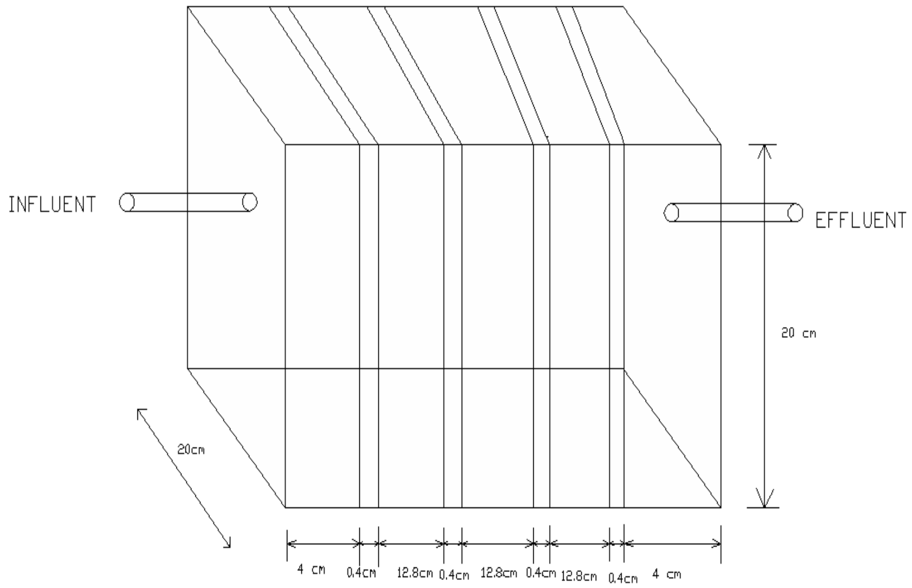

Figure 1: Schematic Diagram of Experimental Setup

Table 4
Specifications of the Reactor

Specifications	Quantity
Reactor Length	48cm
Reactor Height	20cm
Reactor Width	20cm
No of Baffles	4 Nos
Distance between Baffles	12.8cm

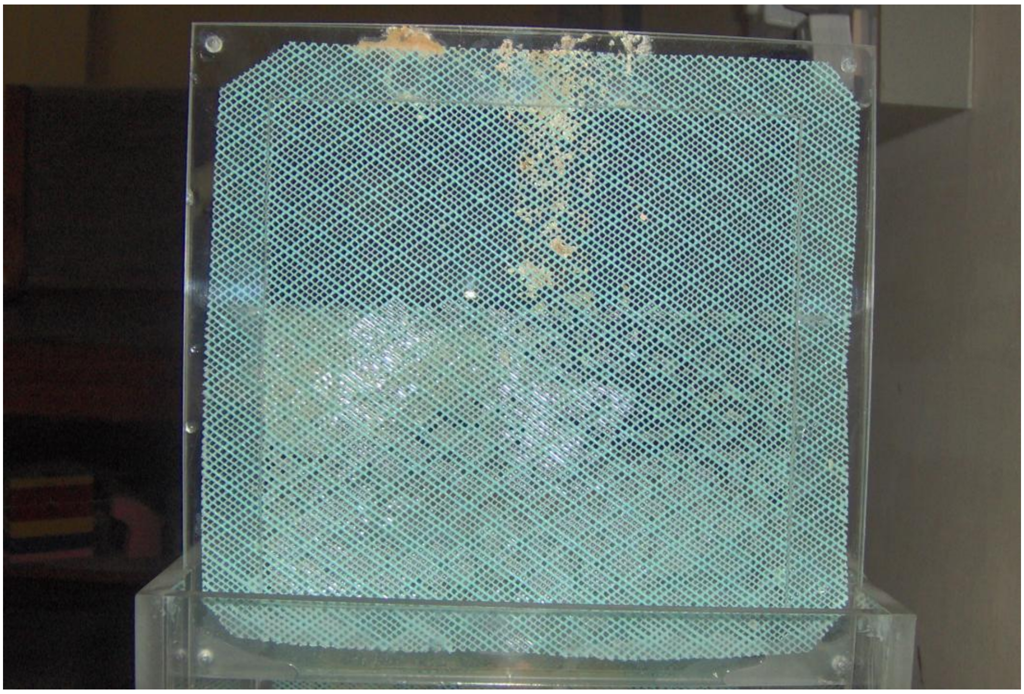

Figure 2: Photographic view of Fresh baffle of Geotextile Baffle Contact System

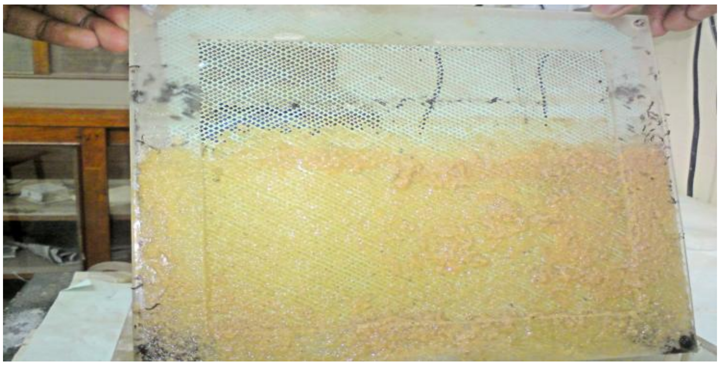

Figure 3: Photographic view of Aged Baffle Growth Attachment

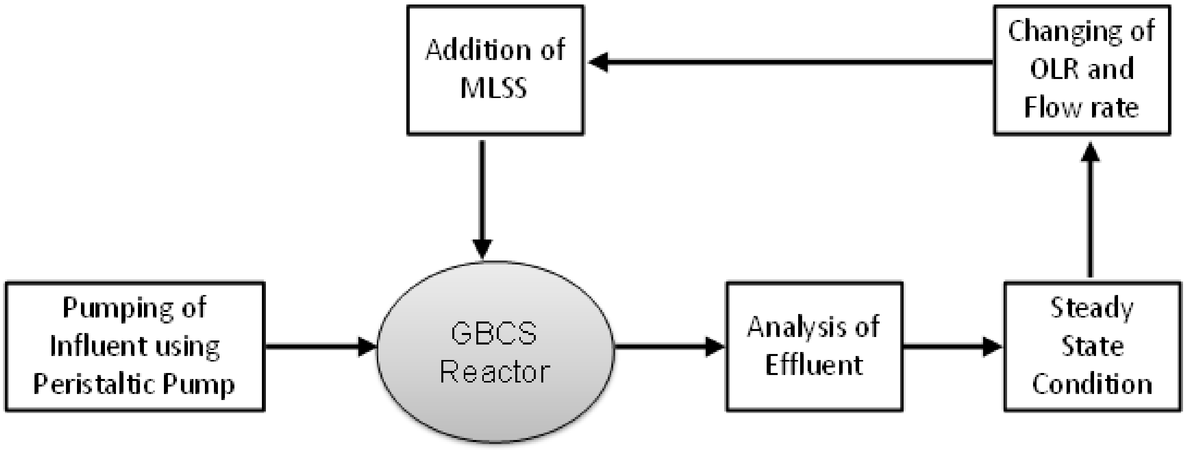

Figure 4: Experimental Steps

Analytical Procedure

For MLSS production, sewage from National Institute of Technology, Tiruchirappalli was taken as source. It was operated in batch mode. Beakers were filled with equal quantity of sewage and nutrient medium and aerated continuously. Ordinary fish aerator was used for aerating the MLSS. The working volume is around 500 ml. The MLSS production was carried out at room temperature and it was around 27^0C. The pH maintained was in the range of 6.5 to 7.5. In order to maintain an optimum pH of 7, sodium bicarbonate was added at times when there was sudden drop in the pH.

Initially the MLSS in the reactor was 2600 mg/l. These were allowed for the biomass to acclimatize to the synthetic substrate. The experiment was carried out with continuous monitoring. Then the MLSS concentration was increased to 3200 mg/l, 3856 mg/l, 4200 mg/l, and 4600 mg/l at different OLRs. The study was conducted at different OLR by analyzing and monitoring parameters such as COD, pH, during process operation. Initially the reactor was operated at HRT of 24 hr until steady state is reached during operation. Subsequently HRT was decreased and accordingly OLR was increased gradually and reactor was operated at 18hr, 12hr, 8hr and 6hr. The reactor was operated on a continuous basis at the desired retention time and synthetic wastewater was fed into the reactor in an upward direction at the required rate using peristaltic pump. The experimental steps are shown in Figure 4.

Results and Discussion

The COD removal for different HRT is shown in Figure 5. Reactor was initially operated at an HRT of 24 hr by continuous feeding of Influent substrate. After that the HRT was changed to 18, 12, 8 and 6 hr in a stepwise manner.

After each change in HRT the reactor was allowed to reach steady state condition. The reduction in COD was very high at the initial stages. After that the system comes to equilibrium. The maximum COD reduction was found to be 88.6%. Similarly the COD reduction with different OLRs is shown in Figure 6. The reduction in COD is decreases with increase in OLR. The change in pH of the system is also monitored throughout the experiment. The change in pH of the system is shown in Figure 7. From Figure7, it can be observed that there is an insignificant change in the reactor. It shows the advantage of the system over other conventional systems for wastewater treatment. Change in MLSS concentration is also monitored. At the beginning of the study, the MLSS concentration was kept around 2600 mg/l (Figure 8), which is the same MLSS concentration usually found in conventional activated sludge process. Then, the MLSS was increased to 3400 mg/l, 4200 mg/l and 4600 mg/l to carry out the work at different OLR.

Table 5 summarizes the steady state performance of GBCS reactor under different OLRs. Initially, from the HRT of 24 hrs, the influent and effluent COD concentrations were in the range of 300-310 mg/*l* and 57.6-35.2 mg/l , respectively, with COD reduction of 81.4 - 86.4% (Table 5). At lower HRT of 6 hrs, influent and effluent COD concentrations were in the range of 300-310 mg/*l* and 150-97 mg/l, respectively, with a COD reduction of 51-68%. Time required for steady state is inversely proportional to HRT. For higher the HRTs less the time is required for reaching the steady state and the for lower the HRTs the more time required to reach the steady state.

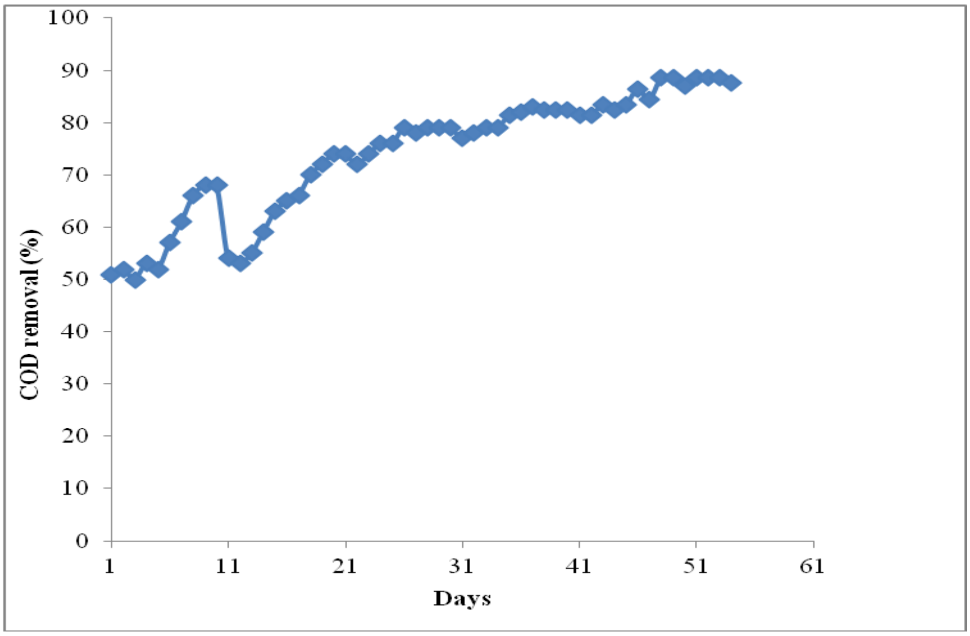

Figure 5: Percentage COD Reduction

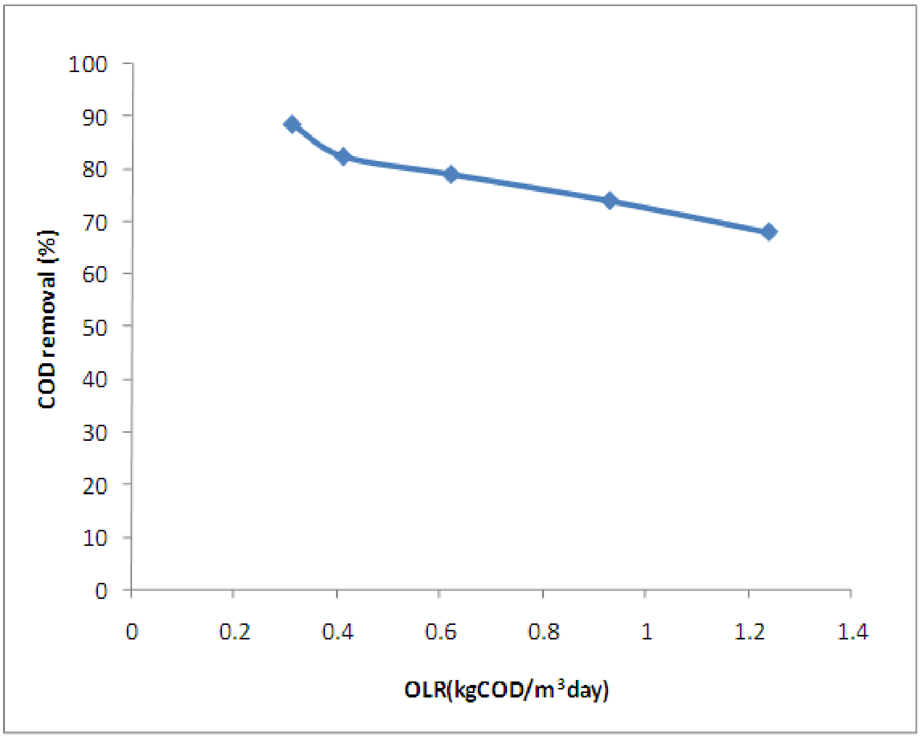

Figure 6: COD Reduction at different OLRs

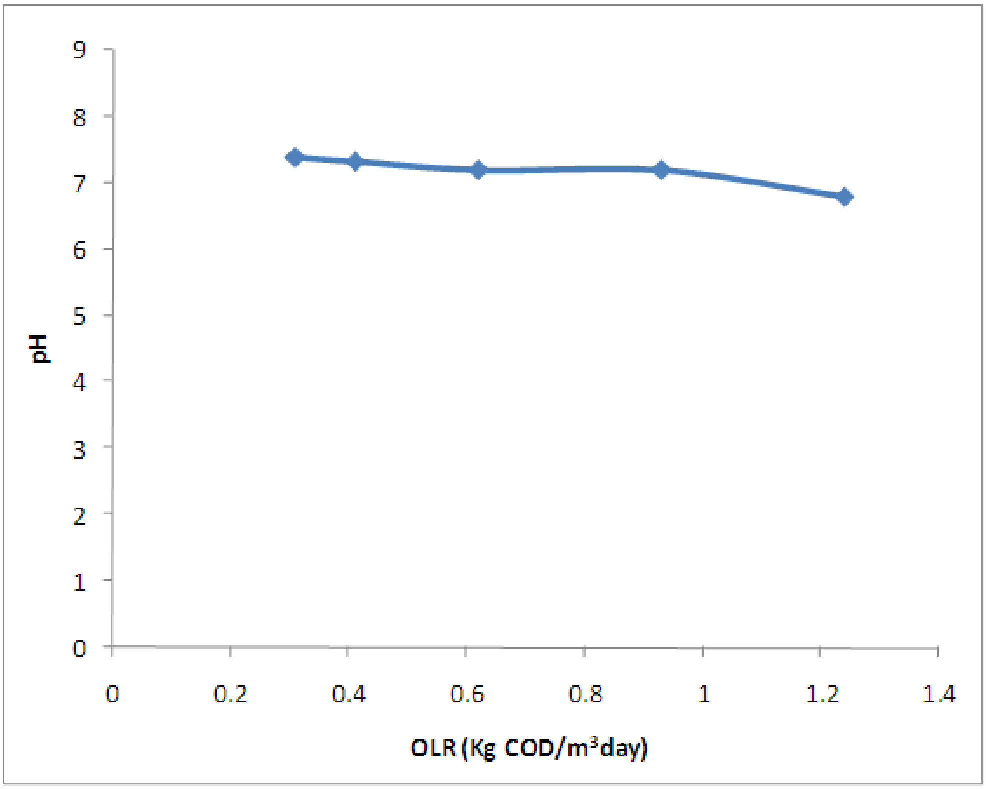

Figure 7: pH Varation in Geotextile Baffle Contact System

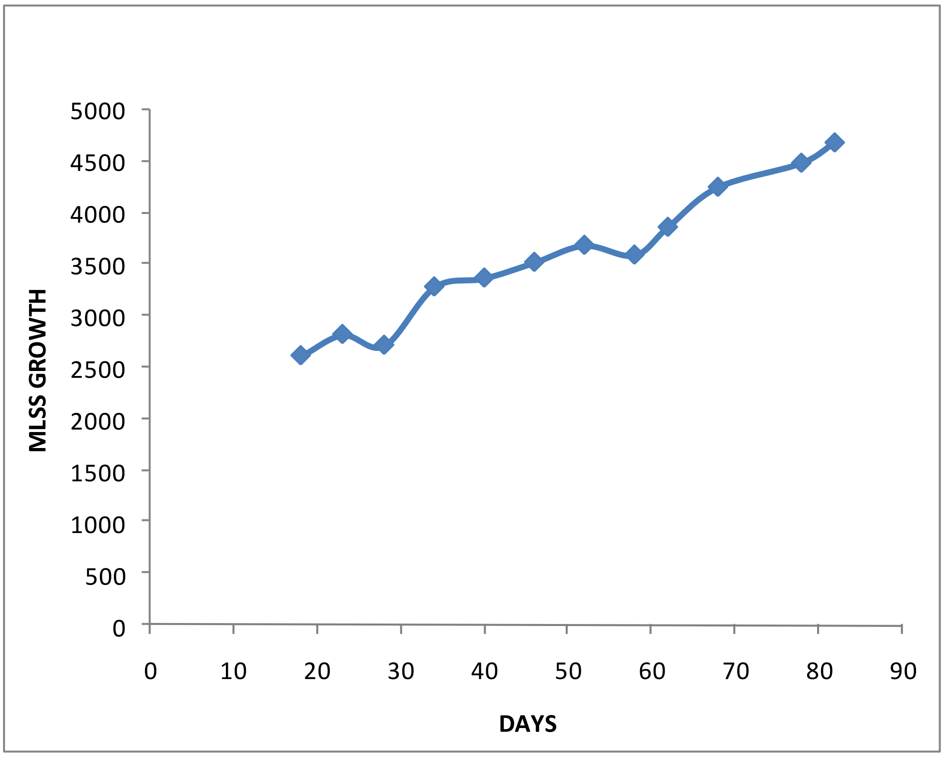

Figure 8: MLSS in Geotextile Baffle Contact System

Table 5
Steady state performance of Geotextile Baffle Contact System Reactor

HRT (Hrs)	**24**	**18**	**12**	**8**	**6**
Feed flow (ml/hr)	625	833	1250	1875	2500
OLR (kg COD /m^3/day)	0.31	0.41	0.62	0.93	1.24
Influent COD (mg/l)	310	310	310	310	310
Effluent COD (mg/l)	35.2	49	69	82	97
% reduction	88.6	84.2	79	74	68
pH	7.4	7.3	7.2	7.22	6.8

Conclusion

The treatment of domestic wastewater in GBCS reactor was conducted at different OLR and HRT. The COD removal efficiency of the system was monitored. The following were the conclusions drawn from this study:

- Based on the performance data obtained from laboratory scale experiments, the GBCS reactor considered as a feasible reactor configuration for treating wastewater at ambient temperatures.
- Treatment efficiency of the GBCS process under different operating conditions (such as MLSS, OLR) was studied. The COD removal efficiency increased as the MLSS concentration increases.
- There is an insignificant change in pH of the system.
- The performance of GBCS has been improved along the operating period, reaching a COD removal efficiency of 68%–86%.
- The efficiency of GBCS reactor is inversely proportional to OLR of the system.
- From the study, it can be concluded that the GBCS is one of the efficient tool for domestic wastewater treatment.

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