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SYNTHETIC GREY WATER TREATMENT USING SINGLE STAGE AEROBIC SBR

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ABSTRACT

The aim of this study is to evaluate the efficiency of SBR for different cycles of operation and to determine the removal efficiencies of COD, total phosphorous, ammonia nitrogen, nitrates and nitrites. The performance of the SBR is satisfactory and shows an efficiency of 83% for phosphates removal and 85% for ammonia nitrogen removal. The COD value show an efficiency of 70-75% for the different operating cycles(12hrs,10hrs,8hrs and 6hrs) while it reduces to 38% for 4 hour cycle.
This method of treatment of grey water is economical and the measured outlet parameters satisfy the limits for reuse of water for various other activities like flushing purposes
Keywords: SBR, grey water, removal , cycle

I. INTRODUCTION

Domestic wastewater can be considered a main source of water pollution due to its organic content and trace elements. Biological wastewater treatment techniques are an attractive option for treating such type of wastewater due to the economic advantages it offers in terms of operation costs. One such alternative that has been introduced is the sequencing batch reactor(SBR). The SBR is an activated sludge process that uses a fill and draw sequence, and can be operated in just one tank. It functions as an equalization, neutralisation and biological treatment and secondary clarifier in a single tank through a timed control sequence, which makes it environmentally friendly technology. SBR technology has five operating steps during one cycle – Fill, React, Settle, Draw and Idle. During the first stage (Fill), the waste and substrate are added to the microbial inoculum. The second stage is React and the objective of this stage is to complete reactions proposed during the fill phase. This stage consists of mixing or aeration, or a combination of both. The third stage is the settling stage, in whichthe treated water is separated from the solids and the treated water is decanted from the reactor during the fourth stage (Draw). Idle is the final stage in an SBR system. Due to its one tank design and setup simplicity the SBR system has recently been identified as attractive technology for the treatment of domestic, industrial and municipal wastewater and has been successfully used for various treatment purposes. However, a good process control is also required to ensure an effective biological wastewater treatment. Thus the SBR technology is a modified activated sludge process used for pollutant removal.

The purpose of this study is to investigate the useof SBR for treating grey water for different cycles of operation and to find out the efficiencies of the removal for various parameters like COD, total phosphorous, ammonia nitrogen, nitrates and nitrites.

II. MATERIALS AND METHODS

A. Bacteria Source And Synthetic Wastewater

The seed bacteria used as a biodegradable agent in this study were collected from the Wastewater Treatment Plant near the Staff Quarters at NITK,Surathkal . The synthetic grey wastewater was prepared in the lab by mixing surfactants with tap water.

B. Setup And Operation Of The Laboratory SBR System

The Sequential Batch Reactor system used in this study is shown in Fig. 1. The SBR was fabricated from a transparent glass cylinder with a capacity of 20L and the working volume is 15L. The vessel is filled with 520 plastic carriers .The surface area of the carriers is about 500m2/m3. They are filled for upto one third the volume of the vessel. Air diffusers are also connected to the vessel to maintain constant aeration within the vessel.

The reactor is filled with 1-2L of bacteria (biomass) and 12-13L of synthetic grey wastewater. The parameters COD, Ammonia Nitrogen,Nitrates, Nitrites and Total phosphorous were monitored regularly in the SBR reactor for the various cycles. The SBR reactor is operated continuously and the samples are taken from the reactor and analysed for influent and effluent concentration to measure the removal efficiency with the treatment conditions.

C. Characteristics Of The Sludge

The sludge sample collected was analyzed for finding out its Mixed Liquor Volatile Suspended Solids (mlvss) and Sludge Volume Index (SVI) using the standard methods.The SVI was found to be 0.35 and the mlvss was 2360 mg/l.

Aerobic sludge collected from the NITK staff quarters was used as an inoculum for the start up of the reactor. The reactor was operated under 12 hrs cycle for almost one month till the reactor was stabilized. The COD values were measured and determined at the outlet of each cycle and a constant COD value over a few days shows that the reactor has been stabilized.

D. Analytical Procedures

The reactor was run for different operating cycles of 12hrs, 10hrs, 8hrs, 6hrs and 4hrs and the COD, Ammonia Nitrogen , Nitrates, Nitrites and Total phosphorous were analyzed according to standard methods to analyse their removal efficiencies.

III. RESULTS AND DISCUSSION

The SBR performance was evaluated by determining COD, TP, AmmoniaNitrogen,Nitrates and Nitrites compounds in the effluent. The determined characteristics during the different cycles operated are presented in Table 1,Table 2,Table 3 ,Table 4 and Table 5.

Table 1: Characteristics of grey water for 12hrs cycle

12HRS	INLET	OUTLET	EFFICIENCY
COD	268	77	72
TP	1.2	0.2	83
NH4-N	21.585	3.675	83
NO3	1.335	5.689	
NO2	0.04	0	

Table 2 : Characteristics of grey water for 10hrs cycle

10HRS	INLET	OUTLET	EFFICIENCY
COD	273	79.1	71
TP	1.2	0.2	83
NH4-N	21.8	3.72	82.9
NO3	1.338	5.696	
NO2	0.04	0	

Table 3 : Characteristics of grey water for 8hrs cycle

8HRS	INLET	OUTLET	EFFICIENCY
COD	273	79	71
TP	1.2	0.2	83
NH4-N	22.5	3.5	84.4
NO3	1.35	5.74	
NO2	0.04	0	

Table 4 : Characteristics of grey water for 6hrs cycle

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6HRS	INLET	OUTLET	EFFICIENCY
COD	268	79.2	70.4
TP	1.2	0.2	83
NH4-N	22.5	3.46	85
NO3	1.35	5.7	
NO2	0.04	0	

Table 5 : Characteristics of grey water for 4hrs cycle

4HRS	INLET	OUTLET	EFFICIENCY
COD	266	167	37.2
TP	1.2	0.2	83
NH4-N	21.48	5.47	74.5
NO3	1.34	5.562	
NO2	0.04	0	

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The plot of the removal efficiencies of the various parameter for different cycled has been shown by the following graphs.

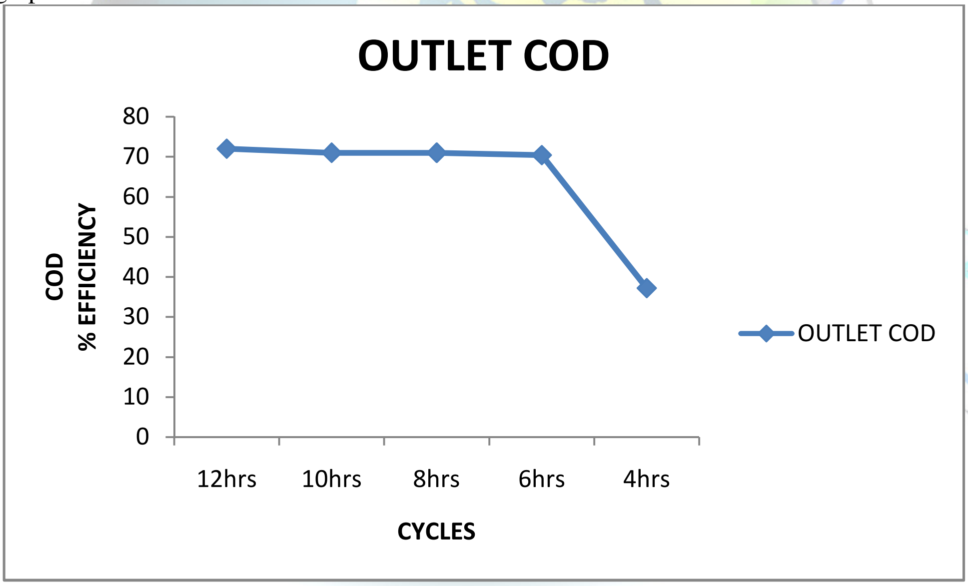

Figure 1 : Percentage COD removal from grey water

During the entire operational period, a high COD removal was obtained in the reactor and the effluent COD was nearly 75 % for 6hrs,8 hrs ,10hrs and 12hrs cycle. The outlet COD values obtained is much below the limits for reuse of treated grey water for various purposes. However a less COD removal efficiency was obtained for 4 hour cycle. This may be due to less mixing time inside the reactor for that cycle. Carbon removing bacteria were able to utilize carbon at pH level 7.0 to 7.5. The grey water treatment process in the SBR also showed very low sludge production. The low sludge production is also an important advantage of the SBR technology.

The total phosphorous removal showed almost the same efficiency for the different cycles operated. The inlet phosphorous content of 1.2 mg/l got reduced to 0.2 mg/l which is much below the limit for phosphorous content for various reuse purposes.

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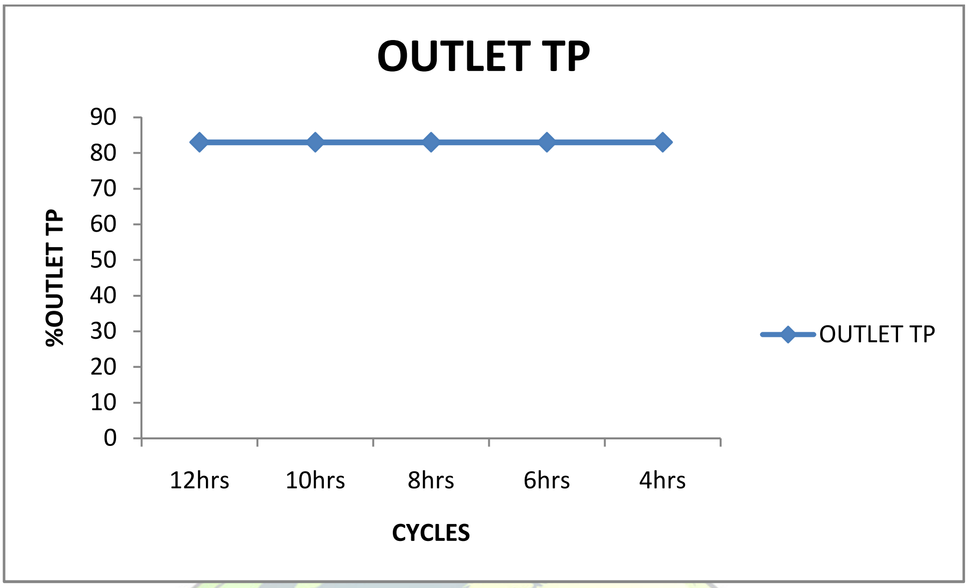

Figure 2 : Percentage phosphorous removal of grey water

The percentage removal of Total Nitrogen and Ammonia-Nitrogen are shown in Figure 3. The removal of nitrate involves two step biological processes in which initially the ammonia (NH4-N) is oxidized to nitrite (NO2) and nitrite is oxidized to nitrate (NO3) during the nitrification process. Then the denitrification process takes place, where the nitrate formed is reduced to small amount of nitric oxide and nitrous oxide during the settling stage. Mostly it occurs in the form of nitrogen gas, which escapes into the atmosphere. A slowly and persistence growth of bacteria seems to occur within a period of two month. The conversion of ammonia to nitrite occurs during the aeration and mixing stages of the SBR process. This is done by a group of autotrophic bacteria. In the second stage this nitrite is oxidized to nitrates by another group of autotrophic bacteria. If high amount of nitrites is found in the outlet it is due to insufficient aeration of due to pH imbalances.

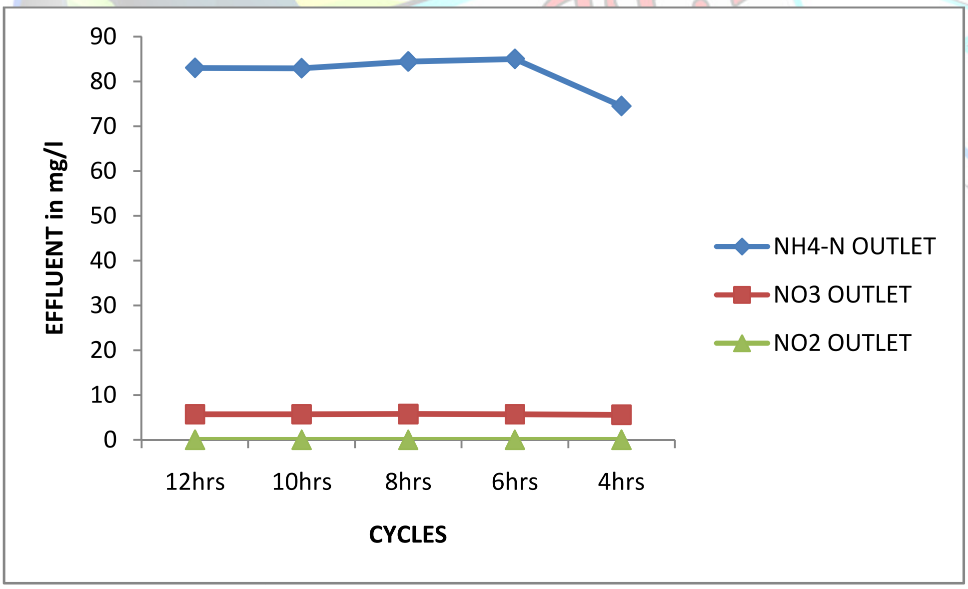

Figure 3. Percentage NH4-N,NO3 and NO2 removal of grey water

IV. CONCLUSION

The SBR system can effectively remove nutrients and promote biodegradation of organic matter for grey water treatment.The treated water can be used for those purposes which do not require direct human contact such as for flushing purposes.The pH should be maitained in the range of 7-7.2 to prevent the inhibition

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of nitrifiers and enhance the growth of microorganisms. A COD removal of 75% was obtained while ammonia reduction of 85% and phosphorous reduction of 83% was obtained. 8 hrs cycle can be considered for obtaining satisfactory removal efficiencies for the different parameters considered. The cost of water treatment using this method is also likely to reduce as it doesn't require an anaerobic unit and as all the processes take place inside a single reactor which is the main advantage of this system.

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