Performance Evaluation of Surface Aerator Assisted MBBR

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***Abstract*— Increasing quantity of wastewater generation in India has created a need of innovative and efficient way of treating it. Different types of treatment systems are available depending upon the influent characteristics of the wastewater and the desired effluent characteristics of the facility. Moving bed biofilm reactor (MBBR) is a new technology which promises excellent result and many advantages over conventional treatments. MBBR is a wastewater treatment technology which incorporates the best characteristics of suspended as well as attached growth system.**

To evaluate the performance of surface aerator assisted MBBR a laboratory scale model having effective capacity of 60 L was developed using GI sheet. The system was fed with synthetic wastewater of fixed characteristic to get the uniform quality of influent. The model was operated at the detention time of 24 hours. Total 3 trails were taken using different combinations of media. The results obtained from this experimental study showed removal efficiency of 83.08 % for BOD, 79.47% for COD and 85.14% for TS. This paper intends to provide information on different type of treatment processes along with brief information about suspended and attached growth system. Also the effort has been made to describe the overall vision of this technology along with its probable application and future scope in the field of wastewater treatment. Also the results obtained during this experimental study are presented in tabulated and graphical format in the present paper.

Keywords*— *Attached growth, designed media, MBBR, mechanical aerator, suspended growth, synthetic wastewater.

I. Introduction

Domestic wastewater is the wastewater generated due to various action of the community like flushing of toilet, cleaning, food preparation etc. Fresh wastewater is grey in color whereas as the time passes its color starts turning to black from grey. Wastewater also contains large floating and suspended solids, smaller suspended solids (such as partially disintegrated faeces, paper, vegetable peel) and very small solids in colloidal (i.e. non-settleable) suspension, as well as pollutants in true solution. It also contains many pathogenic bacteria originated from human colon and other sources which make it hazardous [1]. If such wastewater is discharged directly into the stream it can cause significant harm to the surrounding ecosystem. Due to all these reasons there is a need of effective as well as efficient treatment of wastewater.

There are two main system related to waste water treatment i.e. suspended growth system and attached growth system. Suspended growth system consisted of treatment unit such as activated sludge process (ASP) which offers good removal efficiency for various parameters such as COD, BOD etc. In this system bacterial culture responsible for treatment is in suspension. Whereas attached growth system consisted of treatment units such as trickling filter, rotating biological contactors (RBC) etc. In attached growth system colonies of bacteria responsible for treating wastewater are developed around the media. [2].

For treatment of the wastewater biofilm processes have proved to be reliable and effective. Moving Bed Biofilm Reactor (MBBR) is one of the promising technologies used for treatment of wastewater. The MBBR incorporate benefits provided by both fixed film and suspended growth processes. The MBBR is reliable, innovative and cost effective treatment process for the wastewater. Moving bed biofilm reactor technology was invented in Norway before 25 years [3]. The first MBBR facility became operational in 1990 in Lardnal, Norway. MBBR technology has since made significant penetration into the European market with an installed base of more than 300 MBBR systems [4].

The concept behind MBBR system is to adopt the best features of the activated sludge process (ASP) as well as that of the attach growth system based biofilter process and avoid the disadvantages encountered in ASP. Contrary to the activated sludge reactor, it does not need any sludge recycle. [5] In MBBR unit, biomass grows on the suspended media which have little less density than water and the media in this unit is kept in movement with the help of mechanical stirring or diffused aeration. The biofilm is created around the media which protects the bacterial culture due to which it remains stable under load variance and also shows resistance to change in pH and temperature. Researchers have proven that MBBR technology have many excellent traits such as high biomass, high COD loading, strong tolerance to loading impact, relatively smaller reactor and no sludge bulking problem [6].

The process can either be used as a 1) pre-treatment system ahead of an existing activated sludge system for increased organic matter removal, 2) stand-alone biological treatment process for BOD removal, nitrification and/or denitrification or 3) a retrofit of an existing activated sludge processes to help increase overall nitrification capacity of the existing system [7].

II. AIMS AND OBJECTIVES

The objective of the study was to evaluate the performance of MBBR reactor assisted with surface aerator in combination with specially designed arrayed media. The study was conducted to analyze the performance of the MBBR consisting of three different reactors working on principal of attached as well as suspended growth system. The aim of the study was to obtain increase efficiency as compare to conventional treatment system.

III. EXPERIMENTAL SETUP AND METHOD

A lab scale model was fabricated having effective volume of 60 liters. The model consisted of 3 reactors placed in series having upflow and downflow regime. The inlet and outlet arrangement were provided at the beginning and ending of the model for feeding of influent and withdrawing of effluent. The first reactor having downflow regime consisted of surface aerator followed by second reactor having upflow regime provided with specially designed arrayed media followed by last reactor consisted of MBBR unit. The model was kept under observation for the period 3 months.

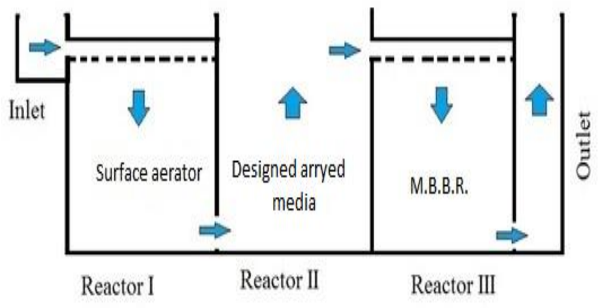

Figure 1 - Schematic Representation of Longitudinal Section of Model

The synthetic wastewater produced from mixture of dog food and peptone solution was fed into inlet cum presedimentation tank. The reactor was operated as continuous flow type with varying type of media. The performance of model was observed for removal efficiency for various parameters such as COD, BOD and TS. Artificial media named MEDIA I, MEDIA II and Anox Kaldnes biofilm carriers were use for development of bacterial culture on the surface of media. Photographic representation of these medias are shown in Figure 2 and Figure 3. Anox Kaldnes biofilm carriers were used in MBBR unit with 65% media occupancy.

Figure 2: Photographic Representation of Anox Kaldnes biofilm carriers and MEDIA I.

Figure 3: Photographic Representation of MEDIA II.

The optimize rotational speed was adopted for the MBBR and aeration unit. The most optimal rotational speed was adopted for the respective reactor unit. Total three number of iteration were carried out for the present model. In the first iteration MEDIA I was used as media for arrayed assembled compartment and for the second iteration, MEDIA II media was used. Photographic representation of the arrayed media assembly is shown in Figure 4. In the third iteration Anox Kaldnes biofilm carriers were used in second compartment for providing a surface for growth of bacterial colonies.

Figure 4: Photographic Representation of specially designed arrayed media

IV. RESULTS AND DICUSSION

Throughout the study, the model was operated at a detention time of 24 hrs. During the entire time of study influent and effluent samples were taken regularly and it was tested for parameters like COD, BOD, and TS. Model showed significant removal efficiency of 83.08 % for BOD, 79.47% for COD and 85.14% for TS. The inlet BOD, COD and TS were in the range of 220, 300, 320 mg/l respectively.

Iteration 1- The reactor was operated with second compartment packed with MEDIA I. The model was operated at detention time 24 hours and rotation speed of 10 rpm for MBBR unit. The result obtained are presented in table 1 and its graphical representation is shown in figure 5.

Table 1- Percent removal efficiency for COD, BOD and TS for model packed with MEDIA I.

	Sample No.	% COD removal	% BOD removal	% TS removal
First Iteration	1	74.41 %	77.96 %	78.88 %
	2	75.95 %	79.95 %	82.21 %
	3	71.66 %	78.41 %	80.34 %
	4	73.38 %	79.42 %	83.11 %
	5	72.13 %	76.32 %	79.88 %
Average % Removal		73.51 %	78.42 %	80.90 %

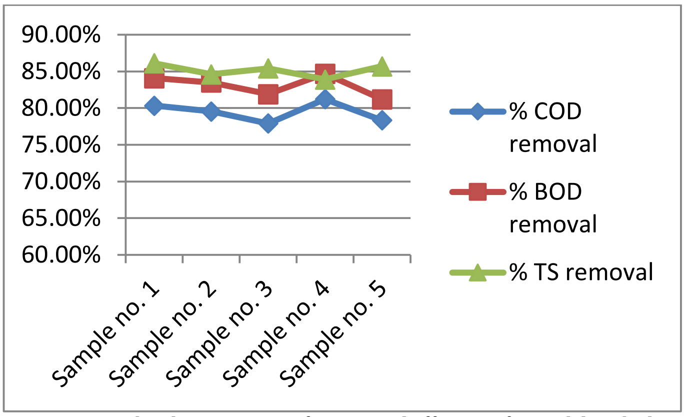

Figure 5 – Graphical presentation of % removal efficiency for model packed with MEDIA I

Iteration 2- The reactor was operated with second compartment packed with MEDIA II. The model was operated at detention time 24 hours and rotation speed of 10 rpm for MBBR unit. The result obtained are presented in table 2 and its graphical representation is shown in figure 6.

Table 2- Percent removal efficiency for COD, BOD and TS for model packed with MEDIA II.

	Sample No.	% COD removal	% BOD removal	% TS removal
Second Iteration	1	77.54 %	80.21 %	84.35 %
	2	74.55%	78.32 %	82.11 %
	3	75.32 %	79.21 %	81.26 %
	4	72.42%	81.14 %	79.86 %
	5	73.94 %	77.18 %	83.14 %
Average % Removal		74.75 %	79.21 %	82.15 %

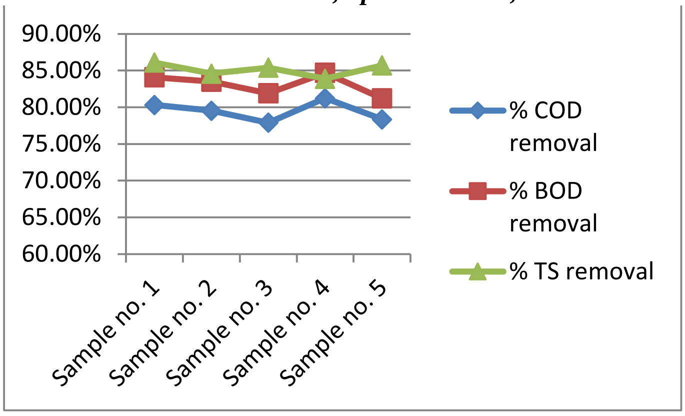

Figure 6 – Graphical presentation of % removal efficiency for model packed with MEDIA II.

Iteration 3- The reactor was operated with second compartment packed with Anox Kaldnes biofilm carriers. The model was operated at detention time 24 hours and rotation speed of 10 rpm for MBBR unit. The result obtained are presented in table 3 and its graphical representation is shown in figure 7.

Table 3- Percent removal efficiency for COD, BOD and TS for model packed with Anox Kaldnes biofilm carriers.

	Sample No.	% COD removal	% BOD removal	% TS Removal
Third Iteration	1	80.32%	84.08%	86.10%
	2	79.54%	83.50%	84.60%
	3	77.90%	81.90%	85.40%
	4	81.23%	84.70%	83.90%
	5	78.35%	81.20%	85.70%
Average % Removal		79.47%	83.08%	85.14%

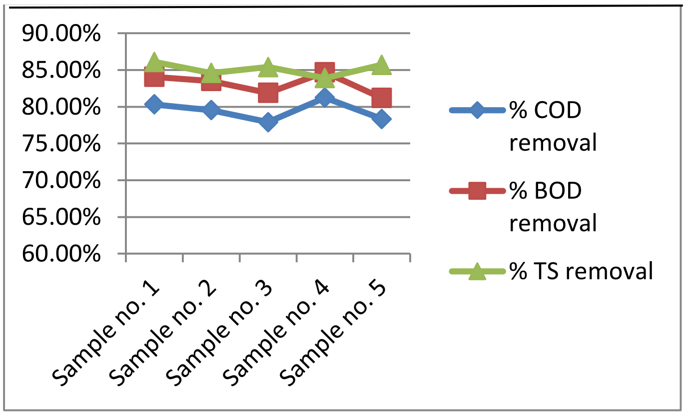

Figure 7 – Graphical presentation of % removal efficiency for model packed with Anox Kaldnes biofilm carriers.

V. CONCLUSION

From the experimental study it is concluded that MBBR gives excellent removal efficiency for BOD and TS. MBBR is effective, compact and efficient option for domestic wastewater treatment. MBBR is also expected to require less attention during its operation compared to other conventional treatment system. Present study provides valuable information for further development of MBBR system.

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