Characterisation of Grey Water and Treatment using Moving Bed Biofilm Reactor (Mbbr)

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Abstract - *Majority of residences and small-scale commercial operators in India dispose waste water either onsite or into the public drainage systems, without paying any attention to the public health and environmental impacts. Need for high investments and the requirement for large operational space are the reasons often quoted against the installation of a proper waste water treatment unit. In this study emphasis has been given to evaluate removal prospects of organic matter by Moving Bed Biofilm-Reactor (MBBR) media as an attached media. The effects of vital factors such as flow rate, hydraulic retention time (HRT) and fill rate affecting the performance of reactor in terms of organic matter (OM) removal are investigated. In the past research studies emphasis has not been given for cost effective and materials which provide excellent bio-surface area as an attached media for the removal of organic matter and nutrients. In this study exclusively Moving Bed Biofilm-Reactor (MBBR) media is used to study its suitability in grey water treatment.*

***Key Words*: MBBR, OLR, HRT, Flow rate, Fill rate**

1. INTRODUCTION

Design and implementation of efficient waste water treatment methods to meet the regional demands of pollution control have always been a major challenge facing by the technologists. Several attempts in the past to limit uncontrolled discharges of polluted water have led to the development of waste water treatment solutions using innovative process concepts.

Grey water is generaly used water from bathroom sinks, showers, tubs and washing machines. It is not water that has come into contact with faeces either from the toilet or from washing diapers.

Nowadays biological waste water treatment seems to be the most promising tool in treatment of waste water. The biological treatment techniques used may be classified as suspended and attached growth process. Suspended growth processes are the biological treatment processes in which the microorganisms responsible for the conversion of organic matter or other constituents in the waste water to gases and cell tissues are maintained in suspension within the liquid in the reactor by employing either natural or mechanical mixing, while in attached growth processes microorganisms are attached to some inert media. Attached growth process seems to be more stable than the suspended growth process when the waste water has considerable fluctuations in flow rate and concentration. In the past research studies emphasis has not been given for cost effective and materials which provide excellent bio-surface area as an attached media for the removal of organic matter and nutrients. In this study exclusively Moving Bed Biofilm-Reactor (MBBR) media is used to study its suitability in grey water treatment.

Javid A.H.*et.al.* (2013) investigated feasibility of upgrading and retrofitting municipal wastewater treatment plants at laboratory scale using Moving Bed Biofilm Reactor (MBBR) process. For this purpose, an aerobic pilot was operated for nearly one year in different conditions, in which a moving bed carrier with a specific biofilm surface area of 500 m2 / m3 and a filling rate of 60% was utilized. System efficiency in removal of BOD5 and COD was examined at different hydraulic retention times (HRTs) of 1, 1.5, 2, 2.5, 3 and 4 h. The obtained results indicated high ability of the system to tolerate organic loading and to remain stable at a high food to microorganism (F/M) ratio. The system produced effluents with good quality at low HRTs and led to an average BOD5 removal efficiency of nearly 88% during the operational period. The Organic Loading Rate (OLR) applied to the system had a range of 0.73-3.48 kg BOD5/m3.day and 2.43-11.6 g BOD5/m2.day, at which the reactor showed a good performance and stability.

2. MATERIALS AND METHODOLOGY

2.1 Material

Moving Bed Bio-Reactor (MBBR) media is a free-floating media which houses huge quantity of active biomass. It provides excellent bio-surface area for microbial growth, thereby increasing the organic load rate. The media is cylindrical in shape

with extended fins and is made of using high quality UV stabilized virgin polypropylene material. Once submerged inside the bioreactor, the floating media operates as non-clogging media. No channels or dead spots are developed like in other technologies. The movement is caused by either aeration, or being mechanically stirred, depending on reactor design and effluent requirements. The MBBR media optimizes growth of biomass and provides shelter and protection for the biomass and makes the wastewater treatment plants extremely robust and reliable. The MBBR media represents flexibility and new-engineered potentials in waste water treatment plant operation.

2.2 Characteristics of Grey Water

Table -1: Characteristics of Grey Water

Sl. No	Parameters	Obtained Value	Effluent Standards
1	COD	2024 mg/L	250 mg/L
2	BOD	1800 mg/L	30 mg/L
3	pH	8	5.5-9
4	TURBIDITY	22.8 NTU	10 NTU

2.3 Start up and loading strategy

The reactor was set up at the Environmental Engineering Lab. A rectangular shaped tank built of acrylic with 1.2 m length, 0.3 m width and 0.4 m depth. Three air diffusers were provided at the bottom of the reactor with a constant aeration rate of 2.5 L/min per each in all stages to supply oxygen to the microbial mass for biological activity and mixing the carriers.

The experimental investigation was divided into three stages. The HRT of the influent was varied at constant OLR of 1.22 kg BOD5/m3.day. The effect of flow rate on the performance of reactor in terms of OM was examined. Three different flow rates of 55, 60, 70 L/d and corresponding hydraulic retention time (HRT) of 39, 36, 31 hours were tested under the fill rate of MBBR as 30%.

Once the optimum flow rate and HRT is obtained the fill rate is changed to a value above and below 30% to obtain the optimum.

3. Results and Discussions

Average COD removal efficiency increased from 79.6% to 87.45% with increasing FLR from 55 to 60 L/d and correspondingly with decreasing HRT from 39 to 36 hours. This indicates that a higher FLR could enhance the activity of aerobic microorganisms. It was found that the COD removal efficiency increased primarily with increase in FLR. However, after it reached to a constant value at FLR of 60 L/d, COD removal efficiency started to decrease significantly. The maximum COD removal was obtained at 60 L/d at a constant OLR of 1.22 kg COD/m3d and it was about 87.45%. As the FLR increases HRT decreases at a constant OLR. The optimum flow rate was obtained as 60 L/d and optimum HRT obtained was 36 hours.

3.1 Effect of HRT on the performance of reactor in terms of organic matter

Hydraulic retention time (HRT) is an important operational variable which can be easily controlled. It is average length of time a molecule of liquid remains in the reactor and can be defined as the volume of the reactor divided by the average influent flow rate. The HRT was changed by varying the flow rate in this phase of the experiment.

In terms of COD removal, although the HRT was decreased, reactor conditions became stabilized shortly within the first few days of each cycle and high removal efficiency was achieved after the stabilization days. The COD removal efficiency

obtained for hydraulic retention time of 39 h was 79.6%. For 36 hours it was 87.45% and 75% for 31 hours. It is shown in Chart 1.

COD removal increased slightly with augmentation of HRT and the highest removal efficiency was obtained at the HRT of 36 hours. This high COD removal was attributed to the reactor advantage that can completely retain biomass present in the mixed liquor to produce a high-quality effluent. In addition, the removal of organic pollutants was a co-function of microbial metabolism. So, after reaching maximum value it begins to reduce. It is the reason for reduction in COD at 31 hours.

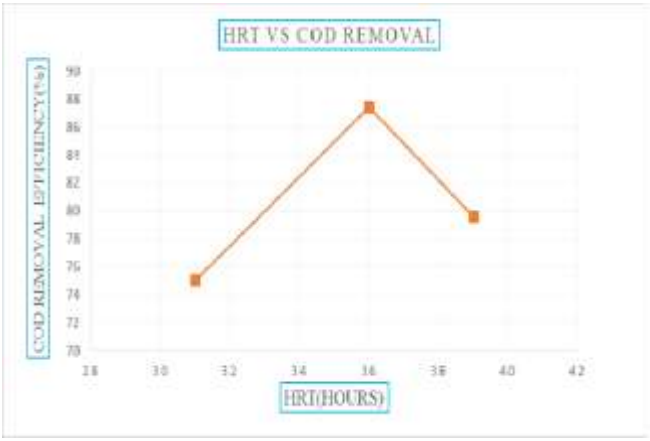

Chart-1 Performance of reactor with HRT

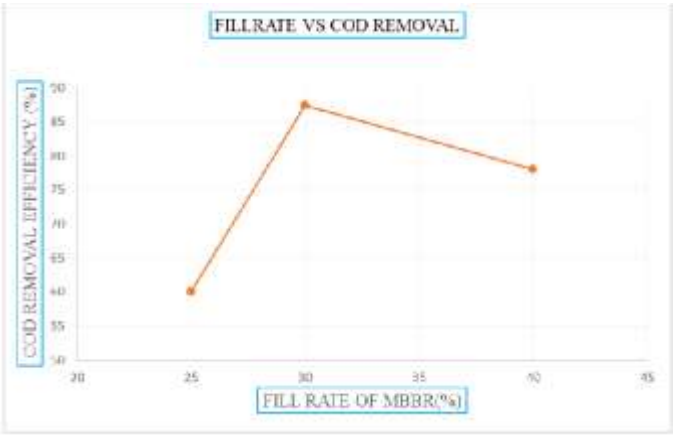

Chart-3 Performance of reactor with fill rate of MBBR

3.2 Effect of flow rate on the performance of reactor in terms of organic matter

Both OLR and HRT are the functions of flow rate. As flow rate increases HRT decreases. The COD removal efficiency obtained for 55L/d, 60L/d and 70L/d were 79.6%,87.45% and 75% respectively. The maximum removal was obtained at flow rate of 60L/d. It was shown in the Chart2.

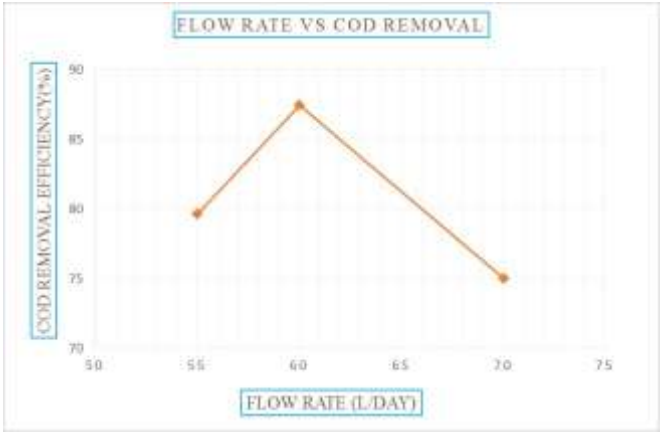

Chart -2 Performance of reactor with flow rate

3.3 Effect of fill rate of MBBR on the performance of reactor in terms of organic matter

The COD removal efficiency obtained for 40%,30% and 25%,fill rate of MBBR were 78%,87.45% and 60% respectively. The maximum removal was obtained at a fill rate of 30%. It was shown in the Chart 3.

4. CONCLUSIONS

The waste water treatment using MBBR as an attached media is a very cost-effective option for the removal of organic matters (OM) from wastewater. This particular research work analysed the removal of OM from grey water using the same reactor. In this study, the effects of vital factors such as flow rate (FLR) and hydraulic retention time (HRT) affecting the performance of reactor in terms of OM removal were investigated.

Some special findings of this study can be drawn as follows:

- It was found that the COD removal efficiency increased primarily with increase in FLR. However, after it reached to a constant value at FLR of 60 L/d, COD removal efficiency started to decrease significantly.
- The maximum COD removal efficiency was obtained as 87.45% at FLR of 60 L/d.
- As the FLR increases HRT decreases at a constant OLR.
- The optimum flow rate was obtained as 60 L/d and optimum HRT obtained was 36 hours.
- The optimum fill rate of MBBR obtained was 30%.

The utility of MBBR as an attached media for the treatment of grey water, loaded with biodegradable matter, has been successfully established in this research. This would certainly result in expanding the engineering applications of MBBR media. The laboratory results obtained from this study have given the necessary information to design and evaluate the long-term performance of a field scale, reactive treatment unit of the volume of reactor.

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REFERENCES

[1.] Javid, A.H., *et al*.,(2013), "Feasibility of Utilizing Moving Bed Biofilm Reactor to Upgrade and Retrofit Municipal Wastewater Treatment Plants", Int. J. Environ. Res., 7(4):963-972, Autumn 2013.

[2.] Bojorn Rusten et. al. (1997) "Moving bed biofilm reactors and chemical precipitation for high efficiency treatment of waste water from small communities", Sci Tech. Vol. 35. No.6. pp. 71-79.1997. 1997 IAWQ

[3.] Borkar R P, Gulhane M L, Kotangale A J, (2015) "Moving Bed Biofilm Reactor – A New Perspective in Waste Water Treatment", IOSR-JESTFT, Vol. 06, Issue 06, Nov-Dec. 2013, ISSN: 2319-2399, pp. 15-21.

[4.] Kermani M., Bina B., et al (2008), "Application of moving bed biofilm process for biological organics and nutrients removalfrom municipal wastewater," American Journal of Environmental Sciences 4 (6): 675-682, 2008.