Dairy Farm Waste Water Treatment Using MBBR as an Attached Media

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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 present study emphasis has been given to evaluate removal prospects of organic matter by Moving Bed Bio-Reactor (MBBR) media as an attached media. 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. It was found that the Chemical Oxygen Demand (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 FLR of 60 L/d and at a constant Organic Loading Rate (OLR) of 1.33 kg COD/m³d and it was about 88%.*

***Key Words*: MBBR, HRT, OLR, COD, FLR**

1.INTRODUCTION

The increase in population density along with rapid industrialization creates threats to the environment. Water pollution has become a serious problem in our country. Treatment of domestic and industrial waste before their disposal into surface water was not given much importance until the recent past. This resulted in converting most of our rivers into super sewers. The ultimate goal of waste water treatment is the protection of environment in a manner commensurate with public health and socio-economic concern.

Nowadays biological wastewater treatment seems to be a most promising tool in treatment of dairy farm wastewater. Dairy farming is a class of agriculture for long-term production of milk, which is processed for eventual sale of a dairy product. The wastewater from dairy farms consist of organic impurities and suspended solids. Here the treatment is carried out using the concept of attached growth process with Moving Bed Bio-Reactor(MBBR) media used as a medium for growth of bacteria. Bacteria cling to the surface of media and utilizes the organic matter in wastewater in presence of diffused air (from diffusers) thus converting it to biomass. 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.

Swati A Patil, Vaishali V Ahire, M H Hussain have done a case study on dairy farm waste water. Due to highly biodegradable nature of dairy waste water, its treatment requires urgent attention. Biological treatment technologies can readily treat the dairy waste water. They found that it contains BOD, COD, total solids, dissolved solids and sometimes pH and oil-grease as highly biodegradable and COD/BOD is less than 1.5.

Borkar R P, Gulhane M L, Kotangale A J (2013) discussed a new advanced biological reactor for waste water treatment. Moving Bed Bio-Reactor (MBBR) presents several operational advantages, compared to other conventional biological treatments. The results indicated that MBBR with polypropylene media as biofilm carrier may possess great potential to be used for removal of organic matter and can be used as an ideal and efficient option for the total nutrient removal from municipal waste water.

2. MATERIALS AND METHODOLOGY

2.1 Material

MBBR media is a free-floating media which houses huge quantity of active biomass. 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.

Table -1: Technical Specifications of MBBR Media

Material	Polypropylene
Effective Specific Surface Area	400 m^2/m^3
Media Height	15 mm/ 10 mm
Media Diameter	22 mm
Weight per unit surface area	0.37 kg/m^2

Specific Gravity	0.90-0.95 g/cm^3
Voidage	>98%
Density	0.93 g/cm^3
Media fill rate range	25-55% of volume

2.2 Characteristics of dairy farm waste water

Table -2: Characteristics of waste water

Sl.no	Parameters	Obtained Value	Effluent Standards
1	COD	1848 mg/L	250 mg/L
2	BOD	1356.51 mg/ L	30 mg/L
3	pH	7.5	5.5-9

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 the stages to supply oxygen to the microbial mass for biological activity and mixing the carriers.

The experimental investigation was divided into three stages. The flow rate of the influent was varied at a constant organic loading rate (OLR) condition of 1.33 kgCOD/m^{3}d. In the first stage, 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%.

3. RESULTS AND DISCUSSIONS

Average COD removal efficiency increased from 79% to 88% with increasing FLR from 55 to 60 L/d respectively. 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. At 70 L/d, the COD removal efficiency was reduced to 80%. As the FLR increases HRT decreases at a constant OLR of 1.33 kg COD/m^{3}d.

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%. For 36 h it was 88% and 80% for 31 h. It is shown in chart 2.

COD removal increased slightly with augmentation of HRT and the highest removal efficiency was obtained at the HRT of 36 h. 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.

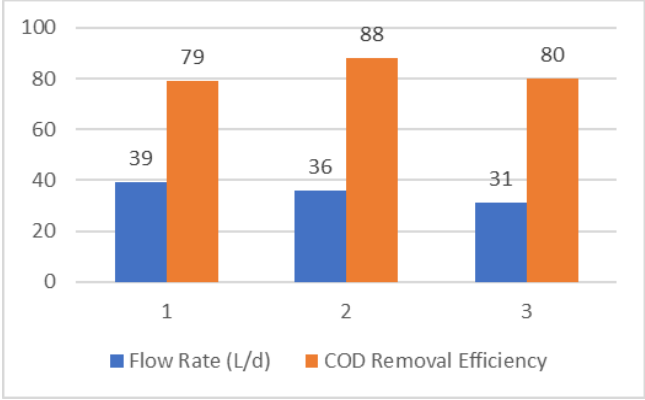

Chart -1: Performance of reactor with HRT

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 analyzed the removal of OM from the dairy farm wastewater using the same reactor. Effects of vital factors such as flow rate and hydraulic retention time (HRT) affecting the performance of reactor in terms of OM removal were investigated.

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 and it was about 88%. As the FLR increases HRT decreases at a constant OLR. The optimum flow rate was 60 L/d and optimum HRT obtained was 36 h.

The utility of MBBR as an attached media for the treatment of wastewater, loaded with biodegradable matter, has been successfully established in this research. This would certainly result in expanding the engineering application 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 sewer unit.

ACKNOWLEDGEMENT

I express my sincere gratitude and thanks to Dr. Soosan George T, our Principal and Dr. Binoy Alias M, Head of the Department for providing the facilities and all the encouragement and support.

I express my sincere gratefulness to Prof. Neena Sunny, for her effective motivation, helpful feedback and great support. I express my sincere gratitude to all the faculties of the Department of Civil Engineering for their help and encouragement.

Finally, I would like to acknowledge the heartfelt efforts, comments, criticisms, cooperation and tremendous support given to me by my dear friends during the preparation of the project and also during the presentation without whose support this work would have been all the more difficult to accomplish.

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