Treatment of dairy wastewater by using moving bed biofilm reactor sequential with integrated fixed-film sludge

Selvabharathi Gopal[1], S. Robert Ravi[2], Etikala Chinna[3]
[1]*Assistant Professor, Department of Civil Engineering, SSM Institute of Engineering and Technology, Dindigul - 624002,Tamilnadu, India*
[2]*Professor, Department of Civil Engineering, ACE Engineering College, Medchal District, Telangana – 501301, India*
[3]*Assistant Professor, Department of Civil Engineering, ACE Engineering College, Medchal District, Telangana – 501301, India*

***Abstract*— Moving Bed Biofilm Reactor (MBBR) is a leading technology of biological solution for wastewater treatment based on the aerobic principle. In this study, lab scale experiments were done by using MBBR with Integrated Fixed-film Sludge(IFAS) process and polypropylene media to analyze BOD and COD removal from wastewater of dairy industries. The system efficiency in removal of BOD and COD was examined at a different rate of Hydraulic Retention Time (HRT) of 1, 1.5, 2, 2.5 and 3 hours. Similarly BOD and COD removal efficiency of 60% and 88% respectively was achieved with 3hrs HRT and also settling time was observed as 4 hours. Finally this study indicates that MBBR with IFAS process and polypropylene media as biofilm carrier posses very good removal of BOD and COD from Dairy Wastewater.**

***Index Terms*—Dairy wastewater, MBBR, IFAS Hydraulic Retention Time (HRT)**

INTRODUCTION

The dairy industry is generally considered to be the largest source of food processing wastewater in many countries. With increase in demand for milk and milk products, many dairies of different sizes have come up in different places. These dairies collect the milk from the producers, and then either simply bottle it for marketing, or produce different milk foods according to their capacities. Large quantity of wastewater originates due to their different operations. The organic substances in the wastes comes either in the form in which they were present in milk, or in degraded form due to their processing. As such, the dairy wastes though biodegradable, are very strong in nature. Several methods are available to reduce the high load content of pollutants in Dairy waste water. Among them Moving Bed Biofilm Reactor (MBBR) is considered as one of the promising process for treatment of wastewater. The basic principle of moving bed process is the growth of biomass on plastic supports that move in the biological reactor via agitation generated by aeration systems (aerobic reactors) or by mechanical systems or by anaerobic reactors. Integrated Fixed Film Activated Sludge (IFAS) is emerging technology that is highly efficient low footprint activated sludge solution. IFAS consists of submerged fixed bed polypropylene, textile media which promotes attached growth biomass in Integrated Fixed Film Activated Sludge.

A MOVING BED BIOFILM REACTOR (MBBR)

Two technologies are commonly used for biological treatment of sewage which is activated sludge and trickling filters, a MBBR is a compilation of these two technologies. The biomass in the MBBR exists in two forms suspended flocs and a biofilm attached to media. MBBR has become popular in the field of wastewater treatment because it maximizes the capacity and efficiency of the treatment plant by minimizing the footprints. It has the capacity to retrofit the old treatment plants, higher nutrient removal ability, produce less sludge as a result of high biomass, retention time, and easy maintenance, economical and so on. The key element of the MBBR is the use of small plastic biofilm support media to allow a high concentration of protected biofilm growth in a well-

mixed reactor. The reactors can be operated under aerobic conditions for carbonaceous and nitrogenous organic matter removal and under anoxic conditions for denitrification. In an aerobic reactor, circulation of media is facilitated through the action of air bubbles injected into the tank by a diffused aeration system. In an anoxic reactor, a submerged mechanical mixer is typically supplied. Before treating wastewater in MBBR (FIG 1), it passes through grit chamber where the grit (dense material such as sand, dirt) is removed. After preliminary treatment this water is fed to aerobic reactor for removing organic matter for the designed retention time.

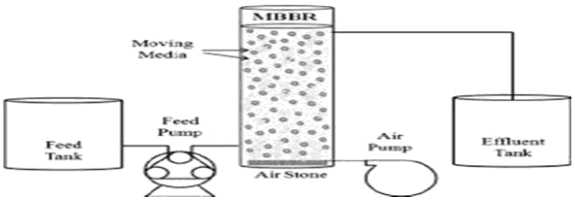

Fig 1: Treatment by MBBR Proess

B. INTEGRATED FIXED FILM ACTIVATED SLUDGE (IFAS)

After biological treatment, effluent passes through the secondary clarifier where biomass is separated as sludge from the treated wastewater. The sludge is removed from the bottom of the clarifier and supernatant is separated from the upper side of clarifier. The sludge is reintroduced into the reactor tank for further treatment of dairy wastewater to increase the efficiency of treatment process (FIG 2).

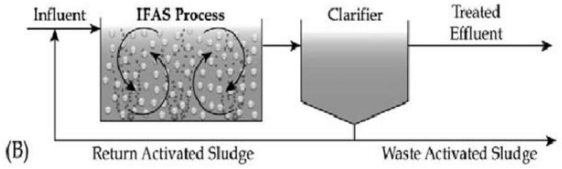

Fig 2: Treatment by IFAS process

Need for the project is as follows: Dairy wastewater is characterized by high BOD and COD concentration. It generally contains fats, nutrients, lactose as well as detergents and sanitizing agents. Hence without pre-treatment when discharged into the land surrounding area gets polluted. The industries wastewater is characterized by high COD, BOD, turbidity etc. Such wastewater main reason for this study is to reduce the pollution of dairy wastewater and to make the water for usability. Objective of the study is Implement the MBBR and IFAS technology as an alternative successful method in treating dairy wastewater. To evaluate the removal efficiency of BOD and COD at varying HRT.The project is to carry out a laboratory and pilot scale.

MATERIALS

Media is the important parameter of MBBR system. Media provides surface area to the microorganisms for growth as biofilm. These media move freely into the wastewater and increase contact between substrate available in wastewater and microorganisms present on the media. Generally this media is made by polypropylene. Working Principle as a static media, K1 media does work biologically, but its primary use in this respect is to trap solids. The media's structure collects suspended particles, and it can then be backwashed (most effectively with air) to clean this away. This is the basis of the nexus k1 filter's mechanical filtration. The waste water is collected from the Amman dairy products pvt. Ltd, Piththalapatti in Dindigul. Fresh waste water from the industry is collected. It consists of many large particles they are removed by screening the water at initially. After screening process the basic initial characteristics of water sample is taken such as pH, Biological Oxygen Demand, Chemical Oxygen Demand, Total Dissolved solids and Turbidity. Quantifying the adhered biomass is very essential. To quantify the adhered biomass around 4-5 media were collected from reactor and immersed in 100ml of distilled water in a beaker which was shaken vigorously till the biomass get detached from media. Media were removed and suspended solids remaining in the beaker were measured. Then adhered biomass was expressed in the form of mg biomass/media.

RESULT AND DISCUSSIONS

After the treatment of wastewater, the pH obtained with varying HRT,

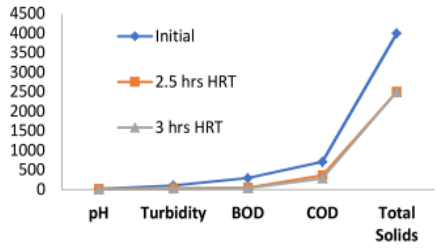

Fig 3: Comparison of HRT values

In the FIG 16, the pH value reaches 7.94 at 2.5 hours HRT and 6.92 at 3 hours HRT from 9.17 initial pH values. The maximum reduction of pH value is at 3 hours HRT. The turbidity changes 24 NTU and 23 NTU at 2.5 hours and 3 hours respectively from initial turbidity as 94.1 NTU. The lowest turbidity value obtained is at 3 hours HRT. The BOD value falls to 45mg/l at 2.5 hours HRT and 35 mg/l at 3 hours HRT from 285mg/l which is the initial BOD value. The ultimate reduction of BOD is at 3 hours HRT. The COD value decreases as 360 mg/l and 280 mg/l at 2.5 hours HRT and 3 hours HRT respectively from initial COD value 700 mg/l .The maximum fall of COD is at 3 hours HRT. Total Dissolved Solids is reduced to 2500 mg/l at both 2.5 hours and at 3 hours HRT from initial TDS value 4000mg/l. Removal Efficiency: The decrease in the parameter values of treated values from untreated values is given by Removal efficiency.

Table 1: Removal Efficiency of varying HRT

PARAMETERS	REMOVAL EFFICIENCY			
VARYING HRT	1.5hrs	2 hrs	2.5 hrs	3hrs
TURBIDITY	69	73	74	76
BOD	61.4	78	84	88
COD	29	57.2	49	60
TOTAL SOLIDS	13	25	37.5	37.5

CONCLUSION

From the experimental results, we have concluded that among the chosen varying HRT, showed a better coagulation and turbidity removal for dairy wastewater. The characteristics of untreated dairy wastewater are pH-9.17,Turbidity -94.1 NTU, BOD-285 mg/l ,COD- 700 mg/l and Total solids – 4000 mg/l. The pH is reduced to 6.92; turbidity decreases to 23NTU;BOD is decreased to 35 mg/l; COD is reduced to 280mg/l and TDS decreases to 2500mg/l. Among the four varying Hydraulic Retention Time (HRT), the maximum reduction of turbidity, BOD,COD and total solids is found to be 76%, 88%, 60% and 37.5% with 3hours HRT;hence 3 hours HRT is suggested for more effective treatment of dairy wastewater. MBBR does not have common problems such as sludge bulking and rising, poor settling and foaming. Strong resistance to impact makes it easier to operate .IFAS process is proven to be comfortable and efficient upgrade for the improve efficiencies of poorly performing WWTP. It can handle shock loads, extreme stresses, and temperature variations. As long as the system is properly maintained, it can function efficiently for decades without major problems. IFAS process will play a vital role for the better scope in the treatment of wastewater in the future era. Both process proved to be economically cost effective. This reactor should be scaled up for effective implementation in the industries. According to the results of lab-scale experiments and literature review, MBBR and IFAS process could be used as an efficient and effective treatment for BOD and COD removal from dairy wastewater. Considering the effluents quality with HRT of 3 hrs, the system meets the desirable limits in eliminating the organic materials.

REFERENCES

[1] James p.McQuarrie V Joshua P.Boltz,"Moving Bed Bioflim Reactor Technology; Process Applications, Design and Performance", Water Environment Research, Volume 83, Number 6

[2] Kim B.K.,et al.,"Wastewater Treatment in Moving –Bed Biofilm Reactor Operated by flow Reversal Intermittent Aeration System", World Academy of Science, Engineering and Technology.

[3] Mangesh Gulhanel Ashwini Ingale2"Moving Bed Biofilm Reactor: A Best Option for Wastewater Treatment" ISRD-International journal for Scientific Research and Development 2008.

[4] H. Odegaard et al." The Moving Bed Biofilm Reactor, "Water Environmental Engineering and Reuse 2008.

[5] Mangesh Gulhane., et al "Moving Bed Biofilm Reactor A Best Option for Wastewater Treatment" ISRD-International journal for Scientific Research and Development 2015.

[6] Odegaard H, Compact Wastewater Treatment with MBBR, Norwegian University.

[7] M.Makowska, M.Spychala, R.Blazejewski, Treatment of Septic Tank Effluent in Moving Bed Biological Reactors with Intermittent Aeration, Polish J.of Environ.Stud.Vol.18, No.6 (2009), pp.1051-1057

[8] M.Kermani, B.Bina, H.Mohedian, M.M.Amin and M.Nikaein, Application of Moving Bed Biofilm Process for Biological Organics and Nutrients Removal from Municipal Wastewater, American Journal of

Environmental Sciences 4 (6),2008 ISSN 1553-345X,pp.675-682

[9] Yang Qiqi, He Qiang and Husham T. Ibrahim Review on Moving Bed Biofilm processes, Pakistan Journal of Nutrition 11 (9),2012,ISSN:1680-5194,pp-804-811.

[10] Ahmadi, M., Izanloo,H., Alian, A. M., Amiri, H., and Sepehr, M. N., (2011), "Upgrading of Kish Island Markazi Wastewater treatment Plant by MBBR." Journal of Water Reuse and Desalination, 1(4),243-249.

[11] American Public Health Association, (2005): "Standard Methods for the Examination of Water and Wastewater." 21st Edition.

[12] Borkar, R. P, Gulhane, M. L., and Kotangale, A. J.,(2013), "Moving Bed Biofilm Reactor – A new perspective in wastewater treatment." Journal of Environmental Science, Toxicology and Food Technology, 6(6), 15-21.

[13] Cassardo, C., and Jones, J.A., (2011), "Managing water in a changing world." Water 2011,3,618-628.

[14] CPCB notification file number – 19014/43/06-MON, (2015), Central Pollution Control Board, Ministry of Environment and Forests, India.

[15] Guidelines for decentralized wastewater management, (2012), Ministry of Urban Development, India.