ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

IARJSET

International Advanced Research Journal in Science, Engineering and Technology

AGNI-PANKH 16

Jawaharlal Darda Institute of Engineering and Technology, Yavatmal

Vol. 4, Special Issue 3, January 2017

The Moving Bed Biofilm Reactor (MBBR)

Ankit B. Pinjarkar[1], Rushikesh D. Jagtap[2], Chaitanya K. Solanke[3], Hitesh H. Mehta[4]

Student, Civil Engineering, J.D.I.E.T, Yavatmal, India[1, 2, 3, 4]

Assistant Professor, Civil Engineering, J.D.I.E.T, Yavatmal, India[4]

Abstract: The Moving Bed Biofilm Reactor (MBBR) technology is a leading-edge biological solution for wastewater treatment, based on a core understanding of microbiology and treatment processes. This simple and strong biological treatment process is suitable for specific wastewater treatment processes – nitrogen reduction, high BOD/COD removal, including difficult industrial wastewater requirements. At the core of the technology, specially designed polyethylene biofilm carriers provide a large surface area for micro-organisms to grow on and perform specific biological treatment functions. Carriers are kept in suspension in the reactor either by the aeration system (aerobic zone) or mixers (anoxic zone). Bacteria from the wastewater attach themselves to the floating carriers. The very compact configuration helps to attain a highly active biomass concentration in the reactor and a low settling load in the downstream solids separation process. Biofilm wastewater treatment technologies are very strong, especially when compared to conventional technologies like activated sludge.

Keywords: Wastewater, biological treatment, biofilm reactor.

I. INTRODUCTION

Over the last decades there has been a growing interest in biofilm processes for wastewater treatment. There are several reasons for the fact that bio-film processes more and more often are being favored instead of activated sludge processes, such as: The treatment plant requires less space. The final treatment result is less dependent on biomass separation since, the biomass concentration to be separated is at least 10 times lower. The attached biomass becomes more specialized (higher concentration of relevant organisms) at a given point in the process train, because there is no sludge return. There are already many different bio-film systems in use, such as trickling filters, rotating biological contactors(RBC), fixed media submerged biofilters, granular media bio-filters, fluidized bed reactors etc. They have all their advantages and disadvantages. The trickling filter is not volume-effective.

Mechanical failures are often experienced with the RBC's. It is difficult to get even distribution of the load on the whole carrier surface in fixed media submerged bio-filters. The granular media bio-filters have to be operated discontinuously because of the need for back washing and the fluidized bed reactors show hydraulic in stability. For these reasons the moving bed bio-film process. There are presently more than 90 treatment plants based on this process in operation or under construction in 17 different countries all over the world. They are used for many different purposes for municipal as well as industrial waste water treatment, like organic matter removal, nitrification and nitrogen removal. In this paper we shall focus on the municipal applications. Moving Bed Biofilm Reactor is an aerobic attached biological growth process. It does not require primary clarifier and sludge recirculation. Raw sewage, after screening and de-gritting, is fed to the biological reactor. In the reactor, floating plastic media is provided which remains in suspension. Biological mass is generated on the surface of the media. Attached biological mass consumes organic matter for their metabolism. Excess biological mass leaves the surface of media and it is settled in clarifier. Usually a detention time of 5 to 12 h is provided in the reactors. MBBR were initially used for small sewage flow rates and because of less space requirement. In large plant, media quantity is very high and it requires long shut down period for plant maintenance. In fact, it may not be successful for large capacity plants. Moreover the plastic media is patented and not available in the open market, leading to single supplier conditions which limit or deny price competition. In addition, due to very less detention time and other engineering factors, functional Moving Bed Biofilm Reactor in India do not produce acceptable quality effluent.

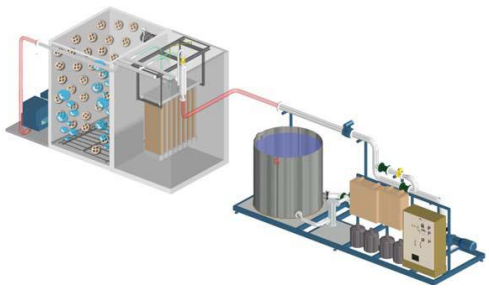


Figure 1 shows the basic idea about the sewage treatment plant based on MBBR

II. METHODOLOGY

The idea behind the development of the moving bed biofilm process was to adopt the best from both the

IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
AGNI-PANKH 16
Jawaharlal Darda Institute of Engineering and Technology, Yavatmal
Vol. 4, Special Issue 3, January 2017

activated sludge process and the biofilter processes without including the worst. Contrary to most biofilm reactors, the moving bed biofilm reactor utilizes the whole tank volume for biomass growth, as does also the activated sludge reactor. Contrary to the activated sludge reactor, it does not need any sludge recycle, as is also the case in other biofilm reactors. This is achieved by having the biomass grow on carriers that move freely in the water volume of the reactor, kept within the reactor volume by a sieve arrangement at the reactor outlet. Since no sludge recirculation takes place, only the surplus biomass has to be separated-a considerable advantage over the activated sludge process. The reactor may be used for both aerobic, an oxi-cor-anaerobic processes, see figure.

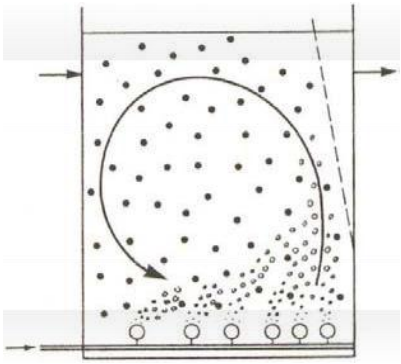


Figure (a) Aerobic reactor

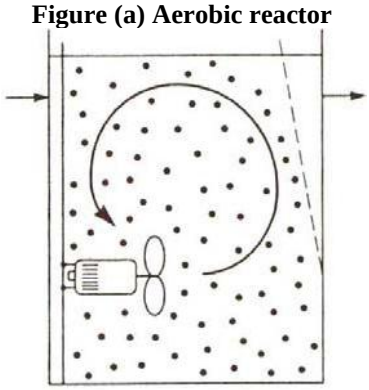


Figure (b) Anoxic and anaerobic reactor

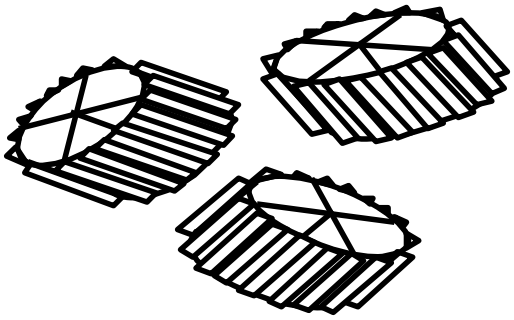


Figure (c) The bio-film carrier(K1)

Figure 2 (a , b & c): The principle of the moving bed biofilm reactor and the shape of the bio-film carrier (ref.paper published by H.Ødegaard on the Moving Bed Biofilm Reactor)

III. DESIGN AND CONSTRUCTION PRINCIPLES

This reactor can have any shape and different loads in a reactor volume depending on carrier filling. Design of the reactor is based on the actual wastewater characteristics and local conditions. MBBR units are placed in series based on the load entering each reactor. Neutralized and settled wastewater passes through MBBR for reduction in BOD/COD. Most of the MBBR plants are provided with vertically or horizontally mounted rectangular mesh sieves or cylindrical bar sieves. Bio-film carriers are made up of high density (0.95 g/cm^3) polyethylene. These are normally shaped as small cylinders with a cross inside and fins outside. The standard filling of carrier is below 70% with a maximum specific area not more than 465 m^2/m^3. Generally, design load for COD-BOD removal is 20 g COD / m^2d. Smaller carriers need smaller reactor volume at a given loading rate (as g/m^2d) when the carrier filling is same. HRT of the reactor is about 3 – 4 hours for effective BOD and nitrogen removal. It is advisable to use MBBR in combination with a septic tank or a pre-coagulation step as a pre-treatment unit, depending on the local conditions and input characteristics. It is a very robust and compact alternative for secondary treatment of municipal wastewater, having removal efficiency for BOD 90 – 95% (low rate) and that of 75 – 80% for high rate. Average nitrogen removal is about 85%. There is no need for sludge recirculation. Phosphorus and faucal coli form reduction is feasible with additional passive (non-mechanical) or active (mechanical) system components.

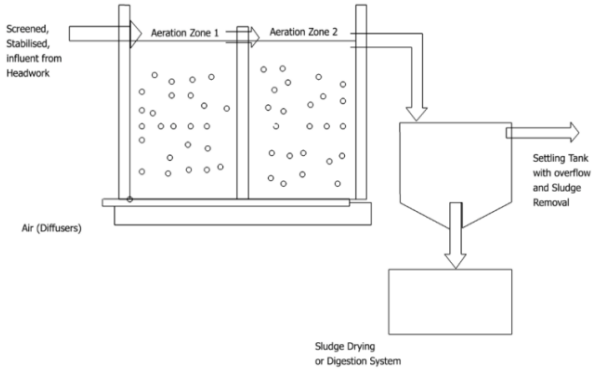


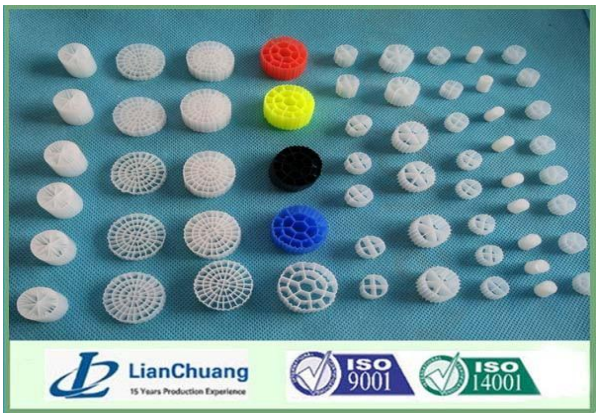
Figure 2 Moving Bed Biofilm Reactor process

IV. DESCRIPTION ABOUT THE MEDIA REACTOR

Mbbr media is one kind of new bioactive carrier as a house for attached growth bacteria in mbbr process. Mbbr media also called kaldness media, it works as carrier for the growth and attachment of microorganisms are directly put into the mbbr system, the waste water go through the suspended carriers in MBBR reactor, kaldness media adopt scientific formula and blend some micro-elements in the high polymer material, which microorganisms attach themselves to submerged moving biofilm carrier, forming a biofilm. Air is transferred into the water, mixing the

IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
AGNI-PANKH 16
Jawaharlal Darda Institute of Engineering and Technology, Yavatmal
Vol. 4, Special Issue 3, January 2017

media and water and providing oxygen to the bacteria. The mbbr media biofilm absorbs oxidizes and reduces organic and inorganic material thus providing treatment.



V. OPERATION AND MAINTENANCE

A constantly operating MBBR does not require backwashing or return sludge flows. It has minimal head-loss. Coarse-bubble aeration in the aeration zone in the wastewater treatment tank provides ease of operation at low-cost. Agitation continuously moves the carrier elements over the surface of the screen thus preventing clogging. Maintenance of MBBR system includes screening, influent equalization, clarifier system, sludge handling and integrated control system. There is no need to maintain f/M ratio as there is self-maintenance of an optimum level of productive biofilm. Skilled labour is required for routine monitoring and operations of pumps and blowers.

VI. COST CONSIDERATIONS

Construction cost of the MBBR is moderate (80%) as compared to other hi-tech wastewater treatment systems, including the screen box, MBBR, clarifier, foundations for units, sludge collection and drying with simple barbed wire fencing for treatment area. The electro-mechanical cost involves machines and monitoring equipment, like pumps for wastewater transfer, blower for air, distribution pipelines for water and air with internal support systems and on-line pressure gauges. Operational costs are inclusive of screen cleaning, biosolids removal, pumping, aeration, and skilled man-power.

VII. EXPERIENCES IN INDIA

MBBR process under various commercial names is being used for sewage treatment in India for the flows ranging from 10 m^3/d to 8 MLD, especially for newly developing townships in the urban, semi-urban or rural-urban areas. It is mandatory for them to treat sewage as per statutory standards before releasing into the environment. There are about 300 – 400 installations in India. These systems are found useful in reducing the space footprint of conventional ASP based STPs. Adaptation of MBBR is reported to reduce solids load in secondary sedimentation tank. There are some limitations of MBBR installations in India. Performance is affected by higher concentration of oil and grease and total suspended solids. The design criteria of MBBR adapted to the Indian conditions are not established, however the technology was introduced in the country a decade ago. Complex process parameters such as biofilm area, biodegration activity and treatment efficiency are based on empirical data of pilot studies or partial full-scale results. The adoption of MBBRs for existing STPs has not been smooth, giving rise to problems, such as clogging because of non-availability of primary sedimentation or large pores of screens. Dissolved oxygen is very essential for
the effectiveness of biofilms. One of the major shortcomings of the technology in Indian conditions is that there is less nutrient removal than that of claimed (IIT 2010 & MoUD 2012)

VIII. MERITS AND DEMERITS MERITS

Moving Bed Biofilm Reactor needs less space since there is no primary clarifier and detention period in reactor is generally 4-5 hour.
Ability to withstand shock load with equalization tank option.
High operator oversight is not required.
Higher effective Sludge Retention Time (SRT) which is favorable for nitrification.
Responds to Load Fluctuations without Operator intervention.
Lower sludge production.
Less area required.
Resilient to toxic shock.
Process performance independent of secondary clarifier (due to the fact there is no sludge return line.

Demerits
High operating cost due to large power requirements
Not much experience available with larger capacity plants (>1.5MLD).
Skilled operators needed.
No energy production.
Effluent quality not up to the mark in India.
Much less nutrient removal.
Designed criteria not well established.

IX. CONCLUSIONS

The moving bed bio film reactor has established itself as a well proven, robust and compact reactor for waste water treatment. The efficiency of the reactor has been demonstrated in many process combinations, both for BOD-removal and nutrient removal . It has been used for small as well as large plants. The rate of BOD-COD has been reduced by use of this technology. The basic advantage of the process as compared to activated sludge

IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

AGNI-PANKH 16

Jawaharlal Darda Institute of Engineering and Technology, Yavatmal

Vol. 4, Special Issue 3, January 2017

reactors is its compactness and no need for sludge return. The advantage over other bio-film processes is its flexibility. One can use almost any reactor shape and one can choose different operating loads in a given reactor volume, simply by choice of carrier filling. Even though it has been focused on municipal waste water applications in this paper, the reactor has been used also for industrial waste water, particular lying the food industry and the pulp and paper industry. Tests area so being performed on anaerobic waste water treatment as well as drinking water treatment.

REFERENCES

[1] The paper published " The Moving BedBiofilm Reactor"byH.Ø degaard Faculty of Civil and Environmental Engineering,

[2] Norwegian University of Science and Technology, N-7034 Trondheim, Norway in Igarashi.

[3] T.,Watanabe, Y.,Asano, T. and Tambo, N.: Water Environmental Engineering

[4] Reuse of Water, HokkaidoPress1999, p.250-305. "Water supply and sanitary engineering",

[5] Dhanpat Rai & Sons, New Delhi, 1994. "Environmental engineering." Book by S.K.Garg.

[6] The brochure of "Veolia water solutions and technologies" of august 2010 .The brochure of "kelean water management consultancy" of 2015 .