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COD Reduction by Moving Bed Biofilm Reactor

Kunal Majmudar
Assistant Professor
Department of Environmental Science & Technology
Shroff S.R. Rotary Institute of Chemical Technology

Jaini Nagar
UG Student
Department of Environmental Science & Technology
Shroff S.R. Rotary Institute of Chemical Technology

Shivangi Pabari
UG Student
Department of Environmental Science & Technology
Shroff S.R. Rotary Institute of Chemical Technology

Foram Maheshwari
UG Student
Department of Environmental Science & Technology
Shroff S.R. Rotary Institute of Chemical Technology

Trupti Joshi
UG Student
Department of Environmental Science & Technology
Shroff S.R. Rotary Institute of Chemical Technology

Abstract

One of the major challenges faced in present scenario is the treatment of wastewater produced during industrial process. Various effluent treatments are adopted for achieving the discharge standards. Different technologies like RBC, ASP, trickling filter, SBR are used for removal of BOD, COD, and TAN etc. We need to adopt such technology to meet with the standards made by CPCB to maintain the environment of the aquatic life. The discharge standards for industrial BOD, COD and TAN are 100 mg/lit, 250 mg/lit and 50 mg/lit respectively. In this project, we have gone through theoretical comparison between aerobic, anaerobic treatments; attached and suspended growth, moving bed and fixed bed reactors. Analysis of various parameters like COD, BOD, TDS, pH, NH3-N+ of the ASP stream. MBBR presents several operational advantages like less HRT, smaller footprint; this technology gives us low concentration of solids leaving the biological reactors and good settling characteristic of sludge. Various trials at different flow rates were carried out to get optimized flow rate.
Keywords: ASP, COD, Feasibility, FETP, Hybrid bed, MBBR, TAN

I. Introduction

This MBBR was developed by Norwegian company, Kaldness Miljotaknologies. Moving bed bio film reactor is the combination of attached and suspended growth treatment method. MBBR is simply nothing but carriers of microbes. This improves the contact area of microbes and their food. It is also the combination of activated sludge process and the bio film process.

MBBR system comprises of an activated sludge aeration system where the sludge is collected on recycled plastic carriers. These carriers have an internal large surface for optimal contact water, air and bacteria. The biofilm carriers are retained in the reactor by the use of perforated plate at the tank outlet so that the media cannot escape the reactor. Air agitation is used to continuously circulate the packing & to keep it moving so as to establish optimum contact with substrate present in waste water & bacteria attached to the media. Packing may fill 25 to 50 % of the tank volume, with specific surface area of about 200 to 500 m^2/m^3 of bulk packing volume.

The bacteria grow on the internal surface of the carriers. The bacteria break down the organic matter from the wastewater. The aeration system keeps the carriers with activated sludge in motion. Only the extra amount of bacteria growth, the excess sludge will come separate from the carriers and will flow towards the final separator. This offers advantages that no return sludge is required & since the media is moving, there is no chance of blocking the media which may of require back washing. A final clarifier is used to settle sloughed all solids.

MBBR employs thousands of polyethylene biofilm carriers operating in mixed motion within an aerated treatment basin. This individual bio carrier increases productivity by providing protected surface area to support the growth of bacteria with its cell. High rate biodegradation within the system is due to the high density bacteria population. Also the biofilm attached to the mobile carriers with the system responds to load fluctuations automatically.

The system can consist of a one or more stage system, depending on the specific demands. But the bacteria along with the carriers remain in their own tank as they are protected by screens.

This method makes it possible to attend good efficiency results of disposal with low energy consumption. The process is used for the removal of organic matter, nitrification and de-nitrification.

A. *Process benefits:*

1) Simple and compact design: Fraction of conventional system. Minimizes the process complexity & operator attention.

2) Expandable: By increasing the fill fraction of biofilm carriers. Capacity can be easily increased.
3) Single pass process : No need of recycling the biomass sludge
4) Load responsive: Load fluctuations are easily responded by activated biofilm.
5) Minimal maintenance: No need to maintain F/M ratios or MLSS levels.
6) Durable

B. *Advantages of MBBR:*

- Simple and compact.
- Low Hydraulic retention time.
- Smaller foot print.
- Low investment cost
- No recycling of sludge
- Single pass treatment
- Stable under load variation
- Can sustain shock load
- No mechanical equipment.

C. *Application of MBBR:*

- Pulp and paper industry wastewater treatment plant
- Municipal wastewater treatment plant
- Food industry

II. DESIGN METHODOLOGY AND IMPLEMENTATION STRATEGY

We have studied various research papers and referred patents in order to get better understanding. This part explains the method adopted for the project. The technical specification of the media used is mentioned in the following table:

Effective specific surface area of media	*400 m^2/m^3*
Colour	*black*
Media height	*16 mm*
Media diameter	*22 mm*
Type of media	*Fluidized bio media*
Structure	*Cylindrical with external fins*
Specific weight (kg/m^2) surface area	*0.37*
Specific gravity	*0.90-0.95 g/cm^3*
Max continuous operating temperature	*80° C*
Voidage	*>98%*
Density(g/cc)	*0.93*
Media fill rate range	*22-25%*

Fig. 1 & 2:

Pilot plant is constructed fulfilling the criteria necessary for effective functioning of the tanks. In the present setup, we have arranged 2 stage aeration –clarification process which will be in continuous phase. This 2 stage setup is expected for increasing efficiency.

Fig. 3:

A. *Dimensions of the pilot plant:*

Units	*Length (mm)*	*Width (mm)*	*Depth (mm)*	*Free Board (mm)*	*Volume (litre)*
Feed tank	*400*	*400*	*300*	*50*	*0.056*
1st stage aeration tank	*500*	*450*	*400*	*150*	*0.124*
1st clarifier	*250*	*250*	*250*	*50*	*0.019*
2nd stage aeration tank	*350*	*350*	*350*	*150*	*0.061*
2nd clarifier	*250*	*250*	*250*	*50*	*0.019*

B. *Materials and apparatus:*

- Aerators
- Pumps
- Screen
- Fitting pipes
- Media

III. RESULT ANALYSIS

Initially we started the pilot plant with employment of simple ASP. Basic idea behind our initiation step was to make the biological system up to mark before addition of the media. Primarily we started by keeping the media fill rate 30% w.r.t volume of the tank. We varied the flow rates 3 times in order to find out the optimum retention time.

Following are the observations noted down during the experimentation. Parameters like pH, COD, NH_3N, DO and TDS are analyzed.

Sr. No	*Flow rate (l/hr)*	*Retention Time (Days)*	*% COD Reduction (30%)*	*% COD Reduction (40%)*	*% COD Reduction (50%)*	*% COD Reduction (60%)*
1	*1.2*	*4.6*	*50.76*	*53.79*	*52.91*	*61.30*
2	*1.6*	*3.3*	*45.33*	*41.68*	*47.34*	*50.46*
3	*2.1*	*2.6*	*40.72*	*53.15*	*41.48*	*46.67*

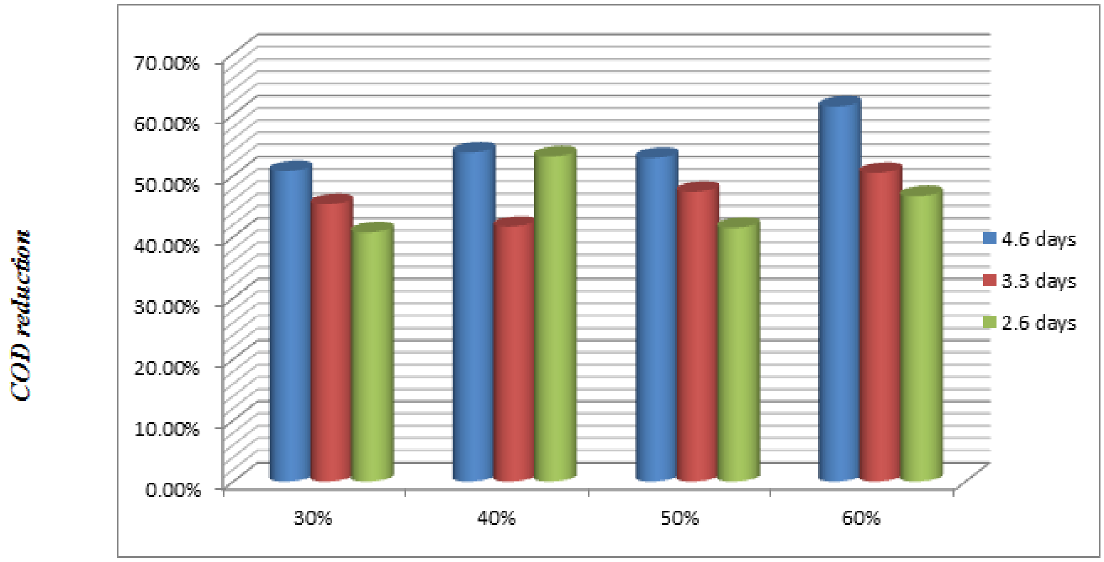

Fig. 4: Media Fill Rate Range

This above graph shows the relationship between COD reductions and retention time for different media fill rate range.

IV. Conclusion

The experimentation work carried was to evaluate the working of MBBR for COD reduction at NCT. The analysis works have shown us good results even at fill rate range of 30-40%. We have achieved COD reduction about 52% with MBBR. But we also compared it with the same scale ASP pilot plant with gave about 61% of COD reductions. Hence we can conclude that even at optimized retention time one cannot achieve that efficiency with MBBR in comparison to ASP for this specific plant.

We also increased our media fill rate range upto 60%. We got maximum COD reductions of 61.3% at retention time of 4.6 days at 60% fill rate. But when feasibility and viability comes the best proportions will be 50% media fill rate range and retention time of 3.3 days i.e flow rate of 1.6 (l/hr).

We can also improve this system by employing Medias with larger surface area in order to increase the efficiency. Complementary to COD reductions, major $NH3^{+}$-N reductions were obtained.

V. Abbreviations and Acronyms

Sr no.	*Short Names*	*Full Names*
1	*TAN*	*Total Ammonical Nitrogen*
2	*ASP*	*Activated Sludge Process*
3	*BOD*	*Biological Oxygen Demand*
4	*CAS*	*Conventional Activated Sludge*
5	*CETP*	*Common Effluent Treatment Plant*
6	*COD*	*Chemical Oxygen Demand*
7	*FETP*	*Final Effluent Treatment Plant*
8	*HMBBR*	*Hybrid Moving Bed Bio-Film Reactor*
9	*HRT*	*Hydraulic Retention Time*
10	*IFAS*	*Integrated Fixed Film Activated Sludge*
11	*MBBR*	*Moving Bed Bio-Film Reactor*
12	*RAS*	*Return Activated Sludge*
13	*RB COD*	*Readily Bio-degradable Chemical Oxygen Demand*
14	*RBC*	*Rotating Biological Contactor*
15	*TDS*	*Total Dissolved Solids*
16	*TKN*	*Total Kjelhdal Nitrogen*
17	*TSS*	*Total Suspended Solids*
18	*VSS*	*Volatile Suspended Solids*
19	*WWTP*	*Waste Water Treatment Plant*

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