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Performance Evaluation of Wastewater Treatment Plant Based on MBBR Technology- A Case Study of Kaithal Town, Haryana (India)

Ashutosh Pipraiya

M.Tech, Department of Civil Engineering, National Institute of Technology Kurukshetra Haryana, India[1]

ABSTRACT:-*Moving Bed Bio-film Reactor (MBBR) technology has benefits provided by both fixed film and activated sludge processes. The MBBR process follows continuous flow patterns. Several, small in size, high density polyethylene (HDPE) carrier elements are added to provide sites for active bacteria attachment in a suspended growth medium. Moving Bed Bio film Reactor (MBBR) process improves reliability, simplify operation and require less space than traditional wastewater treatment system.The need for wastewater treatment plants working under suitable and effective technologies is rising rapidly on global scale, especially in those regions where availability of pure water is in challenging phase. Moving Bed Bio-film Reactor (MBBR) technology is the summation of benefits provided by both fixed film and activated sludge processes.The MBBR process follows continuous flow patterns. HDPE media differs MBBR technology from Activated sludge process.The work carried out in this research presents the results of the performance evaluation of STP based on MBBR technology located in Kaithal town (Haryana) for handling and treating the domestic wastewater. The parameters which were monitored under the study included pH, Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Turbidity, Nitrate (NO_2+ NO_3), Phosphate (PO_4^-), Total Nitrogen and Total Phosphorus.*

KEYWORDS*- Wastewater treatment, Moving bed bio film reactor(MBBR), HDPE,STP,*

OBJECTIVE OF STUDY

To study Performance Evaluation of the STP after treating with MBBR technology located at Kaithal Town Haryana.In this study attempt has been made to study Performance of STP in respect of different Physical and Chemical parameters after treatment process is done. Process followed is as under(1) Collection of the sample (2) Determination of selected parameters for predicting performance of STP.

INTRODUCTION

Sewage Treatment Plants (STPs) are effective units to reduce wastewater loads from environments. STPs can treat wastewater up to a certain limits that it is harmless to reuse. Proper installation of STPs with suitable technologies and required maintenance time to time are necessary for favourable results (CPCB, 2013).The moving bed bio film reactor (MBBR) concept was invented in Norway during the 1980's, in response to agreements by eight European nations to reduce nitrogen loadings to the North Sea. In the MBBR systems reactors that are filled with plastic carriers to provide a surface for bacterial growth.The carrier elements, which are less dense than water, 0.93-0.95 SG, provide a large protected surface for bacteria culture. Reactors can be operated under aerobic condition during BOD removal and nitrification process and anoxic conditions during denitrification process. During aerobic phase plastic carriers kept in constant circulation by air blowers system. MBBR is attached growth system so treatment capacity is the function of specific surface area of reactor.

Media for Attached Growth System	Specific Surface area (m^2/m^3)
Trickling Filter Media Rock Plastic	 45-60 90-150
Rotating Biological Contactor (RBC)	100-150
MBBR Media Kaldnes K-1 Media Hydroxyl Media Kaldnes Flat Chip	 500 400 1200

Table 1: Specific surface area of different media used in attached growth system (Reference Metcalf and Eddy (2003)

LOCATION OF SITE

Study area covers 10 MLD capacity, sewage treatment plant based on Moving Bed Bio film (MBBR) technology near Gadli village in Kaithal town, Haryana state India. The STP is design to handle average flow of 7-8 MLD in winter and 9-10 MLD in summer. The plant was constructed under Public Health Department Haryana Government. This research work evaluated the performance of the STP based on MBBR technology in terms physical andchemical parameters of wastewater and efficiency of treatment of domestic wastewater.

Figure 1: 10 MLD, STP based on MBBR technology at Kaithal town (Haryana) India.

MATERIALS AND METHODS

The experimental method for the this work includes a lab research conducted in Adv Environmental Lab in NIT Kurukshetra. Site visits to the STP, Collection of samples at inlet and outlet during the period from January 2014 to April 2014 were collected. Samples were analyzed for various parameters like pH, BOD, COD, TSS, Turbidity, Nitrates, Phosphate, Total nitrogen, Total phosphorous, and basis on the result, performance of STP was evaluated. Analysis of various parameters and procedure adopted are giving in table.

S.No	Parameters	Bottle Type	Preservation of samples	Analysis Methods	References
1	Turbidity	Sampling bottle	Refrigerator, below 4^0C	Turbidity meter	
2	pH	Sampling bottle	Refrigerator, below 4^0C	pH meter	
3	BOD	Sampling bottle	Refrigerator, below 4^0C	5 day BOD at 20^0C	APHA,2005

4	COD	Sampling bottle	Refrigerator, below 4^0C	CRT method	APHA,2005
5	TSS	Sampling bottle	Refrigerator, below 4^0C		APHA,1998
6	Nitrates(NO_2+NO_3)	Sampling bottle	Refrigerator, below 4^0C	Flow injection analyzer	
7	Phosphate(PO_4)	Sampling bottle	Refrigerator, below 4^0C	Flow injection analyzer	
8	Total Nitrogen	Sampling bottle	Refrigerator, below 4^0C	Flow injection analyzer	
9	Total Phosphorous	Sampling bottle	Refrigerator, below 4^0C	Flow injection analyzer	

Table 2: Details of measured parameters

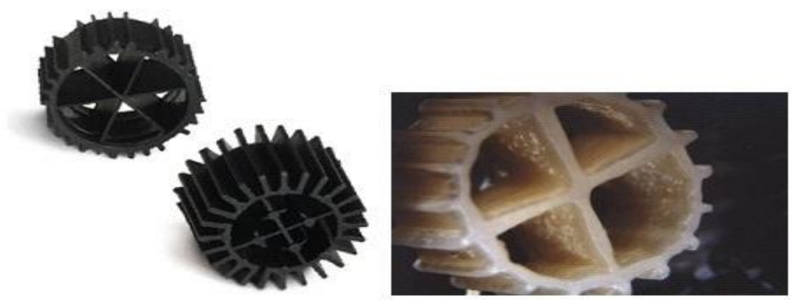


Figure:2 Plastic media for bacterial growth in MBBR technology

RESULT AND DISCUSSION

This STP was designed for treating 10 MLD flow. The STP was designed to treat domestic wastewater to meet the standards given by Central pollution Control Board (Ministry of Environmental and Forest Government of India). Generally treated waste water from plant at Kaithal town is used for irrigation purposes. The results of STPs based on MBBR Technology shows that Turbidity, BOD, COD, Suspended Solids (SS), Phosphate, Nitrates, Total Nitrogen (TN) and Total Phosphorous(TP) removal efficiencies were 86.94%, 86.31%, 71.53%, 83.11%, 27%, 40%, 49.28%, 53%, respectively while variation in pH was noticed as 5.55%. According to Environmental protection rules 1986 [Schedule vi] published in CPCB report August 2013, treated effluent is safe against disposal on land and used for irrigation. Nitrification is carried out by autotrophic organisms in a two-step process. First, ammonia is converted to nitrite, mostly by the group of Nitrosomonas. Then, nitrite is converted to nitrate. Oxygen required for complete oxidation of ammonia is 4.57 g O_2 per g N oxidized, with 3.43 g for the nitrite production from ammonia and 1.14 g for the nitrate production from nitrite. Biological phosphorus removal is carried out by a group of aerobic microorganisms called phosphorus accumulating organisms (PAOs), of which some species are: Acinetobacter, Aeromonas, Arthrobacter, Escherichia coli, Klebsiella, Microthrix, Moraxella, Proteus, Pseudomonas and Xantobacter (Appeldoorn,1993). PAOs requirealternating aerobic and anaerobic cycles. Turbidity, BOD, COD, TSS, Nitrates, Phosphate, TN and TP removal efficiencies are satisfactory and removal efficiencies of parameters can be improved by alternate cleaning of media because some filter media settle at the bottom of the tank due to excessive attached mass. Odegaard, (2006) operated MBBRs similarly to the activated sludge process with the addition of freely moving carrier media. Kermani M., et al (2008) conducted the study to evaluate the organics, phosphorus and nutrients removal from synthetic wastewater by a laboratory scale moving bed bio film process.Delnavaz et al., (2008) suggested that MBBR is a suitable alternative for common activated sludge reactors in treating domestic and industrial wastewaters in commercial scale.There are no perfect methodology to evaluate overall efficiency of wastewater but degree of treatment is identified according to its reuse into different fields. During the period of study (First week of January 2014- First week of April 2014) samples are collected once in a week from the inlet and outlet point of wastewater treatment plant based on MBBR technology, results so obtained are summarised in table

Table 3 Analysis of some Physical and chemical parameters of STP with MBBR

Date of Sampling	1.pH		2.BOD(mg/l)		3. COD(mg/l)		4.TSS(mg/l)	
	IN	OUT	IN	OUT	IN	OUT	IN	OUT
03/01/14	7.51	7.11	155	36	341	98	384	61
11/01/14	7.50	7.20	130	27	230	80	310	50
17/01/14	7.77	7.26	140	33	332	72	162	74
24/01/14	7.55	7.43	148	28	340	105	350	50
30/01/14	7.77	7.10	235	36	425.10	95	332	89
05/02/14	7.85	7.32	178	29	390	110	380	55
12/02/14	7.65	7.32	177	32	330	115	330	48
18/02/14	7.80	7.09	203	27	292	98	420	59
23/02/14	7.46	6.86	291	17	311	79	297	44
28/02/14	7.31	7.21	198	16	401	114	412	69
06/03/14	7.61	7.29	181	19	399	87	574	71
10/03/14	7.62	7.12	260	26	370	108	456	61
14/03/14	7.78	7.14	172	19.11	430.1	111	378	69
19/03/14	7.30	7.09	182	23	238	116	517	108
24/03/14	7.25	7.02	231.0	34	361	107	411	67
30/03/14	7.72	7.14	246	36	412	113	447	74
06/04/14	7.62	7.21	271	27	391	98	331	47
Maximum	**7.85**	**7.43**	**291**	**36**	**430**	**116**	**574**	**108**
Minimum	**7.25**	**6.86**	**140**	**16**	**230**	**72**	**162**	**44**
Average	**7.59**	**7.17**	**199.88**	**27.35**	**352.5**	**100.35**	**381.8**	**64.47**
% Removal	**5.55%**		**86.315%**		**71.532%**		**83.11%**	

5.Turbidity(NTU)		**6.Nitrate(mg/l)**		**7.Phosphate(mg/l)**		**8.TN(mg/l)**		**9.TP(mg/l)**	
IN	**OUT**	**IN**	**OUT**	**IN**	**OUT**	**IN**	**OUT**	**IN**	**OUT**
1121	147	0.56	0.32	2.42	2.10	32.21	15.54	39.13	17.13
987	91	0.61	0.37	2.66	2.12	28.12	13.16	31.34	15.34
568	87	0.63	0.39	2.65	2.08	29.15	14.11	26.23	11.54
1589	136	0.58	0.24	2.67	2.06	26.76	13.75	22.34	09.12
632	57.2	0.69	0.42	2.30	2.24	27.26	11.87	16.58	10.65
1087	69	0.71	0.45	2.15	1.87	24.34	11.09	41.23	20.13
596	110	0.68	0.35	2.40	2.01	25.54	12.15	36.90	17.15
798	87	0.76	0.41	2.46	2.04	27.23	15.34	30.65	14.31
1369	194	0.98	0.62	2.87	2.18	23.65	12.91	17.25	10.04
691	86	0.95	0.53	2.93	2.16	26.34	14.11	15.21	08.11
715	67.10	0.67	0.34	3.14	2.23	29.36	16.07	12.87	05.16
612	81	0.75	0.43	3.37	2.53	31.53	15.61	09.52	05.11
826	70	0.91	0.67	2.50	2.09	28.16	16.01	18.42	10.23
1864	170	0.79	0.39	2.40	2.10	31.25	11.36	18.26	7.23
429	183	0.71	0.53	3.34	2.76	26.71	14.54	17.19	5.29
618	217	0.82	0.62	3.82	1.97	40.27	15.78	9.72	4.48
871	159	1.07	0.71	5.54	1.71	20.22	16.718	8.02	3.37
1864	**217**	**1.07**	**0.71**	**5.54**	**2.76**	**40.27**	**16.71**	**41.23**	**20.13**
429	**57.2**	**0.56**	**0.24**	**2.15**	**1.71**	**20.22**	**11.09**	**8.02**	**3.37**
906.05	**118.29**	**0.75**	**0.458**	**2.91**	**2.13**	**28.12**	**14.12**	**21.81**	**10.25**
86.94%		**40%**		**27%**		**49.78%**		**53%**	

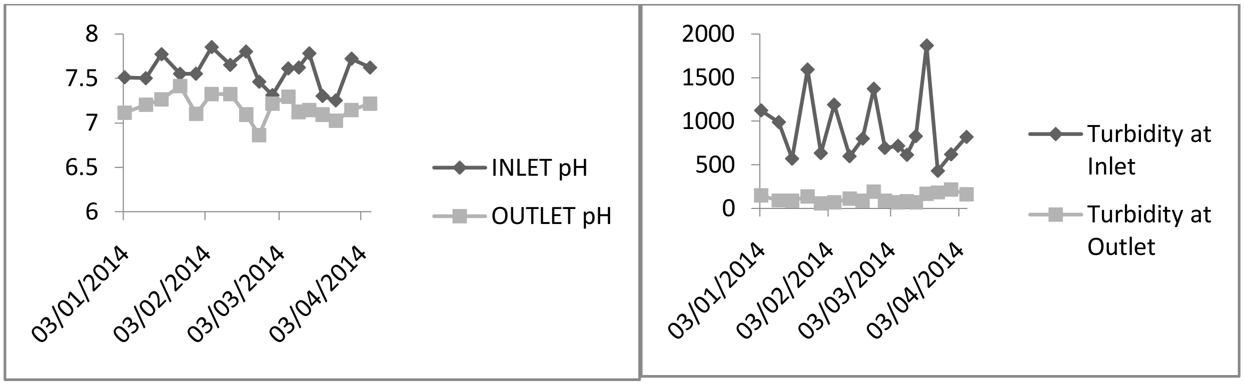


Figure 3 Values of pH and Turbidity at Inlet and Outlet in NTU(Y-axis) with Date of sampling(X axis)

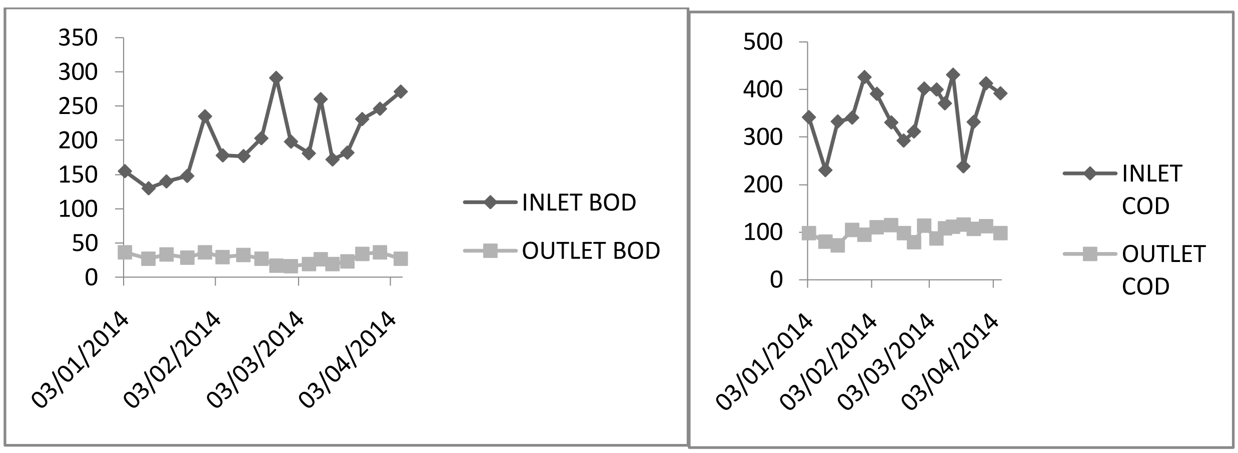


Figure 4 Value of BOD_5 and COD at inlet and outlet in mg/l(Y axis) with Date of sampling(X axis)

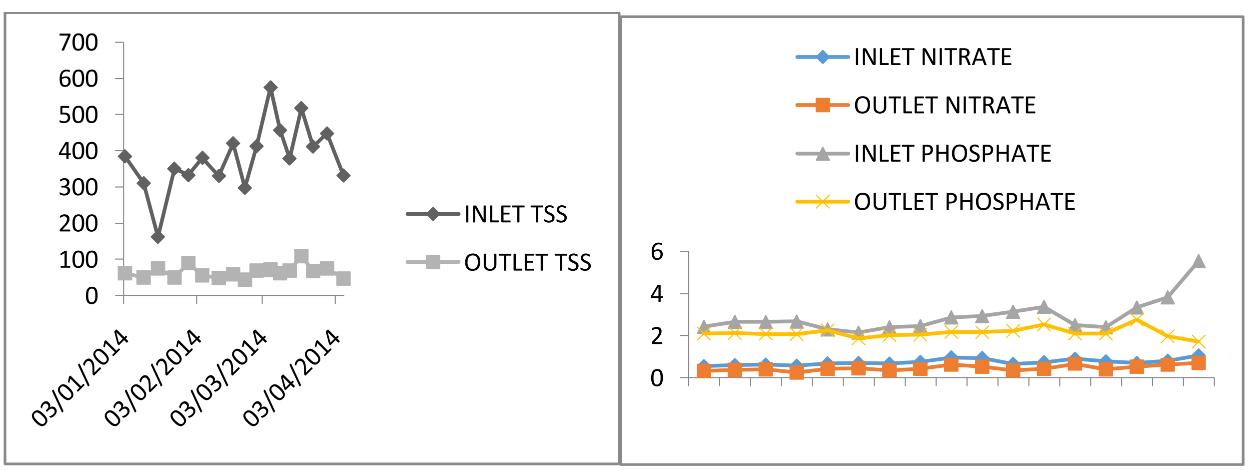
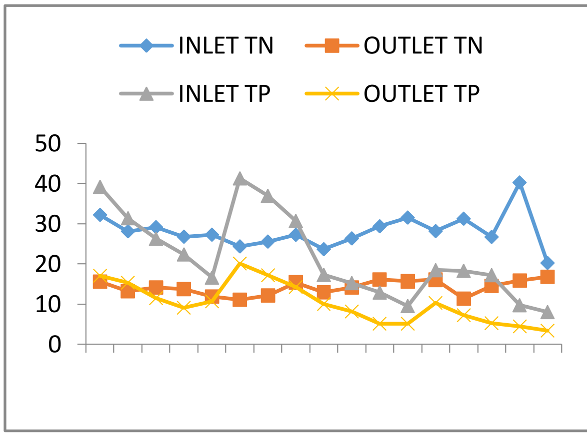


Figure 5 Value of TSS and nitrate & phosphate at inlet and outlet in mg/l(Y axis) with Date of sampling(X axis)



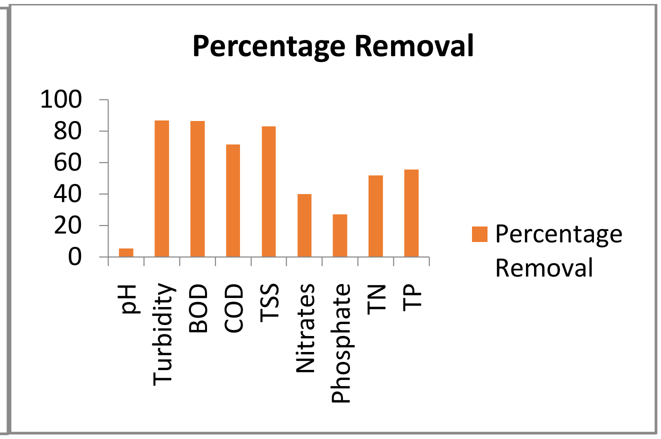


Figure 6 Value of TN and TP and Removal of constituents (in %) (Y axis) with measured parameters (X axis)

CONCLUSION

The Moving Bed bio film reactors technology may operates by using both attached growth system and suspended growth system in respect to wastewater treatments. Results of STPs based on MBBR Technology indicate that Turbidity, BOD, COD & Suspended Solids (SS),Phosphate, Nitrates, Total Nitrogen (TN) and Total Phosphorous(TP) removal efficiencies were calculated to be 86.94%, 86.31%, 71.532%, 83.11%, 27%, 40%, 49.78%, 53% respectively, that indicates efficient removal of the parameters. As compared to other treatment technologies, area requirement is low for MBBR. Average Capital Cost (Secondary Treatment) 68 laces/MLD.Total Area 550 m^2/MLD including Secondary and tertiary treatment. Total daily Power requirement (avg.) is 223.70kWh/d/MLD.The concentrations of parameters like BOD, COD, TSS, Nitrates, Phosphate, Total Nitrogen, Total Phosphorous for 10 MLD STP based on MBBR technology for untreated wastewater are found in the range 291-140, 430-230, 574-162, 1.07-0.56, 5.54-2.15, 40.27-20.22, 41.23-8.02, respectively and range of parameters after treatment were 36-16, 116-72, 108-44, 0.710-0.24, 2.76-1.71, 16.71-11.09, 20.13-3.37, respectively. Variation of pH is also within range. Plant is working well and performance meets CPCB (2013) standards excepts turbidity. For removal of turbidity some coagulants and proper settling are advised.

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