Performance analysis of Modified Rotating Biological Contactors fitted with Radially Divergent Arms Assembly

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Abstract— Conventional rotating biological contactor was provided with radially divergent rotating arms in place of discs. Arms were filled with plastic mesh to increase the residing area of microorganisms. The three compartments in the reactor consisted rotating arms assembly while two baffles that separated the compartments were filled up with plastic scrubbers to provide an extra area for biofilm growth. Domestic wastewater was used to test the efficiency of lab scale model. Tests for BOD, COD and TS were carried out for a detention time of 24 Hours and rotational speeds of 4 rpm, 7 rpm and 10 rpm. Maximum efficiency was observed at rotational speed of 4 rpm. Average percentage removal of BOD, COD and TS was observed as 81.95%, 82% and 79% respectively.

Key words: Biological contactor, baffles, biofilm, rotating arms, wastewater

I. INTRODUCTION

Rotating biological contactors generally consist of discs stacked on a shaft. The shaft is rotated with the help of motor. Rotational speed of 2 rpm to 10 rpm is generally adopted for the operation of reactor [1]. Discs get covered with biofilm layer after submergence into wastewater. The biofilm layer experiences two states, viz. starving and feeding. The bacteria in the biofilm layer remove the organic matter from the wastewater as it feeds upon it and decomposes it by aerobic processes [2]. The disk continues to rotate, leaving the wastewater and moving through the air. During this time, oxygen is transferred from the air to the slime. As the slime reenters the wastewater, excess solids and waste products are stripped off the media as sloughings. These sloughings are transported with the wastewater flow a settling tank for removal [3].

To study the effect of change in the configuration of rotating biological contactors arms were provided in place of discs. Parameters such as BOD, COD and TS were tested to analyze the performance of model. Rotational speeds and detention times were varied to find out the best suitable operational conditions at which the model could perform.

II. AIMS AND OBJECTIVES

The aim of the study was to attain an overall efficiency of 75 to 80% removal of BOD and COD. Also, the shift in the efficiency of model after installation of arms in place of discs was core objective in the study. Changes in the behavior of model with respect to detention period and rotational speeds were studied.

III. EXPERIMENTAL SETUP

A lab scale model was constructed using GI sheet. Volume of the model was set to be 60 litters. The model was a single stage reactor consisting three compartments separated by two stationary baffles. A horizontal central shaft was mounted upon the reactor that held the arms assembly. The shaft was rotated using a motor installed at one end of the reactor. The baffles were filled with scrubbers so as to provide surface area for the growth of bacteria and to enhance the biological activity in the reactor. Domestic wastewater of medium strength was fed to the reactor. The arms were made of aluminum mesh and plastic mesh was inserted into them as media. Submergence of 40% was maintained during the whole operation of reactor.

IV. OBSERVATIONS

The model was kept under operation and observation for 3 months. Wastewater was fed to the reactor and testing was done for inlet sample and outlet sample. Tests for removal of BOD, COD and TS were conducted. Rotational speed of 4 rpm, 7 rpm and 10 rpm was maintained and behavior of the model was noted down in terms of removal efficiency that the model gave at each rotational speed variation. Detention times of 12 hours, 15 hours, 18 hours, 21 hours, 24 hours and 27 hours were adopted to study effectiveness of each detention time and to find out the best suited detention time required for the operation of model.

V. RESULTS

The results were tabulated and graphs were plot in order to understand the best suitable conditions required for the operation of model. Best results were obtained at rotational speed of 4 rpm and at detention time of 24 hours. BOD, COD and TS removal was obtained as 81.95%, 82% and 79% respectively. Results with respect to each rotational speed are tabulated as follow.

Sr No.	Influent	Effluent	% removal	Average % removal
1	214	36	83.18	
2	178	32	82.02	
3	208	38	81.73	81.95
4	234	41	82.48	
5	188	37	80.32	

Table 1: BOD removal at 4 rpm and 24 hours detention time

Sr No.	Influent	Effluent	% removal	Average % removal
1	241	45	81.33	
2	219	43	80.37	
3	238	45	81.09	80.95
4	215	41	80.93	
5	227	43	81.06	

Table 2: BOD removal at 7 rpm and 24 hours detention time

Sr No.	Influent	Effluent	% removal	Average % removal
1	197	40	79.70	
2	231	45	80.52	
3	257	51	80.16	79.54
4	212	47	77.83	
5	195	40	79.49	

Table 3: BOD removal at 7 rpm and 24 hours detention time

Sr No.	Influent	Effluent	% removal	Average % removal
1	356	62	82.56	
2	254	45	82.48	
3	260	42	83.89	82
4	396	79	80.05	
5	470	89	81.00	

Table 4: COD removal at 4 rpm and 24 hours detention time

Sr No.	Influent	Effluent	% removal	Average % removal
1	395	79	80.02	
2	353	77	78.31	
3	396	82	79.20	80
4	364	67	81.69	
5	391	75	80.80	

Table 5: COD removal at 7 rpm and 24 hours detention time

Sr No.	Influent	Effluent	% removal	Average % removal
1	322	69	78.44	
2	372	81	78.31	
3	373	73	80.30	79
4	302	58	80.65	
5	325	74	77.30	

Table 6: COD removal at 10 rpm and 24 hours detention time

Sr No.	Influent	Effluent	% removal	Average % removal
1	255	55	78.31	
2	236	47	80.22	
3	274	51	81.25	79
4	313	72	77.14	
5	217	48	78.10	

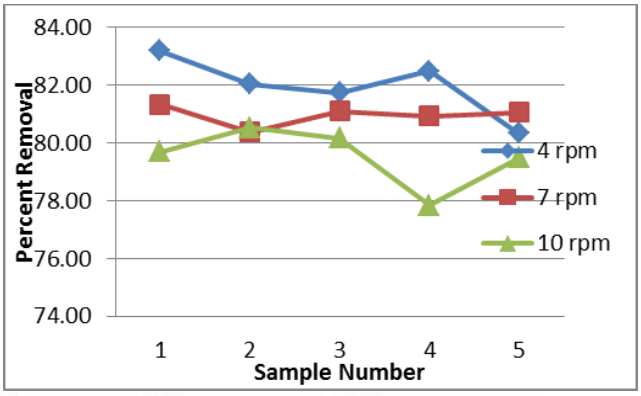
Table 7: TS removal at 4 rpm at 24 hours detention time

Sr No.	Influent	Effluent	% removal	Average % removal
1	361	86.64	76.00	
2	347	85.57	75.34	
3	281	58.22	79.28	77.4
4	276	55.06	80.05	
5	323	76.42	76.34	

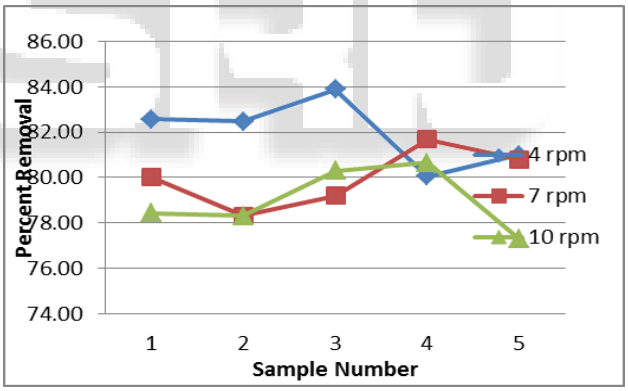
Table 8: TS removal at 7 rpm at 24 hours detention time

Sr No.	Influent	Effluent	% removal	Average % removal
1	345	87.98	74.50	
2	363	78.77	78.30	
3	407	100.61	75.28	76
4	381	88.58	76.75	
5	374	92.83	75.18	

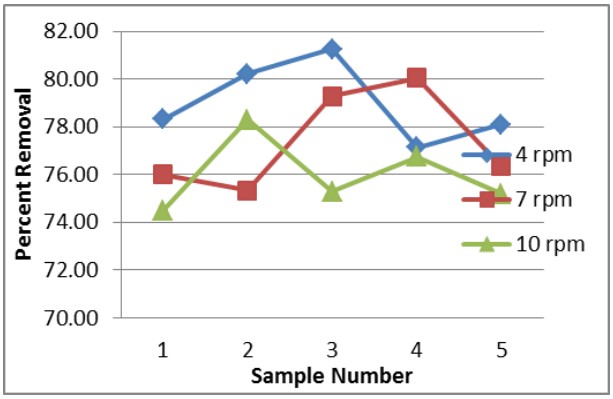
Table 9: TS removal at 10 rpm at 24 hours detention time



Graph 1: Rotational speeds versus percentage removal of BOD at 24 hours detention time



Graph 2: Rotational speeds versus percentage removal of COD at 24 hours detention time



Graph 3: Rotational speeds versus percentage removal of TS at 24 hours detention time

VI. CONCLUSION

Conventional rotating biological reactor when modified into biological contactor with radially divergent arms assembly gave better results. The arms filled up with plastic mesh provided attached growth as well as acted as a filtering media. Upon lowering the rotational speeds, the model had its highest efficiencies. The model can be used for treatment of dairy wastes, agricultural wastes.

VII. ACKNOWLEDGEMENTS

Authors wish to express their gratitude towards Dr. S. P. Tatewar, HOD, Civil Engineering Department for providing all the necessary facilities required to complete the study within time.

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