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Comparison of MBBR system with conventional FAB media and media prepared from waste material for domestic sewage

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Abstract

There is a increase in a pollution of water in India. Pollution increases mainly due to the rapid urbanization. Due to water pollution health problem in human beings are occurring. There are various types waste water sources due to which clear water bodies get contaminated. One of them is domestic sewage. Therefore sewage treatment is very important factor with respect to water pollution. So here we try to design a model for domestic sewage treatment On the basis of this study, the more efficiency for reactor which is filled with bottle caps media with coir. Got more efficiency at 6 hr retention time with 60% media volume, because increase in surface area of media with addition of rubberized coir and punching the hole to bottle cap surface for bacterial growth as compared with FAB media.

Keywords: Comparison, MBBR system, conventional FAB media, media.

Introduction

The waste water which is generated from human activities like toilet, flushing, bathing, washing clothes, washing utensils, is called as domestic waste water that is sewage. There are various types of sewage treatment units. i. Sequential Batch Reactor – In this treatment the reaction is takes place in batch process. First phase is fill, then react, settle, decant. ii. Membrane Bio Reactor – In this treatment membrane technology is used. Submerged membrane module is used in MBR tank for treatment. This treatment is costly than the other treatment but more efficient. This does not require tertiary treatment. iii. Moving Bed Bio Reactor (MBBR) – This treatment is works with the help of MBBR media on which bacterial growth takes place which will help to treat the waste water. iv. Trickling Filter - Trickling filters (TFs) are used to remove organic matter from wastewater. The TF is an aerobic treatment system that utilizes microorganisms attached to a medium to remove organic matter from wastewater. This type of system is common to a number of technologies such as rotating biological contactors and packed bed reactors (bio towers). These systems are known as attached-growth processes. In contrast, systems in which microorganisms are sustained in a liquid are known as suspended-growth processes[1]. v. Constructed wetlands - Constructed wetlands are treatment systems that use natural processes involving (macrophytes) vegetation, soils, and their associated microbial assemblages to improve water quality (USEPA). As the name suggests a constructed wetland is an artificial wetland developed to treat wastewaters from domestic and industrial discharges[2].

On the above treatments we select the Moving bed bio reactor technology for the study purpose. Our main objective is to reuse the waste material and to increase the surface area of carrier media.

Materials and Methods

Materials: The model was prepared using following materials.

Reactor - The model is prepared with the help of 25 lit empty water bottle jar. With the help of this jar two models are prepared. Rector 1 – Domestic waste water treatment with Conventional Fluidised aerobic media (FAB) media. Rector 2 – Domestic waste water treatment with media prepared from water bottle caps. The water bottle used against the acrylic reactor to make the reactor low cost as possible. The volume is decided on the basis of literature review.

Carrier Media – The two type of carrier media is used to compare the performance of reactor. One is selected the conventional FAB Media which is widely used in MBBR system. The FAB media here used is having 400 m^2 surface area. The FAB media is filled in the reactor 1. Second type of media is water bottle caps media. This media is prepared with waste 1 lit and half lit water bottle caps. This caps are used as a alternative option for FAB media because this is similar in structure and material of construction (MOC). To increase the surface area of this media the rubberized coir is used and then it is packed with aluminium foil so that is does not get open in water with FAB media. For the second reactor water bottle caps used as a media. For easily movement of water in the media, base plate of cap is punched with 6 holes with 3 mm size. This media is used in the reactor 2.

Aerators, air pipes and Diffusers – Oxygen is required in the aerobic treatment for the bacterial growth, to maintain DO level. For continues supply of air in reactors this type of air pumps, diffusers and air pipes are used. The two air pumps are used which is having 2x4 Lit/min capacity. The 4 diffusers are used in one reactor for uniform distribution of air in the reactor.

Collection of water sample: For the experimental purpose the sample means domestic waste water was collected by grab sampling from Nalha nearby Omkar Complex Kagal which collects the domestic waste water from Omkar Complex which is having 80 flats and the houses nearby area. This sample is used to analyse inlet and outlet of reactor for following parameters pH, BOD, COD, Solids.

Construction of model: The domestic waste water treatment model is prepared by attaching two water jar vertical to increase the height of reactor. The total depth of reactor is 78cm and diameter of reactor is 20cm. At the bottom of reactor UPVC Pipe valve is fixed to remove the excess sludge from the reactor. Then above that at the spacing of 10cm sampling valves are provided. The water height is kept 70cm. with 40 lit of waste water in one rector. For the biomass development cow dung is the starter for development of MLSS in aeration tank. Fresh cow dung is taken by removing grasses and any other foreign material. The cow dung is mixed in water to make a slurry and added into the reactor in the quantity of $3kg/m^3$ (as such basis). Aeration was kept continuous for 24 Hours. Then Jaggery and DAP also added in reactor to support the growth. Then reactor is kept as it is for 5–6 days. After 6 days 10% supernatant is removed by sampling valve and level is make up with new domestic waste water. This process takes complete 10–12 weeks to grow the bacteria in the reactor. Meanwhile MLSS of the reactor is checked. On the basis of MLSS we get the development of bacteria in the reactor. After the development of bacteria the water analysis is done for the parameters like pH, COD, BOD, Solids of inlet and outlet of the reactor. By changing the % of media in reactor and by changing the retention time.

Figure-1: Reactor.

Figure-2: Carrier Media (FAB Media).

Figure-3: Waste water bottle caps and rubberized coir.

Figure-4: Prepared water bottle cap media with coir and sealed with mesh.

Figure-5: Material used for aeration like air pump, pipe and diffuser.

Figure-6: Material used for aeration like air pump, pipe and diffuser.

Figure-7: Domestic waste water treatment unit with FAB media and water bottle caps media.

Results and discussion

Operation of domestic waste water treatment unit: The two separate reactors are working for FAB Media and Water bottle cap media. In both reactor same quantity of waste water introduced from same source i.e Nalha in Kagal city. The 40 lit waste water is taken in the each reactor.

At the first stage food is added in reactor to grow the bacteria. Cow dung, Jaggery and DAP is added as a food. Then MLSS is checked. The MLSS kept in range of 1800 – 2100 Mg/Lit. After bacterial growth the reactor is worked on two phase. i. With constant media and change in retention time. ii. With constant retention time and change in media.

In first phase the reactor is filled with 60% media and kept the 4 Hours retention time after the four Hours sample is taken for analysis and analysis is done for Ph, BOD, COD.

Five Samples are checked for each cycle. After the 4 Hours cycle. The % media fill is kept same but retention time is increased at 6 hr. After 6 Hours cycle same analysis is done. This same procedure is done for 8 hr.

In Second phase the most effective retention time is kept constant i.e 6 Hours retention time and % fill media increased and decreased by 10%. That is by keeping 6 Hours retention time at 70% media, at 60% media and at 50% media the analysis is done for samples outlet of the reactor.

For this study sample is collected from a nalha which is nearby Omkar Complex Kagal. Tal – Kagal. Dist. – Kolhapur. The Raw water analysis is done at that time of feeding the domestic waste water every time in a reactor. The average vales are shown in Table-1.

Table-1: Raw water characteristics of domestic waste water.

Parameters	Values (Avrg)
pH	7.8
Total Solids	1149 Mg/Lit
Total Dissolved Solids	332 Mg/Lit
Total Suspended Solids	817 Mg/Lit
Biochemical Oxygen Demand	190 Mg/Lit
Chemical Oxygen Demand	235 Mg/Lit

Phase-1: In phase 1 the reactor is filled with 60% media and vary the retention time for 4 Hours, 6 Hours and 8 Hours. On the basis of this the inlet and outlet parameters of the reactor were determined, then following results are determined.

Results for 4 Hours, 6 Hours and 8 Hours retention time.

Table-2: Outlet water analysis at 60% media at different retention time.

Parameters with 60% media (Avrg.)	4 Hours Cycle		6 Hours Cycle		8 Hours Cycle	
	FAB Media	Cap Media	FAB Media	Cap Media	FAB Media	Cap Media
pH	6.8	6.7	7	6.9	6.7	7.1
Total Solids (Mg/Lit)	1150	1005	1260	1198	1165	1210
Total Dissolved Solids (Mg/Lit)	310	325	296	329	350	296
Total Suspended Solids (Mg/Lit)	840	680	967	869	815	914
Biochemical Oxygen Demand (Mg/Lit)	42	20	35	14	42	24
Chemical Oxygen Demand (Mg/Lit)	120	60	90	48	140	68

Table-3: Efficiency of BOD and COD at 60% media at different retention time.

Efficiency in %	4 Hours Cycle		6 Hours Cycle		8 Hours Cycle	
	FAB Media	Cap Media	FAB Media	Cap Media	FAB Media	Cap Media
BOD	77.89474	89.47368	81.57895	92.63158	77.89474	87.36842
COD	48.93617	74.46809	61.70213	79.57447	40.42553	71.06383

Figure-8 shows the BOD, Cod removal efficiency of both reactor that is reactor 1 with FAB media and reactor 2 with CAP media. On the above chart we get that, BOD removal efficiency is higher at 92.63 for 6 hr retention time for cap media. For COD removal efficiency 6 hr retention time for cap media. This shows that 6 hr time is most effective retention time as compare to 4 hr and 8 hr. as well as Cap media is more efficient that FAB media.

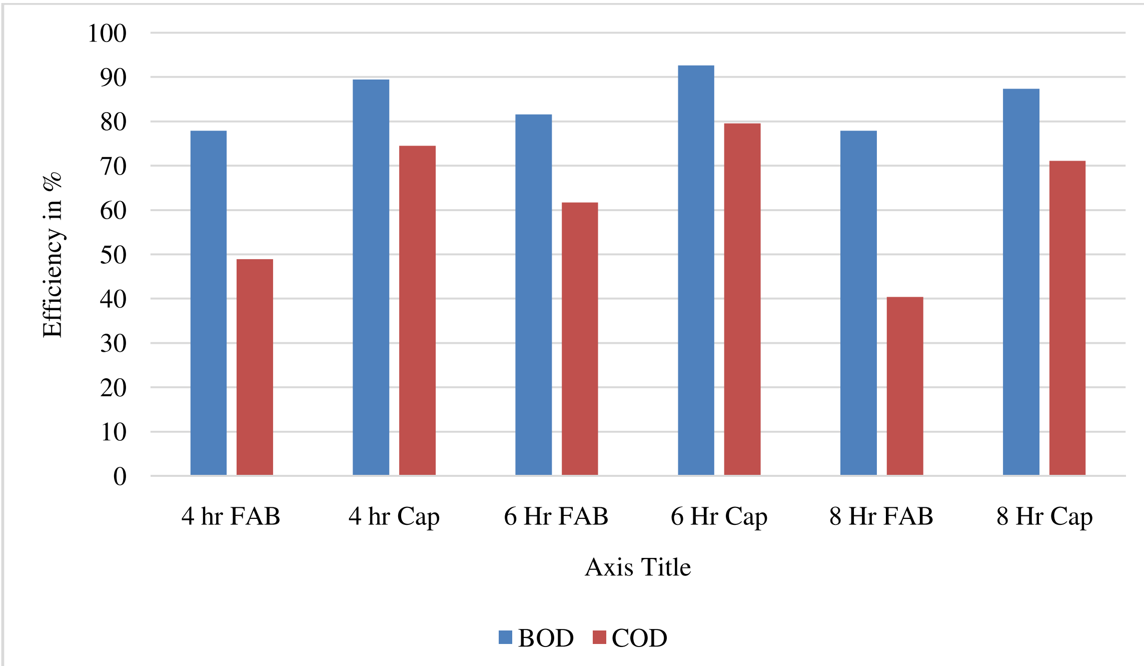

Figure-8: Efficiency of BOD and COD at 60% media at different retention time.

Table-4: Outlet water analysis at 6hr retention time at different % media.

Parameter for 6 hr cycle	70 % Media		60 % Media		50 % Media	
	FAB Media	Cap Media	FAB Media	Cap Media	FAB Media	Cap Media
pH	6.5	6.7	7.1	6.9	6.9	7.1
Total Solids (Mg/Lit)	1250	1205	1260	1298	1265	1210
Total Dissolved Solids (Mg/Lit)	290	315	306	319	320	316
Total Suspended Solids (Mg/Lit)	960	890	954	979	945	894
Biochemical Oxygen Demand (Mg/Lit)	35	14	30	14	38	21
Chemical Oxygen Demand (Mg/Lit)	90	48	80	42	96	49

Table-5: Efficiency of BOD and COD at 6hr retention time at different % media.

Efficiency in %	70 % Media		60 % Media		50 % Media	
	FAB Media	Cap Media	FAB Media	Cap Media	Cap Media	FAB Media
BOD	81.57895	92.63158	84.21053	92.63158	80	88.94737
COD	61.70213	79.57447	65.95745	82.12766	59.14894	79.14894

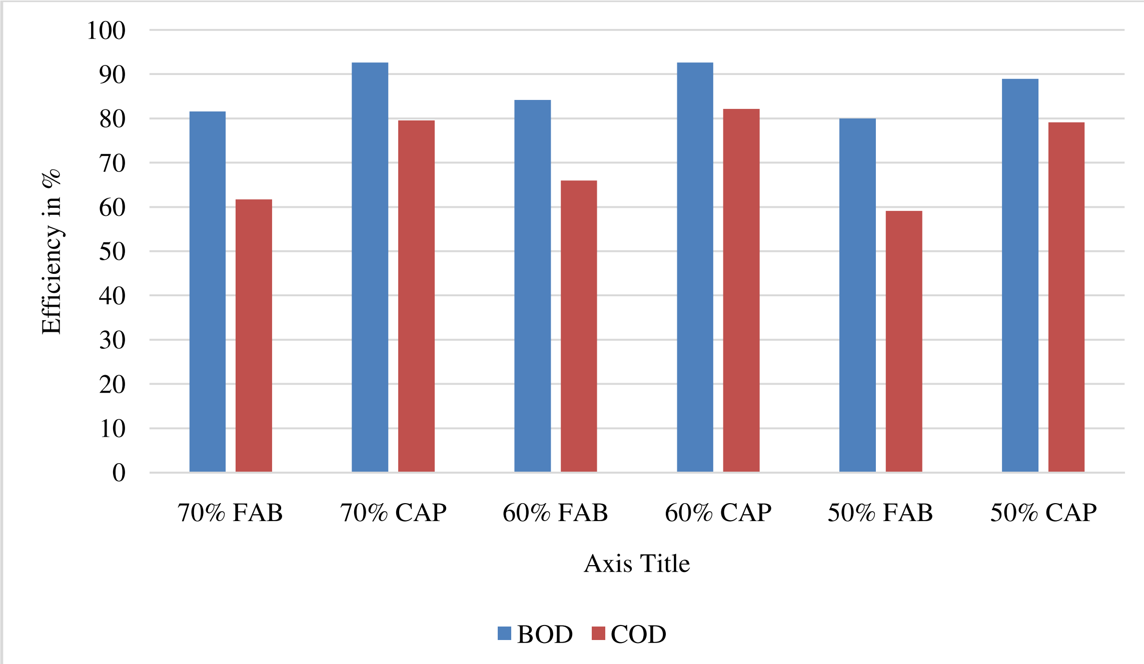

Figure-9: Efficiency of BOD and COD at 6 hr retention time at different % media.

Figure-9 shows the BOD, Cod removal efficiency of both reactor that is reactor 1 with FAB media and reactor 2 with CAP media. On the above chart we get that, BOD removal efficiency is higher at 92.63 for 70% CAP and 60% CAP Media at 6hr constant retention time. For COD removal efficiency 6hr retention time for cap media at 60%. This shows that 60% media fill is most effective % of media as compare to 70% and 80 % as well as Cap media is more efficient that FAB media.

Conclusion

During the first phase of operation reactor with 60% media and 4 Hours, 6 Hours and 8 Hours retention time good performance for BOD and COD removal found is with 6hr retention time. The reason is 4 Hours detention period is less exposure time for treatment and 8 Hours period is the exposure time is more which results in again increase in BOD and COD after treatment. Hence the 6 Hours exposure period is optimum for treatment.

In second phase 6 Hours retention period was kept constant and variation of media was done, which results in more efficiency was found at 60% media. The reason may be, either less area available for exposure at 50% or due to more area availability at 70% the permeability might have hampered. Due to these reasons 60% media is giving good removal efficiency.

The best combination in this study is 6 Hours retention with 60% media provision.

Future scope of work: i. Use of waste metal coir instead of rubberized coir. ii. Use of alternate media or combination with FAB to check the performance. iii. Checking the performance of water bottle cap media for another type of waste water. iv. Addition of filtration system.

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