Treatment of Dye Waste Water using Moving Bed Biofilm Reactor and Granular Activated Carbon with Neem Leaf Powder

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Abstract. In recent days, the waste productions from industries are increased and direct discharge of wastes causes various pollution to the environment. Wastewater treatment in textile and dye industry mainly involves treatment of highly colored wastewater containing variety of dyes in different concentrations. The dyeing industries using different types of pigments and dyes of various concentration during their several production steps. These industries discharge a wastewater which contains organic substance, high colour with high COD and low concentration of BOD. This dye waste water are directly discharge in to the streams and thus contaminate the groundwater. To treat the wastewater, which is discharge from the dyeing industries a simple physio-chemical treatment is not sufficient for the removal of pollutants. So that a biological treatment followed with a physio-chemical treatment have been required. In this study, the experiment was carried out to reduce the organic substance, high colour, COD, BOD, and Heavy metals from dye wastewater using the laboratory scale Moving Bed Biofilm Reactor followed with Granular activated Carbon bed (GAC with NLP-MBBR) with Neem leaf powder. A various thick granular activated carbon bed was used for adsorption technique and for biological treatment of wastewater. The GAC with 8cm thick is layered followed by Ennore sand with 3 grades with 4cm thick equally. Then the MBBR was operated continuously with various retention times. The polypropylene type bio balls were used for microorganism attachment in MBBR. The outlet water from the MBBR are treated using membrane process. Membrane process using moving membranes reduces the pH, organic contents, heavy metals, COD, BOD, turbidity etc., The final effluent water is suitable for Irrigation.

Keywords: MBBR (Membrane Bed Biofilm Reactor), GAC (Granular Activated Carbon), COD (Chemical Oxygen Demand), BOD (Biological Oxygen Demand), DO (Dissolved Oxygen), EC (Electro Chemistry), NLP (Neem Leaf Powder)

1. Introduction

Water pollution means a deviation from pure condition, partially or completely by human activity. Major industries like pulp and paper, chemical, petrochemical, refining, metal working, food processing, textile industries etc. are the major contributors of water pollution. Textile industry generates one of the most polluting effluent compared to other industrial effluents. Due to changes in the consumer’s demand, effluent contents have a rapid change. Synthetic reactive dyes are used in
great amounts now a day. The production processes in textile industry not only utilizes large quantity of water and energy but also generate large amount of waste products. MBBR innovation is one the propelled strategy for the treatment of waste water. The microscopic organisms in the biofilms will devour the organics and supplements introduce in the waste water. It is hard to encourage the water straightforwardly to the MBBR tank. So a pre-treatment of waste water is required. So what we have picked granular actuated carbon. This GAC will diminish the COD level; hence the microscopic organisms connected in the biofilms won't be bothered. The GAC have high retaining power. It expels the shade of the waste water at first. The primary favorable position of the MBBR tank is they diminish the aggregate broke up solids viably. As the microscopic organisms expend its nourishment from the waste the broke up solids can be evacuated effectively. Aside from that, it additionally diminishes pH, COD, BOD, TSS, Alkalinity, Hardness, turbidity, and so forth. The powder of these leaves can replace the chlorine used as a sterilizer. The results of this study indicated that the powder and the leaves of the Neem tree may be used as an alternative to chemicals that have environmental side effects and that the wastewater can be re-used safely.

2. Sample collection and preparation

In our adventure we have used the GAC- Neem and Sand filter tank as primary process and MBBR tank as secondary process. The raw dye waste water was collected at the quantity of 200litres. In GAC Filtration tank, the granular activated carbon made as a layer of bed with the stratum of up to 25cms. The GAC also remove the organics substances, heavy metals, etc. The second process is MBBR tank. The MBBR tank comprises of aerators and biofilms. The biofilms are the polypropylene materials where the bacterium can be growth effectively. Initially the biofilms are soaked in dairy animals excrement in a container. It is then blended with the activated sludge gathered from the air circulation tank of STP. This seed slime will start the development of microorganisms in the biofilms. Initially the waste water is poured in the GAC filtration tank and permitted to dormant for 12 hours. The outlet of GAC filtration tank is connected with MBBR tank. The capacity of tank is 25 litres the quantity of biofilms taken as 100. By using the aerators the tank is fully aerated. This helps to lift the biofilms and make them to turn without making them static. The best possible maintenance time is noted. The maintenance time are taken as 2hours, 4hours, 6 hours, 8 hours.

3. Experimental study

3.1. Initial characteristics of waste water

The textile effluent is to be collected and that effluent initial characteristics are completed. The chemical characteristics were completed. There is pH, Turbidity, Total Solids, Total Dissolved Solids, Ammonia, Conductivity, Calcium, Hardness, Total Suspended Solids, BOD, COD, and DO. The obtained results are shown in the Table1.

| S. No | Initial characteristics | W. W | Unit |
|-------|-------------------------|------|------|
| 1     | Ph                      | 8.76 | -    |
| 2     | Ec                      | 2.65 | Mhos/cm |
| 3     | Cl                      | 349  | mg/l |
| 4     | Cod                     | 1830.8 | mg/l |
| 5     | Bod                     | 359  | mg/l |
| 6     | Do                      | 50   | mg/l |
| 7     | Alkalinity              | 1000 | mg/l |

Table 1. Initial characteristics of tannery waste water and activated sludge.
3.2. GAC
Granular activated carbon (GAC) is a hybrid mixture of a wide variety of graphite platelets that are interconnected by non-graphitic carbon bonding. The adsorptive capacity of GAC makes it ideal for removing a variety of contaminants from water, air, liquids and gases. GAC is also an environmentally responsible product that can be reactivated through thermal oxidation and used multiple times for the same application. Figure 1 shows Granular Activated Carbon.

![Granular Activated Carbon](image)

Figure 1. Granular Activated Carbon

4. GAC-Neem filter process
The capacity of tank is up to 6 liters and 25cm height. The various layers of GAC-NEEM and sand are prepared. The 3 grades of ENNUR sands are layered continuously each up to 3cm. Then the NEEM powder and GAC is layered up to 8cm. The surface loading rate of activated carbon is low. Lower SLR and longer in adsorbent limit will increase adsorption process. The higher volume of the contact bed increase yield. In connection to the qualities of GAC, it might create a superior expulsion of color, odour, heavy metals etc. The expulsion of adsorption treatment was discovered utilizing 8 cm of GAC with 90% evacuation of COD, 60% evacuation of smelling salts and 58% expulsion of shading. The GAC treated water is directly discharged in to the MBBR tank. The final effluent is to be meet the water system norms. Figure 2. shows the GAC-Neem filter tank.

![GAC-Neem filter tank](image)

Figure 2. GAC-Neem filter tank
5. MBBR tank
The MBBR system consists of an aeration tank (similar to an activated sludge tank) with special plastic carriers that provide a surface where a biofilm can grow. The carriers are made of a material with a density close to the density of water (1 g/cm$^3$). An example is high-density polyethylene (HDPE) which has a density close to 1 g/cm$^3$. The carriers will be mixed in the tank by the aeration system and thus will have good contact between the substrate in the influent wastewater and the biomass on the carriers. To prevent the plastic carriers from escaping the aeration it is necessary to have a sieve on the outlet of the tank. To getting away from air circulated biofilms it is important to have a strainer on the outlet of the tank. Figure 3. shows MBBR tank.

![MBBR tank](image)

Figure 3. Membrane Bed Biofilm Reactor tank

6. Treatment in MBBR tank
In this biological treatment, Poly Vinyl Chloride (PVC) transporter materials were used as a part of MBBR. Carrier media’s of MBBR are nutrient with (Micro bacterium Marnilacus), dairy animals discrete.

6.1. Biocarriers
A biofilm used to gather of microorganisms in which cells adhere to each other and frequently additionally to a surface. These follower cells end up inserted inside a foul extracellular network that is made out of extracellular polymeric substances (EPS). Total of microorganisms in which cells that are much of the time installed inside a self-created grid of extracellular polymeric substances (EPSs) stick to each other and additionally to a surface. Figure 4. shows MBBR Treatment Setup

![MBBR Treatment Setup](image)

Figure 4. MBBR Treatment Setup
7. Reuse of Dye waste water in Agriculture
Using treated dye waste water effluents and sludge on agricultural land provides an alternative to disposal by utilizing the recyclable constituents in sludge and waste water in the production of crops. Figure 5. shows Planting Spinach Using Dye Waste Water.

![Figure 5. Planting Using Dye Water](image)

Figure 6. shows planting of spinach using GAC treated water.

![Figure 6. planting using GAC treated water](image)

Figure 7. shows planting of spinach using MBBR treated water.

![Figure 7. planting using MBBR treated water](image)

8. Results and discussion
The wastes associated are decreased and evacuated according to the natural standards. The treated water can be utilized for the water system. The table 2 shows Result of GAC & 3 shows Result of MBBR treated value figure 8,9,10 &11 shows the results of pH, Chloride, COD & BOD. The BOD, COD of water also decreased 88%. A biofilm was used to gather of microorganisms and surface loading rate of activated carbon is low. Lower SLR and longer in adsorbent limit will increase adsorption process. The expulsion of adsorption treatment was discovered utilizing of GAC with 90% evacuation of COD. The NEEEM and GAC play the vital role for reducing a BOD and COD. In most of the paper almost they had used whether carbon or neem powder but in our project we introduced
both GAC and NEEM powder to get a better result. The total solids evacuated are almost 80%. The treated water meets future water demand. The treated water is to be safe for irrigational purpose.

Table 2. Results of GAC treatment

| S.No | Parameter | GAC Outlet | Unit |
|------|-----------|------------|------|
| 1.   | pH        | 7.75       | -    |
| 2.   | EC        | 2.32       | Mhos/cm |
| 3.   | Cl        | 134.9 mg/l | mg/l |
| 4.   | COD       | 570.4 mg/l | mg/l |
| 5.   | BOD       | 30.30 mg/l | mg/l |
| 6.   | DO        | 25 mg/l    | mg/l |
| 7.   | Alkalinity| 750 mg/l   | mg/l |
| 8.   | Hardness  | 54 mg/l    | mg/l |
| 9.   | Ca Hardness| 30 mg/l   | mg/l |
| 10.  | Mg Hardness| 24 mg/l  | mg/l |
| 11.  | Sulphate  | 926.1 mg/l | mg/l |
| 12.  | Acidity   | 420 mg/l   | mg/l |
| 13.  | Turbidity | 35 mg/l    | mg/l |
| 14.  | TS        | 800 mg/l   | Gms |

Table 3 shows the Results of MBBR treatment

Table 3. Results of MBBR treatment

| S.No | Parameter      | MBBR outlet |
|------|----------------|-------------|
|      |                | 2hr | 4hr | 6hr | 8hr |
| 1.   | pH             | 6.2  | 6.7 | 7.2 | 7.5 |
| 2.   | EC             | 1.5  | 1.52| 1.7 | 1.73|
| 3.   | Cl             | 89.9 | 90.7| 92.9| 96.3|
| 4.   | COD            | 138  | 128.8| 165.6| 174.8|
| 5.   | BOD            | 9.09 | 6.06| 3.03| 3.51|
| 6.   | DO             | 15   | 13.5| 12  | 12  |
| 7.   | Alkalinity     | 475  | 525 | 550 | 575 |
| 8.   | Hardness       | 55   | 57.5| 60  | 62.5|
| 9.   | Ca Hardness    | 18   | 18  | 20  | 20  |
| 10.  | Mg Hardness    | 37   | 39.5| 40  | 42.5|
| 11.  | Sulphate       | 643  | 660 | 687 | 690 |
| 12. Acidity | 125 | 122 | 124 | 132 |
|-------------|-----|-----|-----|-----|
| 13. Turbidity | 48 | 51 | 56 | 58 |
| 14. TS | 318 | 331.5 | 342 | 345 |

**Figure 8.** Values of pH

**Figure 9.** Values of Chlorides

**Figure 10.** Values of COD
Figure 11. Values of BOD

9. Conclusion

- This experiment has demonstrated that the Moving Bed Biofilm process alongside Granular Activated Carbon can be utilized as a perfect and effective choice for the organics and supplement expulsion from color squander water.
- The physical and compound attributes of the wastewater from the coloring business are especially decreased and it can be utilized for water system reason.
- The estimation of pH is almost 7.5 at ideal maintenance time.
- The COD evacuated about 88%. The BOD and DO is to be evacuated about 30.3& 50% at primary process itself. The shade of the wastewater is totally evacuated.
- The solids which lessened almost 80% at the primary procedure itself.
- The chlorides removal is done almost 93%.
- The alkalinity of water removed 82%.
- The hardness present in the water is removed up to 42%.
- The turbidity of water is evacuated almost 60%.
- Our MBBR-GAC can evacuate the physical and compound attributes of the wastewater from the coloring effectively. In this manner it can be utilized for water system.

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