Treatment of Pretreated Textile Wastewater Using Modified Mbbr

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Abstract

Currently, water pollution control is one of the major logical zones. The textile industry is a major pollution causing industry among the industrial pollutions. Treatment of textile effluent utilizing customary physical as well as chemical strategies is costly, produces enormous amounts of sludge and needs the expansion of lethal chemicals. BOD to COD proportion of textile effluent is low. Thus it is not appropriate to treat textile effluent by a solitary physicochemical or biological process. In this investigation, the textile effluent is dealt with utilizing Moving Bed Bio-film Reactor (MBBR) with the magnetic field after improving the biodegradability by the solar photo-Fenton process. The carriers in MBBR is inoculated with azoarcus bacteria isolated from textile sludge. The fundamental parameters as pH, carrier filling ratio and contact time were optimized utilizing Box Behnken factual design. The MBBR process has most extreme efficiency at pH 7, filling ratio of 62% and a contact time 2.4 days. In this optimum condition 68.9% BOD and 80% COD are expelled. At the point when the pretreated wastewater was dealt with MBBR reactor under the influence of magnetic field, the efficiency of the treatment is additionally expanded, so 87.4% COD expulsion and 87% BOD evacuation were accomplished at 12 mT attractive field power when exposure time was at 12 hrs.

Keywords: *Box Behnken factual design; magnetic field; MBBR; solar photofenton; textile effluent*

1. Introduction

The textile industry is one of the best generators of fluid effluent toxins, because of the tremendous amounts of water utilized as a part of the dyeing processes. With the expanded interest for textile items, the textile industry and its wastewater have expanded relatively making it one of the fundamental sources of extreme pollution issues worldwide (1,2,21,22). The effluent within the sight of wastefully treated dyestuff can cause tasteful and ecological issues in aquatic ecology interfering with biological digestion on the grounds that most dye materials are dangerous and conceivably carcinogenic [3,7,20,27,28,30]. Along these lines, a concentrated treatment is required for the textile effluent previous to its disposal. Execution of physical or chemical strategies alone makes the treatment exorbitant since it includes more energy utilization and chemicals employments. The biological treatment through microbial decolorization and debasement of dyes has been of extensive enthusiasm since it is cheap, eco-friendly, and delivers a less measure of sludge. The adequacy of microbial decolorization relies upon the versatility and the movement of chosen small scale organisms [5,9,10,27].

The moving bed biofilm reactor (MBBR) is a very viable biological treatment process that has been created on the premise of conventional activated sludge and bio filter methods. The biomass in the MBBR exists in two structures: suspended flocs and a biofilm joined to transporters. This procedure depends on non-clogging biofilm reactor with no requirement for discharging, low headloss and a high particular biofilm surface zone. It is a totally blended and continuously operated biofilm reactor, where the biomass is developed on small carrier components that have a little lighter density than water and are kept in development alongside a water stream within the reactor. The development of a reactor can be caused by air circulation in an oxygen consuming reactor and by a mechanical stirrer in the reactor [8,18,19,24,25].

The Design Expert Software Minitab adaptation 16 was utilized to design the number of examinations to be performed, evaluate the experimental information and assess the test outcomes. With a specific end goal to examine the impacts of critical factors and to get the optimal conditions in this examination, the Box-Behnken factual design was utilized. The enhancement methodology includes examining the reaction of actually outlined mix, evaluating the coefficients by fitting experimental data to the reaction capacities and foreseeing the reaction of fit model. [31]

Magnetic water treatment is generally new systems in natural administration with a considerable measure of utilizations, for example, scale avoidance/disposal, soil improvement, plant development, crop yield, water sparing, and wastewater treatment [11]. Magnetic field introduction adjusts physical as well as chemical properties of water particles bringing about extraordinary qualities. Past research center and field studies have demonstrated the high effectiveness of electromagnetic strengths as adjunctive or option treatment for traditional wastewater treatment [12, 13]. The magnetic field application has a potential in affecting the biological properties through the change of bacterial movement. Magnetic application likewise enhances the physical properties of wastewater as far as strong fluid partition basically through a conglomeration of colloidal particles [12,13,14,15,16,17].

The textile wastewater has low biodegradability and the BOD/COD proportion is around 0.2. In this manner to make it

agreeable for MBBR process chemical pretreatment is done and BOD/COD proportion is upgraded to 0.5. The solar photo-Fenton treatment is picked as the pre-treatment since it permits a high rate of degradation at room temperature and pressure, simple to lead and in particular, the procedure uses the characteristic daylight as an energy source [29, 30].

In this work, the treatment of pretreated textile wastewater utilizing MBBR process and the impact of magnetic field on the treatment is examined. The impact of parameters like pH, carrier filling ratio along with its contact time in the removal of BOD and COD from the wastewater by MBBR treatment is contemplated. Likewise, MBBR is operated by the magnetic field to ponder the impact of field exposure time and field intensity. Finally, the maximum removal efficiency of BOD and COD is resolved under the optimized conditions.

2. Materials and Methods

2.1. Sampling of Textile Wastewater

The specimens of untreated real textile wastewater were gathered from Cannanore Handloom Exports Ltd, Kannur. The water prerequisite for the industry is 40 to 50 m^3/day and the dyeing procedure produces 20 to 30 m^3 wastewater while preparing 200kg cotton each day. The dyes mainly utilized by the industry are Ramazol Red F 3B, Olive R and Ramazol Turquoise blue CG. The wastewater samples are stored at 4°C and investigated to decide the attributes. Table 1 demonstrates the qualities of untreated real textile wastewater.

Table 1 characteristics of untreated textile wastewater

Parameter	concentration	Unit
BOD	210	mg/L
COD	980	mg/L
pH	12	-
TDS	970	mg/L
Alkalinity	1200	mg/L
Chloride	180	mg/L
Turbidity	64	NTU
Hardness	140	mg/L
Sulphide	44	mg/L

2.2. Pretreatment Using Solar Photofenton

The solar photo-Fenton treatment was given to the wastewater. 500mL sample volume was taken. pH was balanced utilizing H_2SO_4 or NaOH. At that point, iron salt ($FeSO_4.7H_2O$) of required weight was included. It was blended well with wastewater for 10minutes. The trial setup was put under the sunlight and required volume of H_2O_2 was included. The response time begins with the mixing of H_2O_2 and the reagents were completely blended. The light intensity was measured utilizing a light meter. The solar photo-Fenton treatment was done at pH 3, response time 30 min., Fe^{2+} 4mg/L, and 20 mM H_2O_2. This trial was directed at solar intensity of 20W/m^2 which was the most accessible solar power at the time of venture work. By this pretreatment, BOD: COD proportion increased from 0.21 to 0.54.

2.3. Moving Bed Biofilm Reactor (MBBR) Experiment

A lab-scale reactor with a volume of 11.25 L is utilized to treat the wastewater. It is an acrylic glass reactor of size 15 X 15 cm along with height 50 cm. An aerator of limit 3L/min. was joined to the base of the reactor for the air supply. Paddles made up of acrylic sheet fitted with a motor were additionally given in the middle to combine the carrier components with the wastewater. The paddles are pivoted at a speed of 30 rpm. The carrier elements for the MBBR process were PVC corrugated cylinders with internal diameter of 1.5 cm, external diameter of 2 cm and height of 1.4 cm. The carriers have a density of 0.94g/cm^3 and specific surface area of 350 m^2/m^3

2.4.Inoculation of Carrier Elements

The sludge from air circulation tank of Cannanore Handloom Exports Ltd was collected to isolate the overwhelming bacterial species and brood the same to the carrier components. The ID and confinement of microscopic organisms were done in the Department of Microbiology, Kerala Agriculture University, Vellanikka-ra. The recognizable proof is finished by 16S-rRNA technique. The prevalent species was azoarcus. The colonies of azoarcus were isolated, transferred to peptone nutrient medium and permitted to develop and multiply for 24 hrs at room temperature. At that point, the carriers are placed in the bacterial culture for 12 hrs. The transporters were air-dried and filled in the reactor. The Quadrant streaked culture of azoarcus microorganisms is appeared in fig. 1.

Fig.1: Quadrant streaked culture of azoarcus bacteria

2.5. Experimental Design of MBBR

Different components influencing treatment of textile wastewater in moving bed biofilm reactor are contact time, pH and filling proportion of carriers in the empty reactor. Optimization of differing parameters is finished by Box Behnken technique utilizing MINITAB programming. For pH, the range is chosen from 6-9 which depends on past investigation. This pH range is reasonable for bacterial development. For filling ratio (FR), the range is 40-80% and the contact time received was in the range 1-3days.

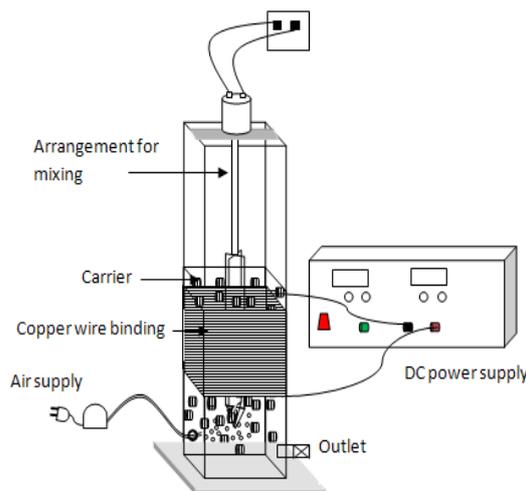## 2.6. MBBR under Magnetic Field

Fig. 2: Schematic diagram for MBBR with magnetic field

The magnetic field applied to the wastewater in the MBBR reactor to decide its impact on the procedure. Two reactors with arrangements for air circulation and blending were orchestrated so one act as a control (without magnetic field). Magnetic field is created by winding copper wires around the second reactor and passing DC current through it (Fig. 2).

The impact of the field on MBBR process is considered by fluctuating the field exposure time and field intensity. The two reactors

were worked at a given pH, filling ratio of carriers and contact time. The distinctive magnetic intensity (4 to 14 mT) is applied by altering the DC supply and for each run of the examination rate expulsion of BOD and COD are computed.

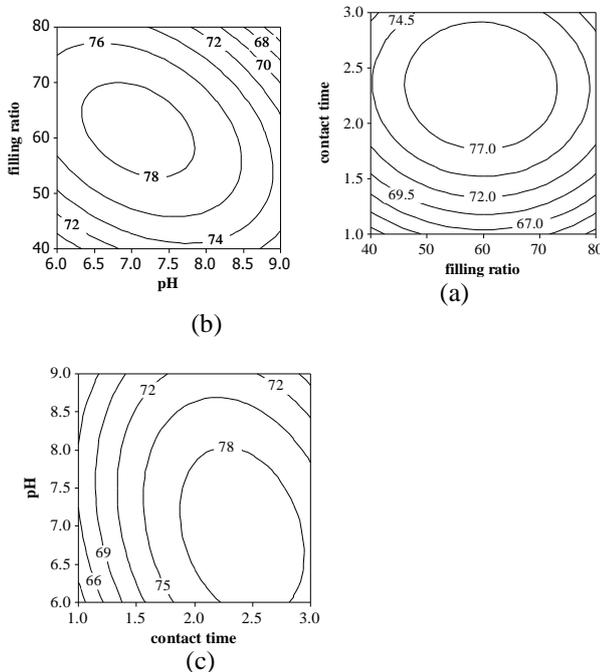# 3. Results and Discussions

3.1. Effect of Parameters on COD Removal

(b)

(a)

(c)

Fig.3: Contour plots of COD removal vs (a) pH and filling ratio at contact time 2 days, (b) filling ratio and contact time at pH 7.5, (c) pH and contact time at filling ratio 60%

The impact of parameters like contact time, pH and filling ratio on COD expulsion can be effortlessly translated from the contour plots given in figure 3. As the contact time expands, COD removal increases and after that decreases and the most extreme removal is acquired when the time achieves 2.5 days. As filling ratio increases from 40-70%, COD removal increases. When filling proportion increases to 80%, efficiency diminishes. This is because when filling ratio is expanded over 70%, there won't be appropriate mixing. When filling ratio is diminished below 40%, oxygen exchange efficiency will be poor. Optimum pH is in the range 7.5-8.5 in light of the fact that bacterial development in MBBR is optimum in that pH range.

3.2. Effect of Parameters on BOD Removal

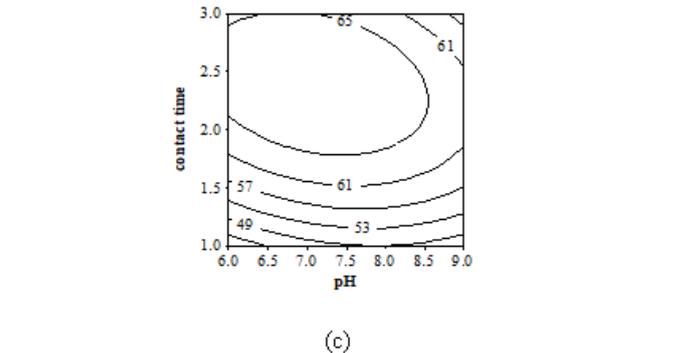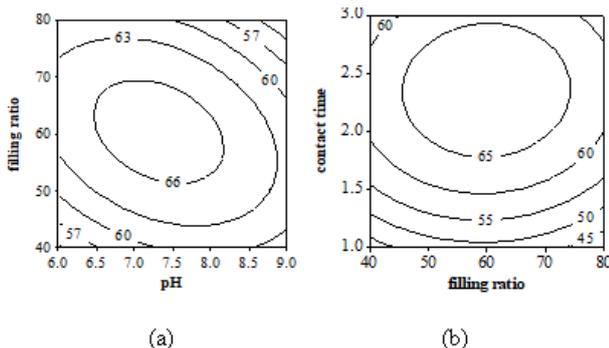The contour plots of BOD removal appeared in figure 4 clarify the impact of every parameter simultaneously.

(a)

(b)

(c)

Fig.4: Contour plots of BOD removal vs (a) pH and filling ratio at contact time 2 days, (b) filling ratio and contact time at pH 7.5, (c) pH and contact time at filling ratio 60%

BOD removal efficiency is most extreme when pH in the range 6-8, time in the range 2-2.2 days in addition to filling ratio in the range 60-70%. This is because that azoarcus bacteria has optimal development in the pH range 7-8. As time increases BOD removal effectiveness increases and 80% removal is seen at 2 days and after that slight lessening in efficiency on account of bacterial demise because of the absence of feed which expands the biological load. BOD removal efficiency increases when filling ratio is in the range 40-70% and the optimal value is discovered when filling ratio is in the range 60-70%. When filling ratio is expanded over 70%, BOD removal efficiency decreases because of the absence of appropriate mixing of carriers within the reactor.

3.3. Optimum Conditions of MBBR

The optimization plot for COD and BOD removal appears in figure 5. The efficiency of MBBR process is maximum at a pH of 7 and for a filling ratio of 62% after a contact time of 2.4 days. At these conditions, BOD evacuation of 68.9% and COD expulsion of 80% was acquired for the textile wastewater.
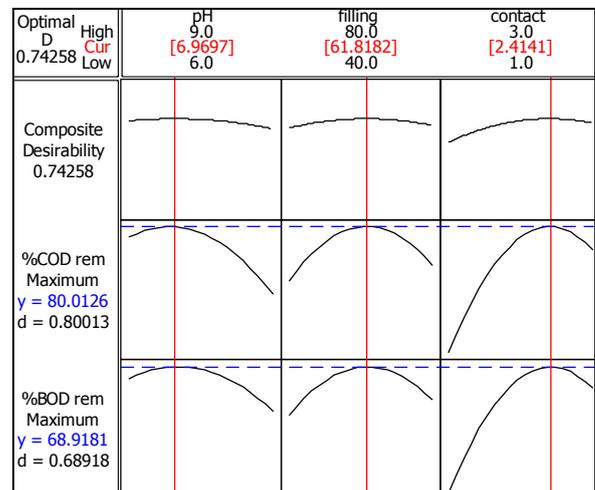

Fig.5: Optimization plots for BOD and COD removal

3.4. Effect of Magnetic Field on MBBR Treatment

The utilization of magnetic field to the wastewater under MBBR treatment demonstrates a slight increment in COD removal effectiveness. The reactor under magnetic field accomplished a COD removal efficiency of 87.4% while the reactor without magnetic field had a higher efficiency of 80%.

3.4.1. Effect of Field Exposure Time

The influence of field exposure time on COD removal at optimized states of MBBR under a magnetic field of 5 mT appears in figure 6. The COD removal increases as the exposure time in-

creases and it might be because of the expansion in ionization rate took after by mutual fascination and settlement of particles. The most extreme removal is attained at an exposure time of 12 hrs.
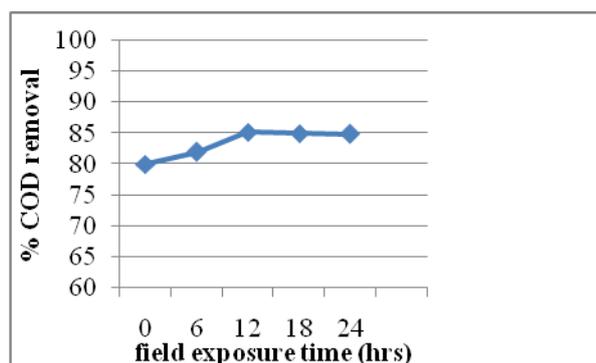

Fig.6: Effect of field exposure time(at pH=7, FR=62%, contact time=2.4 days,field intensity = 5 mT)

3.4.2. Effect of Magnetic Intensity

The COD removal acquired at different magnetic field intensities at optimized states of MBBR after an exposure time of 12 hrsappears in figure 7. At first, as the magnetic field strengthens COD removal likewise increases. The organic molecules in effluent adsorb energy when it passed through the magnetic field. Some energy enhanced molecules were then induced to an excited state which increased the degradation of organic matter[11]. The greatest COD removal and BOD removal was attained at a power of 12 mT individually.
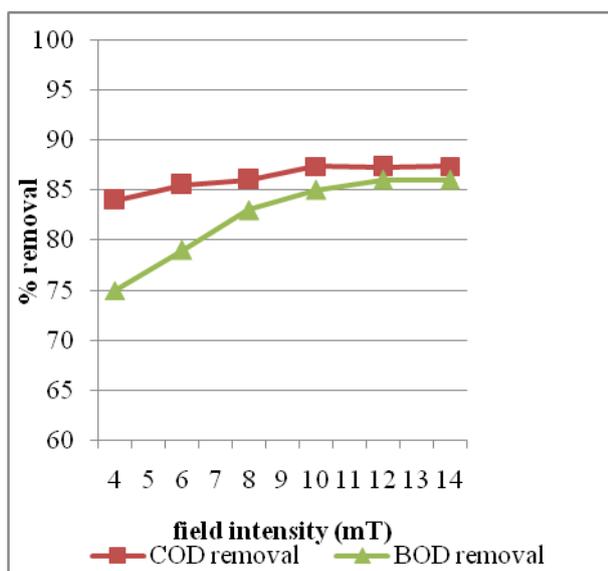

Fig.7: Effect of magnetic intensity (at pH=7, FR=62%, contact time=2.4 days,field exposure time = 12hrs)

4. Conclusion

The treatment of pre-treated textile wastewater by Moving Bed Bio film Reactor was assessed through this work. The response enhanced for COD and BOD removal and MBBR process demonstrates most extreme efficiency at pH 7, filling ratio 62% and a contact time 2.4 days. Under these conditions, 68.9% BOD removal and 80% COD removal are attained. The treated wastewater can be utilized for irrigation purpose. By the influence of magnetic field, the efficiency of the MBBR is additionally improved. This modification results 87.4% COD removal and 86% BOD removal at 12 mT magnetic field intensity and 12 hr exposure time. The treated wastewater can either be released to surface water bodies or into irrigation water since it meets the benchmarks of Environmental Protection govern, 1986.

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