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Removal of Diamozol Red ED-3 from Simulated Textile Wastewater in Membrane Bioreactor (MBR) System

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Abstract – In this research, the decolourization process of Diamozol Red ED-3 textile dye by using activated sludge collected from wastewater treatment facility in Bilecik First Organized Industry Zone was examined in membrane bioreactor (MBR) system. The Lab/Pilot Scale MBR system had a working volume of 170 L and was equipped with a coarse and fine air bubble creation mechanism for membrane and biological aeration, respectively. The temperature of the aeration tank was controlled at 25±1°C, the pH value and the concentration of DO was kept, respectively, in the range of 6.5-7.0 and 2.0-2.5 mg/L in the aeration tank. The initial dye concentration and COD concentration of the synthetic wastewater prepared for decolourisation process were 50 and 952 mg/L, respectively. The dye concentration, COD concentration value were measured daily in effluent to assess the removal efficiency. Most of the analytical techniques used in this study were mentioned in the standard methods. At the end of the study treatment percentage colour removal was approximately 76% and COD removal was 79% in 7 days. The results obtained from this study showed that textile dyes can be effectively decolorized by the activated sludge in MBR system.

Keywords: Biodegradation, COD, Decolourisation, MBR, Textile wastewater.

I. Introduction

The reuse of wastewater reduces both the consumption of freshwater resources and minimizes the environmental impact of discharged wastewater. Biological treatment technologies have been utilized in wastewater reclamation for over a century. Membrane Bioreactors (MBRs) can be broadly defined as systems integrating biological degradation of waste products with membrane filtration. Membrane bioreactors are composed of two primary parts, the biological unit responsible for the biodegradation of the waste compounds and the membrane module for the physical separation of the treated water from mixed liquor. They have proven quite effective in removing organic and inorganic contaminants as well as biological entities from wastewater. Membrane bioreactor technology has great potential in a wide range of applications including textile wastewater treatment. The textile industry is characterized not only by the vast quantity of process water used, but also by the variety of chemicals used.

A significant number of research studies have been conducted on evaluating the performance of MBR technology for textile wastewater during the past decade. Schoeberl et al. [1] found that COD and colour removal from textile wastewater was 89-94% and 65-91%, respectively. Similar observation was made by [2] who found that MBR reduced 60-95% of COD and 46-98.5% of colour at 525 nm. [3] found that the average COD and dye removal efficiency was 94.8% and 72.9%, respectively by aerobic MBR treatment. Deowan et al. [4] investigated the MBR treatment for textile wastewater and found that COD removal efficiency was around 90% by MBR and they also found that red and blue colour removal efficiencies were 25-70% and 20-50 % respectively.

In this study, removal of Diamozol Red ED-3 from simulated textile wastewater by using activated sludge collected from wastewater treatment facility in Bilecik First Organized Industry Zone was examined in membrane bioreactor (MBR) system.

II. Materials and Method

Dye and Chemicals

All chemicals were obtained from Merck. Diamozol Red ED-3 dye were supplied from the local textile factory.

Lab/pilot scale MBR system

The volume of MBR system was 170 L. The detailed information about the MBR system used in this study was previously presented by Özan and Acikgoz [5], and also the schematic diagram of the lab/pilot scale MBR system was given at Özan and Acikgoz et al. [6]. The activated sludge collected from wastewater treatment facility in Bilecik First Organized Industry Zone transferred to membrane bioreactor system. Each experimental run, 100 L of synthetic dye containing water was fed into the aeration tank by the pump in the MBR system. The MBR system had a diffuser which supplied continuous air with an intensity of 9 L/min for complete mixed in order to supply dissolved oxygen to the fungus. The temperature of system was controlled at 25 ± 1 ^{0}C. Also the pH and the dissolved oxygen (DO) concentration were in the range of 6.5-7.0 and 2.0-2.5 mg/L in the aeration tank. A schematic view of the MBR system is shown in figure 1.

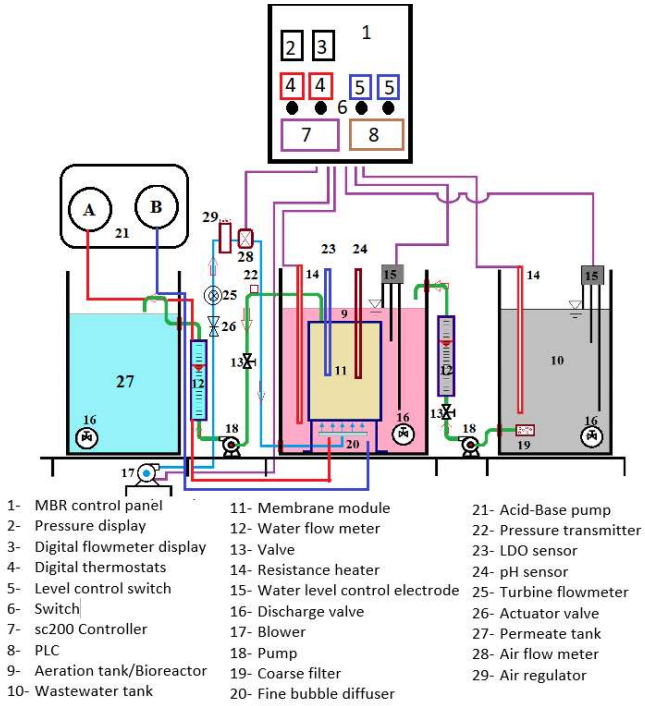

Fig. 1 Schematic view of lab/pilot scale MBR system.

Synthetic wastewater

The medium, included 1.5 g/L starch, 1 g/L glucose, 0.4 g/L urea, 0.099 g/L $CaC1_2$, 0.255 g/L NaCI, 0.17 g/L Na_2CO_3, 0.17 g/L $NaHCO_3$, 1 ml/L trace elements and (5 g/L) dyestuff, was used for biodegradation process.

The trace element stock solution was prepared as 0.125 g $CuSO_4$, $5H_2O$, 0,05 g H_2MoO_4, 0.061 g $MnSO_4$, $5H_20$, 0.043 g $ZnSO_4$, $7H_2O$, and 0.082 g $Fe_2(SO_4)3$, 14 H_2O in 1 L of Milli-Q water.

Analytical methods

The analytical measurements of dye containing wastewater were done by using a spectrophotometer (JENWAY 7315 spectrophotometer). The absorbance peak was measured at 540 nm for Diamozol Red ED-3. Scanning was performed between 300 and 800 nm.

The calibration curve of "absorbance vs. concentration" was used for calculation of dye concentration and the reduction of dye concentration was used to calculate the rate of depolarization efficiency.

Rate of decolorization (%) = $(C_o - C_f) / C_o \times 100$ Eq.(1)

In this equation, C_o and C_f represent the initial and final dye concentrations (mg/L), respectively.

COD analyses were performed by means of a spectrophotometric test (Spectroquant Merck) and later determined spectrophotometrically (Nova 60Aspectroquant), at 528 nm. Samples (influent, effluent) were centrifuged (Nuve NF 400) for 5 min. at 10,000×g and diluted appropriately before each COD determination.

III. Results

The removal efficiency of dye and COD results obtained in the MBR system were given in Table1.

Table 1. The removal efficiency of COD and dye results in 7 days.

Time	pH	Temperature (°C)	DO (mg/L)	COD (mg/L)	%COD Removal	Dye concentration (mg/L)	%Dye removal
Initial value	6.7	25	2.1	952	-	50	-
1. Day	6.8	25	2.3	725	24	23.56	53
2. Day	6.7	24	2.1	524	45	20.69	59
3. Day	7	25	2.4	316	67	18.97	62
4. Day	6.6	26	2.5	285	70	18.39	63
5. Day	6.8	25	2.3	255	73	17.24	66
6. Day	6.9	24	2.3	218	77	13.79	72
7. Day	6.7	26	2.5	197	79	12.07	76

The dye concentration and COD concentration of the synthetic wastewater prepared for experimental study were 50 mg/L and 952 mg/L, respectively. The removal efficiency of COD and dye obtained from experimental study were given in Fig.2 and Fig.3.

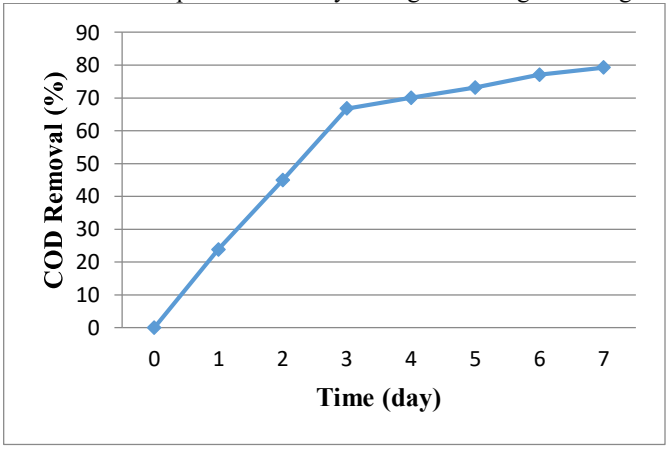

Fig. 2 The removal efficiency of COD.

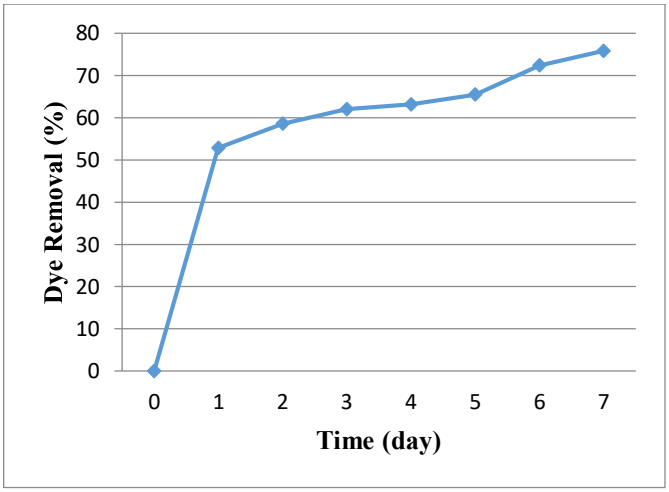

Fig. 3 The removal efficiency of dye.

IV. DISCUSSION

It was observed that after 3 days of treatment, the decolorization percentage reached to a 62%. It is observed for the Diamozol Red ED-3 dye that after 7 days of treatment the decolorization percentage was over 76 %, respectively.

The influent COD concentration was 952 mg/L, during the decolorization process in the MBR system. The aerobic treatment resulted in a COD abatement of 79%. The results obtained from this study are consistent with the results in the literature. In the literature, it was given that red colour removal and COD removal efficiency by MBR system were 25-70% and 90%, respectively [4].

Some other researchers have also worked in continuous or semi-continuous modes, achieving effective decolorization percentages. However, their experimental systems have smaller capacity than our MBR system.

The results indicated that the organic removal efficiency achieved was up to 79% by means of biological treatment, with the assistance of membrane filtration. This suggested that membrane filtration played a significant role in maintaining high and stable organic removal efficiency.

V. CONCLUSION

Textile industry is one of the most significant manufacturing sectors that produce large volumes of highly polluted and toxic wastewater. As result of experimental studies, the removal efficiency of color and COD was determined as 76% and 79%, respectively. It can be concluded that textile dyes can be effectively decolorize by in the MBR system.

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