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Submerged Membrane Bioreactor (SMBR) for Treatment of Textile Dye Wastewatertowards Developing Novel MBR Process

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Abstract

This paper deals with the application of a submerged membrane bioreactor (SMBR) with commercial membrane module and novel MBR modulefor the treatment of model textile dye wastewater (MTDW). For this work, MTDW was developed based on different publications and a pilot-scale automated SMBR unit was applied to carry out the tests with this model wastewater. The system is on the way to be upgraded to attain novel MBR module replacing the applied commercial membrane by novel membrane materials which have been developed by the European Commission funded project "BioNexGen" [1].The hydraulic volume of the employed SMBR reactor was 57 L. One flat sheet commercial MBR module was submerged in the reactor. The module consisted of 3 sheets, with 25 cm × 25 cm dimensions of each sheet covering total active membrane area of 0.33 m^2. To reach the target, different MBR process parameters like COD, BOD, TOC, pH, conductivity, flux, TMP, MLSS, colour contents, air supply, O_2 consumption, HRT, SRT, drying residue, nutrients etc. have been investigated. It is reported that under the operating conditions of permeate flux of 4 L/m^2h, around 50 mbar of TMP, 12 g/L of MLSS, 40-80 h of HRT, 1.0 m^3/h of air supply to MBR reactor, pH of 8.2±0.2- 10.5±0.2 and temperature of 18±2 °C, the COD removal efficiency was around 90% for 2450 mg/L inlet COD fed to the membrane bioreactor and Red and Blue colour removal efficiencies were 25-70% and 20-50% respectively. In order to develop novel MBR process, a novel MBR module has already been applied replacing the commercial one and the preliminary results are reported.

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1. Introduction

Wastewater reclamation and reuse are effective tools for sustainable industrial development programs. Increasingly stringent environmental legislation and generally enhanced intensity, efficiency and diversity of treatment technologies have made the reuse of water more viable in many industrial processes. Membrane Bioreactors (MBRs) technology will be an essential part of advancing such water sustainability because they encourage water reuse and open up opportunities for decentralized treatment.The textile industry is long regarded as a water intensive sector, due to its high demand of water for all parts of its procedures. Textile wastewater includes quite a large variety of contents, chemicals, additives, different kinds of dyestuffs and so on. For each ton of fabric products, 20-350 m^3water are consumed, which differs from the colour and procedure used [2].

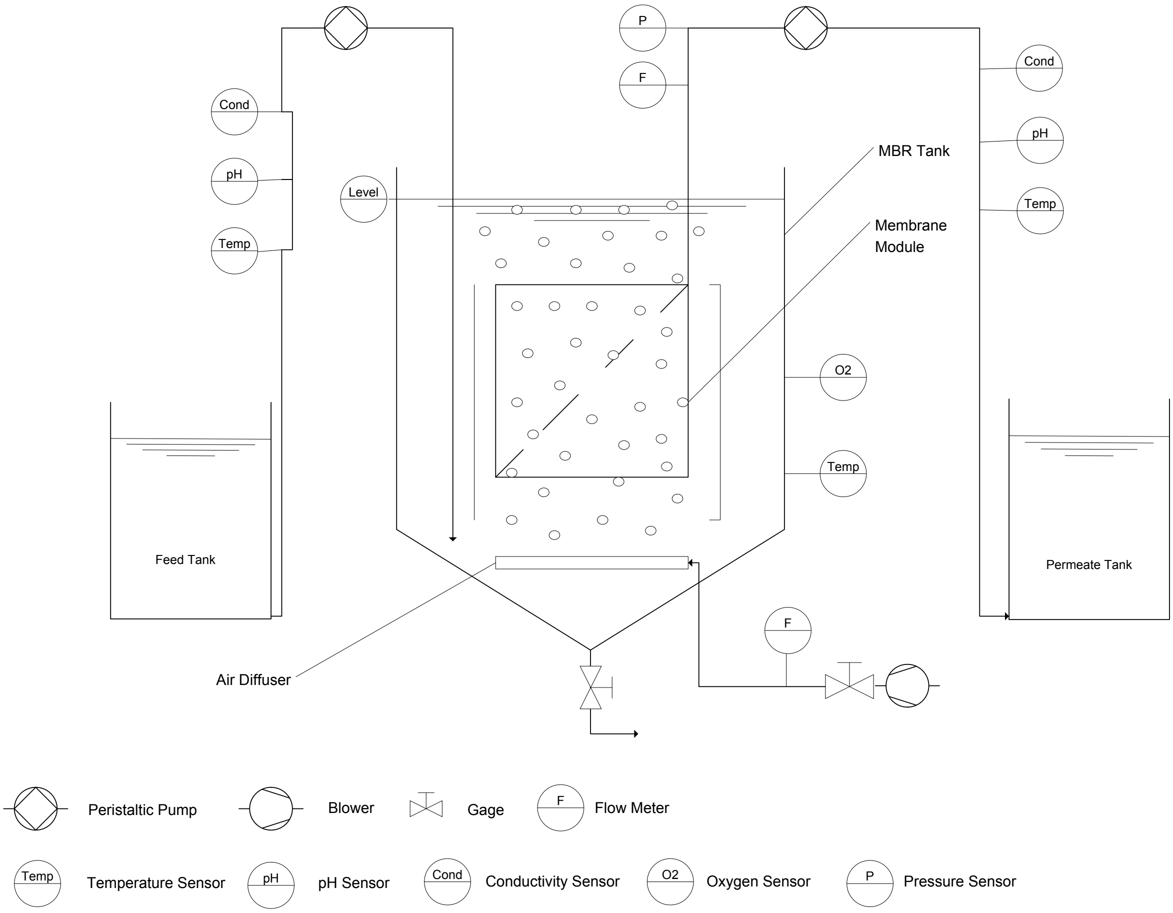

Fig. 1. Schematic diagram of MBR set up

The aim of this work is to develop novel MBR process using novel membranes to treat textile wastewater removing highly biodegradable organics and colouring matters and dyestuffs, which are low in biodegradability.

2. Materials and Methods

2.1. Experimental set up of pilot scale MBR plant

An MBR pilot plant with a flat sheet membrane module (Membrane:UF, membrane material: PES, pore size: 0.050µm, dimensions: 25cm×25cm,) from company Microdyn-Nadir, Germany, submerged in the reactor was used in this experiment. For novel MBR module, a novel coating on commercial PES membrane was prepared. The active volume of the reactor was 57L. Fig. 1 shows a schematic diagram of the MBR pilot plant.

The module consists of 3 flat sheets membrane each of these having 0.11 m^2 of area giving total area of 0.33 m^2. The membrane module was equipped with mechanical aerator at the bottom of the module cassette and permeate suction channel in the middle of the cassette. Air was supplied by a compressor.Water level and foam were controlled by level and foam sensors respectively andtransmembrane pressure (TMP) was recorded by pressure sensor. Feed was supplied by a feed pump.Some other sensors were installed to measure pH, conductivity, temperature of feed and permeate. All the process parameters were monitored and data were stored by LabVIEW program controlled computer system.

2.2. Wastewater compositions

Since the quality of textile wastewater changes due to employed colouring matters, dyestuffs, accompanying chemicals and processes from season to season and time to time, the model textile dye wastewater (MTDW) wasdeveloped based on literature studies to design a typical wastewater quality [2-4]. The composition and the characteristics of model textile dye wastewater (MTDW) are shown in Table 1 and 2.

Table 1. Compositions of model textile dye wastewater (MTDW)

Dyestuff & chemicals	Concentration (mg/L)	References
Remazol Brilliant Blue R	50	
Acid Red 4	50	
NaCl	2500	[2]
$NaHCO_3/Na_2CO_3$	1000	[3]
Glucose	2000	[3]
Albatex DBC (Detergent)	50	[4]

2.3. Analytical methods

COD and Nitrogen were determined applying ready-made cuvette tests (Merck KGaA, Germany) [5, 6]. Red and Blue colours were measured by determining the spectral absorbance at wavelengths 505 nm and 595 nm respectively using UV/VIS spectrometer (Shimadzu, Japan) [7]. BOD_5 was measured following the method provided by WTW (Oxitop®IS6) [8]. MLSS were analyzed according to German Standard methods.

3. Experiments

The experiments were carried out using the MTDW under the operating conditions at permeate flux of 4 L/m^2h, around 50 mbar of TMP, 12 g/L of MLSS, 40-80 h of HRT, 1.0 m^3/h of air supply to MBR reactor, pH of 8.2±0.2- 10.5±0.2 and temperature of 18±2 °C. The experiments were divided into several phases (like acclimation, neutral pH, high pH, high pH+ low nutrients, high pH+ high nutrients, low pH+high nutrients etc.) and continued for more than 300 days.

Table2. Characteristics of model textile dye wastewater (MTDW)

Parameters	Unit	Values
pH		8.2±0.2-10.5 ±0.2
Temperature	°C	18±2
COD	mg/L	2450
BOD_5	mg/L	200
Chloride	mg/L	1756
Total Nitrogen	mg/L	5.9/57
Conductivity	mS/cm	6.6

4. Results and Discussion

A variety of results under different operating conditions have been obtained. Due to space limitations, only the main results are presented in this section.

4.1. COD removal efficiency

COD is one of the main parameters to define the performance of a MBR system in terms of biodegradability. Theexperiment was running in seven different operational phases as mentioned below and areshown in Fig. 2.

Phase1 : acclimation with neutral pH7.2±0.2
Phase2 : Continuationwith pH 8.2±0.2
Phase3 : Continuationwith pH 10.5±0.2
Phase4 : Continuation with pH 10.5±0.2 and high N contents
Phase5 : Continuation with new MBR module with pH 10.5±0.2 and high N contents
Phase6 : Continuation with new MBR module with pH 7±0.2 and high N contents
Phase7 : Continuation with novel MBR module with pH 7±0.2 and high N contents

As shown in Fig. 2the COD removal efficiency was around 90% except some fluctuations in phase1 (acclimation), phase3 and phase5. The COD removal efficiency with the novel MBR module in phase7 was around 93% and it is expected to be higher in the next phase.

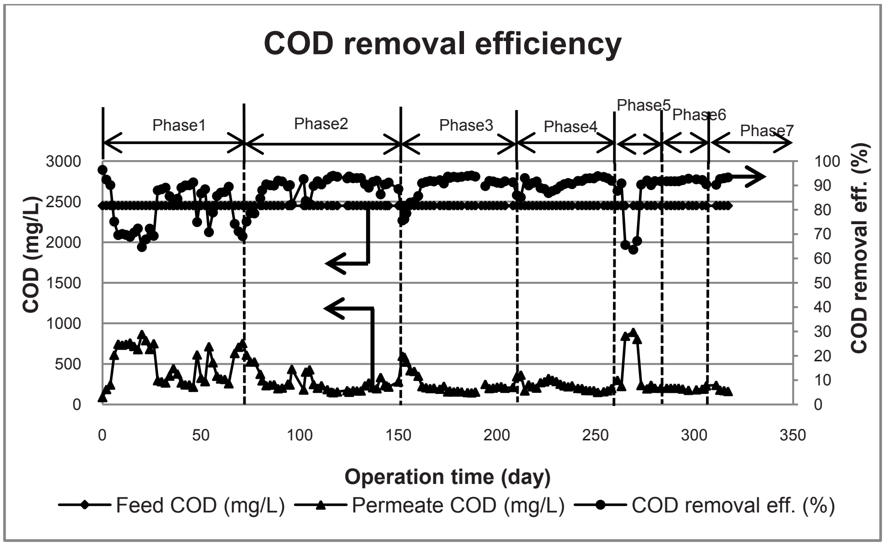

Fig. 2. COD removal efficiency

4.2. Colour removal efficiency

The colour removal efficiency from textile wastewater is one of the most critical aspects. As indicated in Fig. 3 the Blue colourremoval efficiency at the beginning of the phase1 was higher (60%) than during stable condition (20-50%). This might be due to adsorption of the Blue colour on membrane surface. In phase3, both Red and Blue removal efficiencies reduced due high pH conditions which was stressful for microorganisms. In the rest of the phases, Red and Blue removal efficiencies were 25-70% and 20-50%respectively.The Red and Blue removal efficiencies with novel MBR module were around 60%.

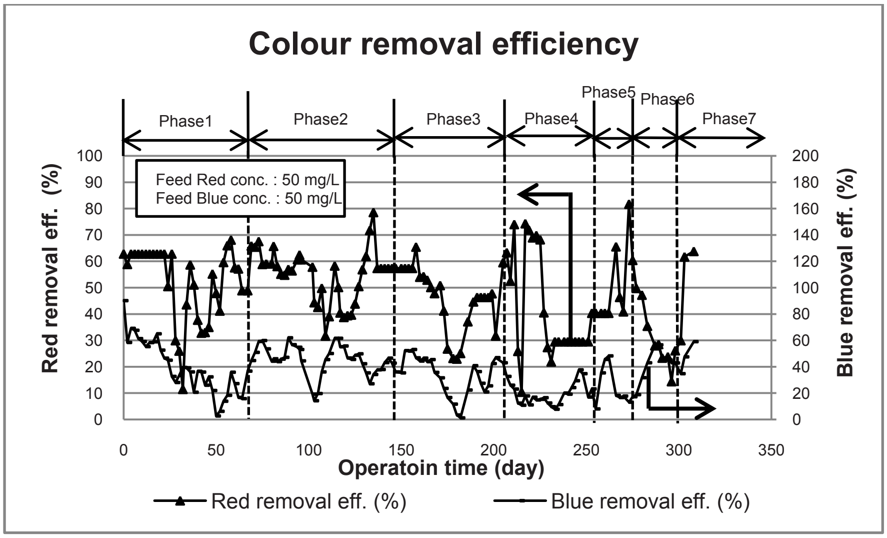

Fig. 3. Colour removal efficiency

5. Conclusion and Future Works

The experiment has been carried out for more than 300 days in different phases and conditions using commercial MBR modules. The experiment with novel MBR module has been started two weeks back under the same operating conditions. The preliminary results carried out using novel MBR module shows bit higher COD and colour removal efficiencies. In the next phase, the experiment with novel MBR module will be continued and the results will be compared with the commercial one.

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References

[1] www.bionexgen.eu, accessed on November2, 2012.

[2] Alaton IA, Isil, Balcioglu IA, Bahnemann DW, Advanced oxidation of a reactive dyebath effluent: Comparison of O3, H2O2/UV- A process, water research 36 (2002) 1143-1154.

[3] MustafaIsik, Delia Teresa Sponza, Anaerobic/ aerobic treatment of a simulated textile wastewater, separation and purification technology 60 (2008) 64-72.

[4] Bahadır K. Körbahti, Abdurrahman Tanyolac, Continuous electrochemical treatment of simulated industrial textile wastewater from industrial components in a tubular reactor, J. Hazard. Mater 170 (2009) 771–778.

[5] www.merck.de, 114541 COD cell test, accessed on 02.11.2012

[6] www.merck.de, 1.00613.0001 Nitrogen cell test, accessed on 02.11.2012

[7] L. Jahan, Process of determining individual dye concentration from mixed solution of two different dyes, project B, Sensor Systems Technology, Karlsruhe University of Applied Sciences, October 20, 2012

[8] http://www.wtw.com/downloads/manuals/ba31107de03_Oxitop_IS6_IS12.pdf, accessed on 02.11.2012