Effect of PAC on membrane fouling in aerobic membrane bioreactor treating hospital wastewater

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Summary:

In this study, membrane fouling was investigated in aerobic membrane bioreactor (MBR) systems with and without powdered activated carbon (PAC) addition treating hospital wastewater. The addition of PAC did not provide an improvement in the flux. At the end of 42 days operation, the flux values obtained for both systems were almost same. However, the fouling of membrane surface was found lower in the reactor with PAC addition according to the results of optical profilometer and confocal laser scanning microscope.
Keywords: hospital wastewater; membrane bioreactor; membrane fouling

Introduction

Recent studies revealed that hospital wastewater presents considerable environmental risk, cytotoxic–genotoxic effects, and multi-antibiotic resistance due to emerging contaminants including pharmaceuticals, radionuclides, solvents and disinfectants (Verlicchi et al., 2012; Yilmaz et al., 2017). Since conventional municipal wastewater treatment plants are not able to treat these compounds completely, alternatives like MBRs have been investigated (Kovalova et al., 2012). However; besides the insufficient removal of some pharmaceuticals, low fluxes and membrane fouling problems have directed the researchers to improve the MBR's operation by adding activated carbons (Nguyen et al., 2014; Kaya et al., 2016). The objective of this study is to investigate membrane fouling in MBR systems with and without PAC addition.

Material and Methods

Experimental set-up and operating conditions

The experiments were conducted in two 6 L aerobic MBR systems (with (R1) and without (R2) PAC addition) using a flat sheet microfiltration membrane (FM MP005, Microdyn Nadir-Germany) with a total surface area of 84 cm^2 and nominal pore size of 0.05 μm. MBR systems were filled with 4 L of hospital wastewater and a constant pressure of 400-450 mbar was applied. The inoculum sludge was taken from a municipal wastewater treatment plant. Both systems were operated during 42 days under the sludge retention time (SRT) of 10 days.

Wastewater and PAC

Wastewater samples used in this study were taken from a medical faculty hospital located in Istanbul, Turkey. The hospital has an average daily water consumption of 1500 m^3/day. Hospital wastewater containes a total COD of 490 mg/L, 49 mg TKN /L and 2 mg PO_4^{-3}-P/L. A commercial activated carbon (WAC i600 M200-Eurocarb Products, UK) was used in the operation of R1 system. 3 g/L of PAC addition was applied to R1 at the beginning of the study, and then 1.2 g of PAC was daily added since 400 mL of sludge was withdrawn from the reactor at SRT of 10 days.

Methods

The permeate flux (J) was measured every minute by an electronic balance and recorded by a computer. Membrane autopsy studies were performed to evaluate membrane fouling. The surface morphologies of clean and fouled membranes were characterized using optical profilometer (Zygo Brand Optical profilometer, USA). A confocal laser scanning microscope (Nikon C2, Japon) was used to examine biofilm layer on fouled membrane.

Results and Conclusions

Figure 1 shows the variations of the permeate flux with time in R1 and R2. The flux showed a gradual decrease within 22 days (from 16 L/m^2.h to 5.2 L/m^2.h) and reached to 7±1 L/m^2.h at the end of 42 days for R1. The flux was unstable during 10 days in R2 and almost a steady-state was obtained after 10 days (5.2 L/m^2.h).

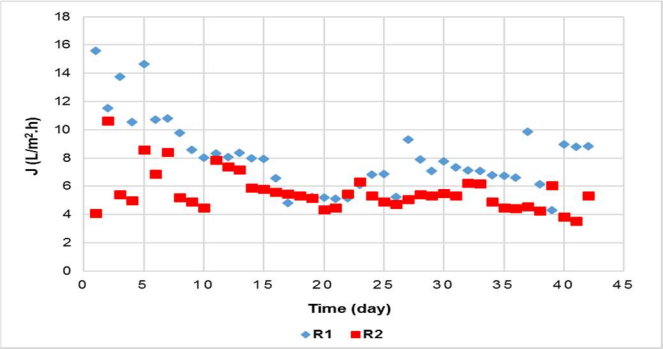
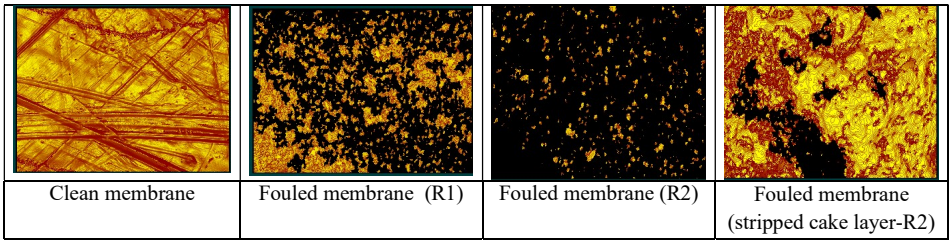


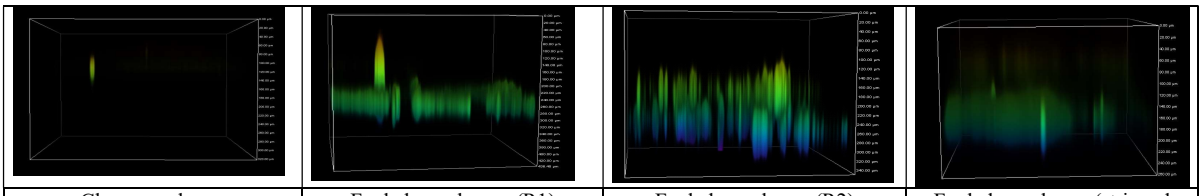
Figure 1. The permeate flux versus in the R1 and R2

The roughness values (RMS) of the membranes were determined with optic profilometer (Figure 2). The RMS values were found as 0.369, 4.463 and 4.049 µm for clean and fouled membranes (R1 and R2), respectively. The RMS value of fouled membrane used in R2 (after stripping of the cake layer) was obtained as 0.559 µm.



Clean membrane	Fouled membrane (R1)	Fouled membrane (R2)	Fouled membrane (stripped cake layer-R2)

Figure 2. Images of optical profilometer in clean and fouled membranes



Clean membrane	Fouled membrane (R1)	Fouled membrane (R2)	Fouled membrane (stripped cake layer-R2)

Figure 3. Images of biofilm in clean and fouled membranes

As shown in Figure 3, biofilm layer was not observed in the clean membrane. The biofilm layer thickness of fouled membranes in R1 and R2 reached to 240 and 200 µm, respectively. The biofilm thickness on fouled membrane (R2) decreased to 100 µm after stripping of the cake layer.

Acknowledgements

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