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Investigation of acetone as co-solvent on performance PES nanofiltration membrane

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ABSTRACT

Polyethersulfone (PES)-based on mixed matrix nanofiltration membrane was developed by amalgamation with partially reduced acetone nanocomposite. The effect of acetone fillings on the morphology and performance of the prepared membranes was examined by scanning electron microscopy (SEM) and water contact angle analysis. The blended membranes showed improved water permeability and fouling resistance likened to the simple PES. When the content of acetone was 100 wt.%, the water flux touched a maximum value (10.5 kg/m2 h) nearly twice of that of the simple PES membrane (3.5 kg/m2 h). Fouling confrontation of the membranes studied by stupid serum albumin solution filtration presented that 10 wt.% acetone membrane had the best antifouling property. Nanofiltration performance of the prepared membranes was assessed by rejection of three organic dyes with different molecular masses

***Keywords**:* Nanofiltration, acetone, Antifouling, Dye separation, Mixed membrane

1. Introduction

In the recent periods, nanofiltration (NF) technology has involved growing attention in the fields of water unstiffening and filtration of micro molecules due to its compensations such as low energy consumption, dense design, absence of phase change, and ease of operation [1]. Besides the stated advantages, a main limitation of NF membranes used in the separation procedures is flux weakening due to membrane fouling, which is caused by unwanted adsorption and sedimentation of foul ants onto the membrane surface or into pores [2,3]. The main swaying factors in the fouling of a membrane are its surface properties like unevenness and hydrophobicity and also, feed solution chemistry and process conditions. It is believed that an increase in the membrane hydrophilicity can recover its fouling resistance because many foul ants are naturally hydrophobic [4,5]. Several modification methods have been quantified to improve the hydrophilicity of polymeric membranes.

2. Experimental

Manufacturing grade powder was produced from Qingdao Ruisheng Co., Ltd., China (327/6 mesh, 95/5% purity). Those were full by Merck Co., Germany. Analytical score dimethyl acetamide (DMAC) and Polyethersulfone (PES ultrason E6020P with MW=58,000 g/mol) were bought from BASF Company (Germany). Polyvinyl pyrrolidone (PVP, MW = 29,000 g/mol), were got from Sigma-Aldrich Co., Germany. Three carbon-based dyes, C. I. Reactive Green 19, C. I. Direct Yellow 12 and C. I. Sensitive Blue 21, were bought from Shimi Boyakhsaz Co., Iran.

3. Results and discussion

The SEM images of acetone, PES and acetone/PES examples are obtainable in Fig. 1. As can be seen in the SEM image of acetone, it has a crumpled area and worm-like construction that shows the successful exfoliation of graphite coatings. In the SEM image of hydrothermally manufactured acetone sample, the combination of co-solvent and a nonidentical particle size distribution are clear. But, as is clear in the SEM image of acetone/PES co-solvent, the acetone is consistently dispersed on the crumpled surface of PES sheets with a suitable density.

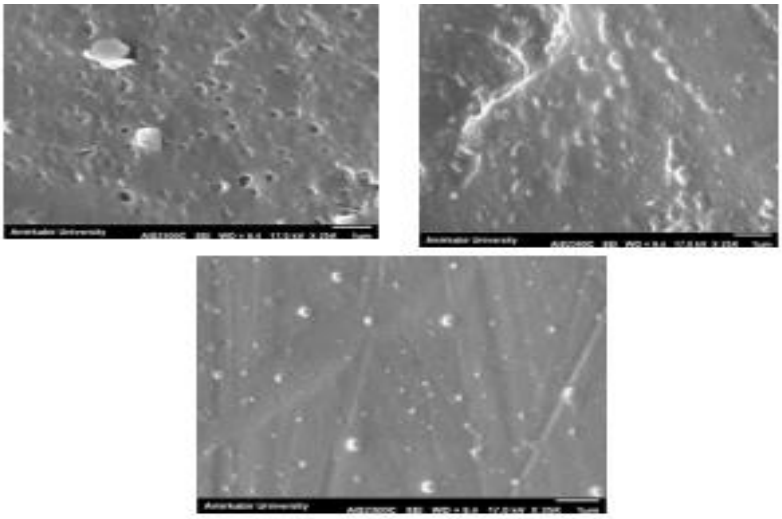

Fig. 1: Surface SEM images of the fabricated membranes.

Table1. Regularity parameters of blended matrix PES membranes resulted from four chosen components.

Acetone (weight %)	DMAc (weight %) num.	PVP (weight %)	PES (weight %)
0	100	1	18
10	90	1	18
20	80	1	18
30	70	1	18
40	60	1	18

Fig. 2 shows the top surface photographs of the ready simple and mixed PES membranes that demonstrates that the top surface of the membranes modified with acetone was darker than the original PES membrane due to the color of this preservative. Also, the nano composite acetone/PVP/PES membranes had a darker surface due to the attendance of acetone with higher molar relation (DMAC/acetone: 70/30) and the gloom of the membranes was increased by increasing the deliberations of acetone/ PES nanocomposite in the molding solutions. As can be seen from Fig. 2, the rejection value of RB21 is only 70.5% using original PES membrane and 74.4, 80.1 and 85.6% for 10 wt.% acetone/ PES, 10 wt.%

acetone/PES and 10 wt.% acetone/PES membranes, respectively. Instead, the rejection performance of the mixed matrix membranes was augmented by increasing the amount of acetone/PES nanocomposite in the membrane matrix up to 20 wt.%.

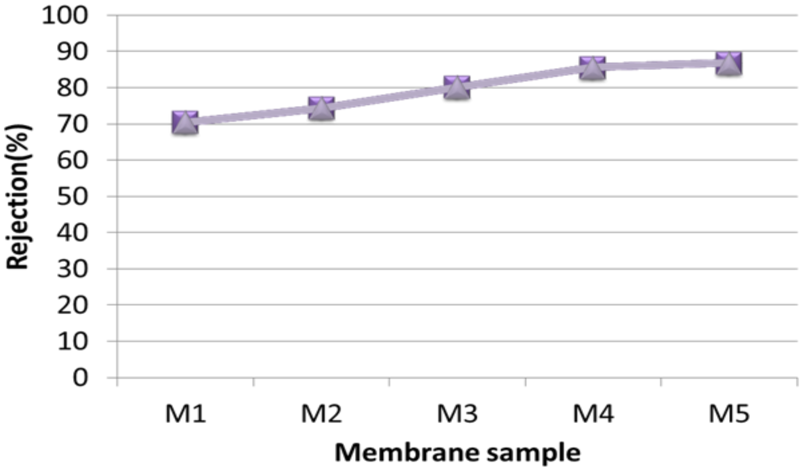

Fig. 2: Dye rejection presentation of the ready nanofiltration membranes (pH= 7.0 ± 0.1).

The filtration recital of the prepared membranes was studied using a dead-end system with an operative membrane area of 19.587 cm2. The compaction of the membranes was complete at 0.6 MPa for 29 min before filtration tests to get constant water flux. All of the experiments were did at an operation pressure of 0.5 MPa and ambient temperature [6]. The rejection tests were showed with an aqueous solution of organic tints (100 mg/L). The UV-Vis spectrophotometric method was used to compute the deduction efficiency of the dyes by a Shimadzu UV-2450, Japan device. The water flux, Jw,1 (kg/m2 h) and rejection, R, were calculated using Eqs. (1) and (2), consistently:

$$J_{w,1}=M/At \qquad (1)$$

$$R\%=(1-C/C_0)\times 100 \qquad (2)$$

where M, A and t represent the weight of the composed permeate (kg), the membrane effective area (m^2) and the infusion time (h), respectively. R is the peroxide rejection (%), C_0 and C are the concentration of dye in the feed and permeate solution (mg/L), correspondingly. The antifouling property and flux recovery ratio (FRR) of the acetone/PVP/PES membranes were assessed using the following development: after water flux tests, a solution as a good fouling agent (500 mg/L) was directly substituted in the stirred cell and the flux of solution, J_p (kg/m2 h), was chronicled based on the weight of permeated water at 0.5 MPa for 90 min. After percolation of solution, the contaminated membranes were left in purified water for 20 min. Lastly, the pure water flux was restrained again using washed membranes, $J_{w,2}$ (kg/m2 h). The FRR, as a parameter for compare the antifouling property of the membranes, was calculated using Eq. (3) based on the gotten results:

$$\text{FRR }\%=(\mathrm{J}_{w,2}\, J_{w,1}) \times 100 \qquad (3)$$

Also, to study the fouling procedure in detail, fouling resistance parameters were measured to investigate the fouling resistant ability of the fortified membrane [7].

4. Conclusions

In this study polyethersulfone based on mixed matrix nanofiltration membrane was advanced by amalgamation with partially reduced acetone nanocomposite. The effect of acetone fillings on the morphology and performance of the organized membranes was studied. The blended membranes showed improved water permeability and fouling resistance likened to the simple PES. Fouling confrontation of the membranes considered by stupid serum albumin solution filtration. Nanofiltration performance of the prepared membranes was evaluated by rejection of three organic dyes with different molecular masses.

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