Petroleum Research

Petroleum Research 2019 (June-July), Vol. 29, No. 105, 13-16

DOI: 10.22078/pr.2018.3295.2518

Surface Modification of PES Nanofiltration Membrane by Chitosan-GO Nano-plates Coating for Reduction of Fouling and Performance Enhancement

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DOI: 10.22078/pr.2018.3295.2518

Received: May/12/2018 Accepted: October/14/2018

INTRODUCTION

Nowadays, there is need to find new methods with lower cost, less energy and minimizing the use of chemicals to purify water and improve the efficiency of water purification technologies [1-3]. The membrane process is an attractive industrial technology. Among this, NF membrane with low operating pressure, high permeate flux, high rejection of multivalent salts and organic solutes gained much attentions. In addition, literatures reported efforts aiming membranes modification/improvement of structure and performance. Usually, the organic/inorganic composite membranes showed better performance. In this study, In the current study, PES nanofiltration membranes modified by the composite chitosan/GO nanosheets through coating process and the performance and antifouling properties of membrane was investigated.

EXPERIMENTAL PROCEDURE

The PES NF membranes were modified by chitosan-GO through coating method. The NF membranes were fabricated by phase inversion method through immersion precipitation technique [4-6]. For the purpose, 18 wt.% PES and 1 wt.% PVP dissolved in DMAC. Gained homogeneous solutions were then sonicated to ensure removing air bubbles. Fabrication was followed by casting solutions onto clean and smooth glass plates with the constant film thickness of 150 µm by a homemade applicator. Dipping polymeric films immediately after casing into the deionized water as coagulation bath was as the next step. Then 0.6 g chitosan dissolved in 20 ml aqueous solution containing 1 %v acetic acid along with dispersion different amount of GO. The solution was then sonicated and stirred. After adding 2 ml GA, the PES membranes dipped in modifier solution and heated at 60 °C for 2 h. Finally, they washed with DI and kept in it for at least one day. Scanning electron microscopy (SEM), pure water flux, permeability flux, salt rejection, water content, porosity, pore size, water contact angle and flux recover ratio were applied to study the prepared membranes performance and properties. Fourier transform infrared spectroscopy (FTIR) was used to characterize the membrane.

RESULTS AND DISCUSSION

The FTIR spectra of modified membrane (Fig. 1) showed a new absorption peaks at 1060 cm^{-1} and 1645 cm^{-1} which attributed to the stretching vibration of C-O-C of GO and COOH of chitosan.

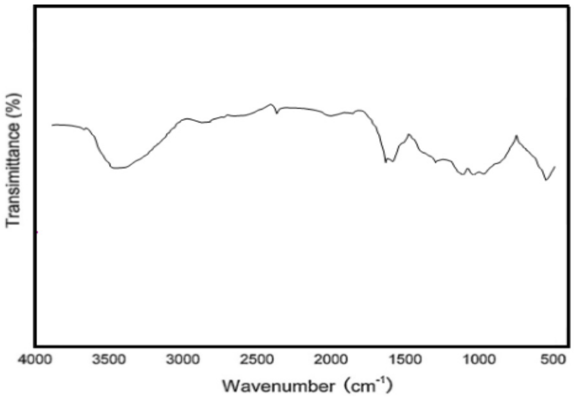

Figure 1: FTIR spectra of modified membrane.

SEM image of modified membrane is shown in Fig. 2. The image confirms the formation of GO-chitosan layer on membrane surface decisively. The results of water contact angle analysis exhibited that contact angle of membrane was decreased from 65° to 47° by adding GO into the modifier solution leading to the higher surface hydrophilicity.

The results of membranes performance were shown in Fig. 3. The results revealed that flux was declined by this surface modification. Decrease of flux can be attributed to decline in pore size and membrane porosity as shown in Fig. 4.

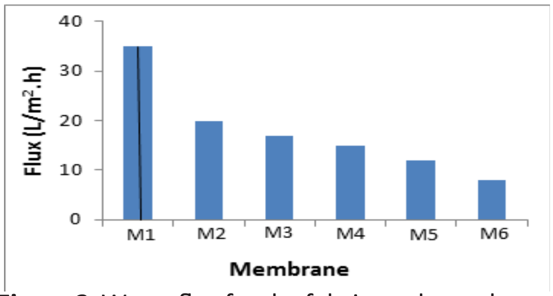

Figure 3: Water flux for the fabricated membranes.

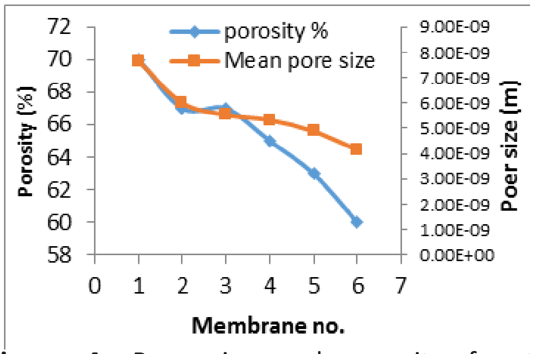

Figure 4: Pore size and porosity for the membranes.

The membrane rejection was improved from ~68 % to ~94% by adding GO in the modifier solution (Fig. 5). This is due to smaller pore size for the modified membranes along with the negative charge of modifier layer and its adsorption ability in salt removal. In this condition, the number of ions and salt molecules traffic through the membrane will reduce which lead to the enhancement of rejection. Furthermore, it is widely accepted the aggregation of foulants molecules on to the hydrophilic surface is lower than hydrophobic ones and improves rejection [6]. The antifouling ability and the values for FRR of virgin membrane and the superior ones are given in Figs. 6 and 7.

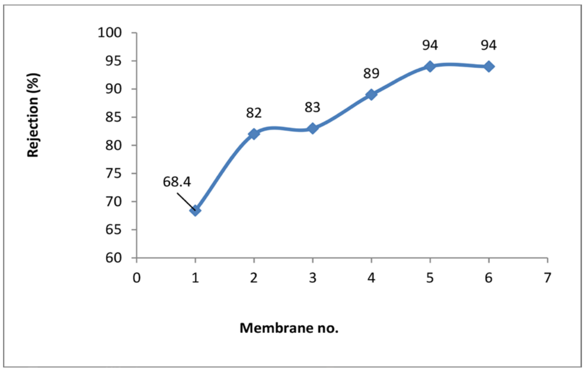

Fig. 5: Salt rejection for prepared membranes.

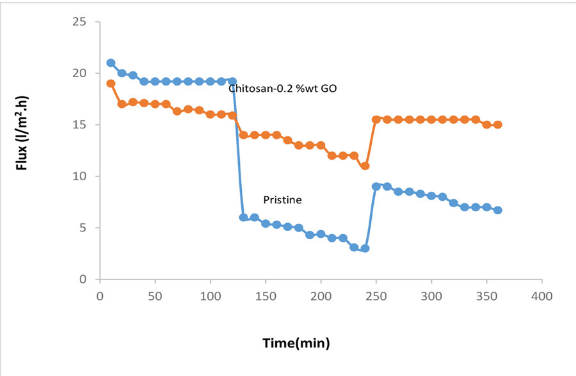

Figure 6: Antifouling ability for the virgin membrane and superior ones.

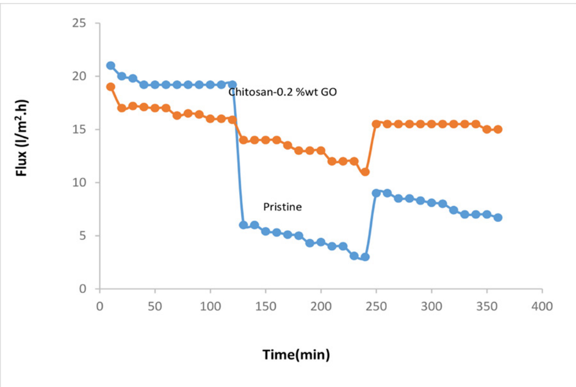

Figure 7: FRR for pristine membrane and superior ones with CS_2 wt.% GO.

As can be seen, decreased flux ratio of modified membrane greatly is smaller than that of pristine PES membrane. This phenomenon indicates that a higher antifouling property can be expected for the prepared composite membranes. Thus, surface modification of PES nanofiltration membrane enhanced antifouling performance with improvement of membrane hydrophilicity [5,6].

CONCLUSIONS

PES based nanofiltration membranes modified by chitosan/GO nanosheets coating layer to improve its separation performance and antifouling property. The results revealed that salt rejection strongly improved and their hydrophilicity enhanced rather than PES. The flux was decreased by this modification. Moreover, contact angle was decreased because of chitosan and GO nanosheets hydrophilic nature. The increase of flux recovery ratio and reduction of total fouling ratio indicated successfully enhancement of antifouling properties of membrane by coating of chitosan/GO nanosheets.

ACKNOWLEDGMENT

Authors gratefully acknowledge Arak University for financial support during this study.

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