Zinc Oxide Nanoparticles Blended Polymeric Membranes

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Abstract

Membranes are widely used in food, petrochemical, and energy industries and water/wastewater treatment due to their high removal efficiency and low cost. The high surface-to-volume ratio and low cost of zinc oxide nanoparticles (nZnO) make them an excellent alternative to titanium oxide nanoparticles. In this work, nZnO-doped polyether sulfone (PES) membranes were prepared using the phase inversion method. Synthesized membranes were characterized using Scanning Electron Microscopy, Fourier Transform Infrared Spectroscopy, and contact angle goniometer. Then the filtration performance of nZnO blended PES membranes was investigated. The results show that blending nZnO increased the filtration performance of the PES membranes.

Keywords: Polyether sulfone; Polymeric Membranes; Ultrafiltration; Zinc Oxide Nanoparticles.

1. Introduction

Membranes are widely used in water/wastewater treatment, seawater desalination, food and beverage industry, etc. (Koyuncu, 2018). Due to the hydrophobicity of the polymeric membranes, macromolecules easily adhere to the membrane surface and accumulate, which is called fouling (Celik et al., 2011a). Although membrane filtration is one of the most preferred processes in water and wastewater treatment, fouling limits the use of membranes. One of the methods to reduce fouling is increasing membrane hydrophilicity. There are three different methods to increase the hydrophilicity of membranes, which are (1) mixing the polymer with hydrophilic additives, (2) grafting the polymer with functional groups, (3) coating the membrane with a hydrophilic substance (Celik Madenli et al., 2017).

Zinc oxide (ZnO) is a non-toxic, low water-soluble semiconductor with a wide range of application areas. It is a promising material for various applications with its resistance to radiation, the melting point of 1975 °C, biocompatibility, compatibility with the skin (Alıvı, 2021). The high surface-to-volume ratio and low cost of zinc oxide nanoparticles (nZnO) make them an excellent alternative to titanium oxide nanoparticles. In this work, nZnO doped polyether sulfone (PES) membranes were prepared using the phase inversion method as described in our previous publications (Celik Madenli and İşgüder, 2022; Celik Madenli et al., 2021; Celik et al., 2011a; Celik et al., 2011b; Celik and Choi, 2011). Synthesized membranes were characterized using Scanning Electron Microscopy, Fourier Transform Infrared Spectroscopy, and contact angle. In addition, filtration tests were conducted for all synthesized membranes.

2. Material and Methods

nZnO blended PES membranes were synthesized by phase inversion method using nZnO as an additive and NMP as a solvent. The resulting membrane solution was subjected to ultrasonication to remove air bubbles. Afterward membrane solution was cast onto a glass plate using a casting knife and an automatic film applicator and immediately dipped in distilled water. A thin polymeric film separated from the glass within a few minutes. The prepared membranes were washed with distilled water and kept in distilled water until use. Synthesized membranes were characterized using Scanning Electron Microscopy, Fourier Transform Infrared Spectroscopy, and contact angle. In addition, filtration tests were conducted for all synthesized membranes.

3. Results and Discussion

The successful preparation of nZnO blended PES membranes was confirmed using Scanning Electron Microscopy and Fourier Transform Infrared Spectroscopy. Membrane filtration tests were performed to determine the performances of the synthesized membranes. Blending nZnO not only increased the hydrophilicity of the membranes, but also increased selectivity without reducing the flux of the membranes.

4. Conclusions

nZnO blended polymeric membranes were prepared by the phase inversion method. One of the main drawbacks of polymeric membranes is to increase the membrane flux without reducing selectivity. Blending nZnO in the polymeric membranes showed higher selectivity with similar flux compared to the bare membranes. This study provides a basic understanding of the effects of blending nZnO in the membrane structure.

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