**Synergistic effect of concurrent presence of core-shell zirconium oxide and iron oxide ~~in the form of core-shell~~ nanoparticles on the performance of $Fe_3O_4$@$ZrO_2$ /PAN nanocomposite membrane**

https://www.sciencedirect.com/science/article/pii/S0272884217320734?via%3Dihub

## Abstract

In this research, to benefit from the hydrophilic properties of zirconia nanoparticles as well as ~~the role of~~ iron oxide nanoparticles in improving porosity of polymer membranes simultaneously, $Fe_3O_4$@$ZrO_2$/PAN nanocomposite membrane was synthesized and its performance was examined in reducing biological fouling of the membrane ~~was examined~~. FESEM analysis confirmed a size distribution of 35-55 nm, and TEM analysis confirmed a core-shell structure for $Fe_3O_4$@$ZrO_2$ nanoparticles. FTIR analysis identified the functional groups in the $Fe_3O_4$@$ZrO_2$ nanoparticles and confirmed their presence in the matrix of 1 $Fe_3O_4$@$ZrO_2$/PAN NCM membrane. Contact angle analysis confirmed the role of zirconia nanoparticles in enhancing the membrane hydrophilicity by 51%, and porosimetry analysis confirmed the role of iron oxide nanoparticles in improving porosity of nanocomposite membranes by 47%. Usage of 1 wt% of $Fe_3O_4$@$ZrO_2$ nanoparticles in the PAN membrane matrix brought about 40% increase in water flux and 37% growth in dye rejection for 1$Fe_3O_4$@$ZrO_2$/PAN NCM membrane. Investigation of the role of $Fe_3O_4$@$ZrO_2$ nanoparticles in the ~~-~~filtration of biological macromolecules indicated that 1 $Fe_3O_4$@$ZrO_2$/PAN NCM membrane has 60, 51, and 56% less resistance to filtration of humic acid, sodium alginate, and BSA, respectively, when compared with raw membranes.

**Key Words:** $Fe_3O_4$@$ZrO_2$ Nanoparticle; Nanocomposite Membrane; Porosity; Hydrophilicity; Biofouling

## 1. Introduction

Biological macromolecules are among the most important indicators and factors ~~developing~~ that develop membrane fouling in biological ~~medium~~ media such as active sludge [1]. Humic acid, sodium alginate, and sodium bovine albumin (BSA) as representatives of natural organic matters (NOMs), polysaccharide materials, and protein materials, respectively are the most important biological macromolecules developing biological fouling for polymer membranes [2]. In recent years, extensive research has been conducted on filtration resistance of polymeric membranes during filtration of natural macromolecules [3]. With the aim of decreasing biological fouling, various changes have been performed on the composition [4], structure [5], and surface and morphological properties [6, 7] of polymer membranes. Blending polymer membranes with anti-bacterial polymer [8], superficial modification of membranes through plasma irradiation [9], and deposition of thin anti-bacterial films on the membrane surface [10] are among the most important solutions for decreasing biological fouling. In recent years, use of nanomaterial for reducing biological fouling of membranes has been the objective of many studies [11, 12]. Various nanoparticles including $TiO_2$, Ag, $Al_2O_3$, ZnO, $Fe_3O_4$, and $ZrO_2$, etc. have been applied