Application of UV irradiation enhanced by CuS photosensitive nanoparticles to mitigate polysulfone membrane fouling

https://www.sciencedirect.com/science/article/abs/pii/S1010603019313930

Abstract

In this research, enhanced ultraviolet (UV) irradiation was used to offer antifouling properties to the surface of polysulfone (PSf) membranes. For this purpose, a thin layer of polyacrylic acid (PAA) was grafted to the membrane surface through UV irradiation in order to synthesize PAA/PSf membrane. Aiming to enhance the performance of UV irradiation, copper sulfide (CuS) and acrylic acid coated copper sulfide (AA©CuS) nanoparticles were embedded in the acrylic acid thin layer ~~and~~ where CuS/PAA/PSf and AA©CuS/PAA/PSf membranes were fabricated. Presence of CuS and AA©CuS enhanced the wavelength of excitability of ~~polusylfone~~polysulfone from 254 to 322 and 354 nm, respectively. ~~Therefore~~Thus, UV irradiation for 165 min on the surface of PSf membrane caused ~~to enhance the~~heightened degree of grafting from 16% for PAA/PSf to 19 and 46% for CuS/PAA/PSf and AA©CuS/PAA/PSf membranes, respectively. UV Irradiation for 240 min in the presence of nanoparticles also caused the CuS/PAA/PSf and AA©CuS/PAA/PSf membranes to be 28 and 42% more hydrophilic and 26 and 37% less rough respectively compared to PAA/PSf membrane. The mentioned factors eventually contributed to 40%, 23%, and 20% irreversible fouling for PAA/PSf, CuS/PAA/PSf, and AA©CuS/PAA/PSf membranes, respectively.

Key Words: UV Irradiation; Photosensitive nanoparticles; CuS; AA©CuS; Fouling;

1. Introduction

Usage of irradiation mostly gamma and UV has recently attracted a great deal of attention for improving the characteristics of polymer membranes. Improving the catalytic activity [1, 2], enhancing ion exchange capacity [3-5], enhancing ionic conductivity [6], and targeted drug delivery by smart membranes [7] are among the most important modifications performed on polymer membranes through irradiation. Meanwhile, the modification operations by irradiation in most cases have been ~~performed~~ done to enhance the extent of separation [8, 9], enhance permeability [9, 10], and reduce fouling [11, 12]. The irradiation used for performing the mentioned modifications is mostly UV, gamma, and in some cases both. Further, it has been shown that the membranes modified with UV in comparison with gamma irradiation needed shorter polymerization time to achieve a high grafting efficiency [4].

In different studies, in order to strengthen the operations of UV on the membrane surface, various modifiers have been used including cross-linkers [1, 13], different co-monomers [14, 15], and photo initiators [16, 17]. Photo initiators complicate monomer recovery, and they ~~are~~ get only involved in the initiation of the polymerization process [18]. Further, the only modifying effect of co-monomers and cross-linking agents includes changing the polymer microstructure and compressing the deposited polymer layer, while the other superficial properties of the membrane remain unaffected. ~~Therefore~~Thus, it seems that presence of modifiers that remain in the structure of the membrane ~~and can~~which are able to both strengthen the density of the deposited layer and improve the superficial properties of the membrane can be highly valuable. Usage of modifiers