

Public Abstract

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Title:Modification of Thin Film Composite (TFC) Membrane by Incorporation with Copper Nanoparticles (Cu-NPs) for Antibacterial Properties

Membrane biofouling has been a challenging problem restricting the application of reverse osmosis (RO) desalination process. Copper is known for its antimicrobial properties and is easily available with low cost. In this paper, copper nanoparticles (Cu-NPs) with a mean diameter of 15nm were synthesized by the reduction of copper (II) chloride with sodium borohydride (NaBH_4), using cetyl trimethylammonium bromide ($(\text{C}_{16}\text{H}_{33})\text{N}(\text{CH}_3)_3\text{Br}$, CTAB) as a capping agent. After purification of Cu-NPs by dialysis, the particles were successfully immobilized onto the surface of thin film composite (TFC) membranes via either electrostatic interactions or by covalent bonding with cysteamine as a linker. The electrostatic method was simply to immerse the newly made TFC membranes to the Cu-NPs suspension. Since the CTAB had formed cationic bilayer outside the Cu-NPs, the Cu-NPs was not only adsorbed on the membranes but also attached to the surface because of the electrostatic effect with the negatively charged membrane surface. The covalent bonding method utilized cysteamine ($\text{C}_4\text{H}_{12}\text{N}_2\text{S}_2$) to activate the thin film layer with thiol functional groups first and then incorporated the metallic copper nanoparticles to form the stable covalent chemical bonding in between. The resulting membranes by these two methods were labeled as TFC-CuNPs and TFC-S-CuNPs, respectively, in this study. Scanning electron microscopy (SEM) imaging and associated energy-dispersive X-ray spectroscopy (EDS) showed that large amounts of Cu-NPs existed on both types of membranes. Surface hydrophilicity of the membranes was enhanced by the presence of Cu-NPs, as indicated by the measured contact angle of 63.25 ± 0.75 for TFC, 38.63 ± 2.16 for TFC-CuNPs, and 58.00 ± 3.39 for TFC-S-CuNPs. Consistently, the water flux obtained from the RO desalination system was increased from 47.07 ± 0.84 for TFC, 49.10 ± 0.22 for TFC-CuNPs, and 69.13 ± 1.43 for TFC-S-CuNPs, with this increase in hydrophilicity. The salt rejection based on NaCl was slightly decreased for both modified membranes when compared with the original TFC. The TFC membranes with Cu-NPs both exhibited excellent antibacterial properties against *P. aeruginosa* based on the disk incubation test and the SEM observation. Moreover, TFC-S-CuNPs were more stable and with better anti-bacterial properties than TFC-CuNPs.