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Polyethylenimine Modified Silica Nanoparticles Enhance Interfacial Interactions and Desalination Performance of Thin Film Nanocomposite Membranes

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Abstract

Thin film composite (TFC) membranes incorporated with inorganic nanoparticles into the polyamide layer have recently gained great research interests. However, the incompatibility of introduced nanoparticles and their instability in the TFC membranes are the main challenges. It has been questioned that how the hybridized nanoparticles could sustainably enhance the overall desalination performance within the complex filtration mechanisms in terms of water permeability and salt rejection, as well as mechanical strength of the membranes. Herein, hydrophilic polyethylenimine (PEI) modified silica nanoparticles (SN), noted as SN-PEI, are synthesized with the aim to fabricate SN-PEI hybridized thin film nanocomposite (TFN) membranes for desalination. The successful incorporation of SN-PEI into the TFC membranes is confirmed through characterization techniques. The functional SN-PEI showed promising chemical characteristics to enhance interfacial molecular interactions between the SN and polymer matrix which improve the compatibility of SN with the polymer structure and the mechanical properties of the TFN membranes. Higher hydrophilicity of the TFN membranes due to the SN-PEI incorporation is beneficial for enhancing water molecular transfer through the membrane. Our experimental and statistic data revealed that the SN-PEI hybridized TFN membranes demonstrated up to 46 % improvement in water flux, higher salt rejection, and improved mechanical strength compared to the control TFC membranes. Higher hydrophilicity of the TFN membranes due to the SN incorporation is