Loose Nanofiltration Membranes Based on Interfacial 4-Diamino-6-Hydroxypyrimidine for Improving Permeation and Antifouling Performance

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Abstract

Nanofiltration (NF) technology plays a crucial role in water treatment, effectively separating neutral and charged solutes. However, commercial polyamide (PA) NF membranes often face challenges such as flux decrease and diminished separation efficiency due to undesirable surface properties and susceptibility to contaminants. To address these issues, this study introduces 2,4-diamino-6-hydroxypyrimidine (DAHP) during interfacial polymerization, leading to significant enhancements in permeation and antifouling performance. Through comprehensive characterization techniques including Fourier transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM), atomic force microscopy (AFM), static water contact angle measurement, and zeta potential analysis, increased hydrophilicity and negative charge density in the modified membranes are revealed, contributing to improved permeation. The resulting DAHP-PIP NF membrane exhibits impressive Na_2SO_4 rejection (96.0%) and remarkable water permeability (36.6 L m^{-2} h^{-1} bar^{-1}). Antifouling experiments further demonstrate the membrane's excellent resistance to fouling, particularly against bovine serum albumin (BSA), with a low flux decline ratio (FDR) below 14.2% and a high flux recovery ratio (FRR) of 91.3%. This environmentally friendly synthesis method presents an efficient strategy for producing high-performance PA-based nanofiltration membranes, holding promise for advancing water treatment technologies.

Keywords

Pyrimidine, Hydrophilicity, Negative Charge, Nanofiltration Membrane, Antifouling