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Restricted piperazine diffusion by polyacrylic acid for high flux nanofiltration membrane

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ABSTRACT

Increasing the water flux of nanofiltration membrane is of great significance for expanding the application field of nanofiltration membrane, reducing energy consumption and building a conservation-oriented society. Polyamide nanofiltration membrane prepared by traditional interfacial polymerization has many problems, such as dense internal structure and poor water permeability. In this study, polyacrylic acid (PAA) was introduced into the interfacial polymerization. There are electrostatic and hydrogen bond interactions between PAA and piperazine (PIP). At the same time, the polymer properties of PAA increase the viscosity of aqueous solution. Under the joint action of two factors, the diffusion of PIP to the organic phase was effectively restricted. A thin (~62 nm) separation layer was prepared to improve the water flux of the nanofiltration membrane. In addition, the introduction of PAA also enhanced the hydrophilicity and electronegativity of the membrane surface. The results showed that the optimum addition of PAA was 0.15 wt.%, and under the working condition of 25°C and 0.5 MPa, the pure water flux of the PAA_0.15@PA membrane is 80.18 $L \cdot m^{-2} \cdot h^{-1}$, which is nearly 25% higher than that of pristine PA membrane. The salt rejection order is $Na_2SO_4 > MgSO_4 > NaCl > MgCl_2$, which is a typical negatively charged nanofiltration membrane. The PAA_0.15@PA membrane has a narrow pore-size distribution, has a high rejection rate for small molecule (180–400 Da) organics while maintaining a high flux, and has good separation stability.

Keywords: Nanofiltration; Polyacrylic acid; Piperazine diffusion; Interfacial polymerization; High flux

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