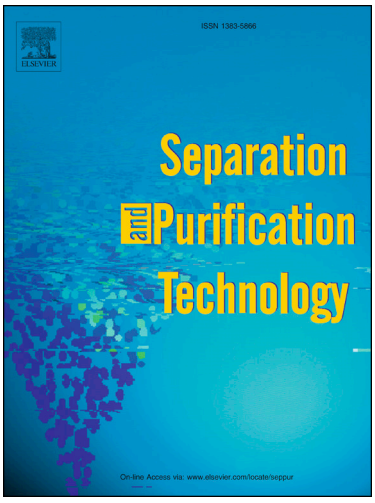

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Micropollutant rejection of annealed polyelectrolyte multilayer based nanofiltration membranes for treatment of conventionally-treated municipal wastewater

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Abstract

The ever-increasing concentrations of micropollutants (MPs) found at the outlet of conventional wastewater treatments plants, is a serious environmental concern. Polyelectrolyte multilayer (PEM)-based nanofiltration (NF) membranes are seen as an attractive approach for MPs removal from wastewater effluents. In this work, PEMs of poly(allylamine hydrochloride) (PAH) and poly(acrylic acid) (PAA) were coated in a layer by layer (LbL) fashion on the surface of a polyacrylonitrile ultrafiltration support to obtain PEM-based NF membranes. The impact of PEM post-treatment, by applying salt and thermal annealing, was then investigated in terms of swelling, hydrophilicity, permeability, and ion rejection. While thermal annealing produced a more compact structure of PEM, it did not improve the ion rejection. Among the different salt concentrations examined for the salt-annealing process, the highest ion rejection was observed for $(PAH/PAA)_{15}$ membranes annealed in 100 mM $NaNO_3$, interestingly without any decrease in the water permeability. This membrane was studied for the rejection of four MPs including Diclofenac, Naproxen, 4n-Nonylphenol and Ibuprofen from synthetic secondary-treated wastewater, over a filtration time of 54 h. At an early stage of filtration, the membrane became more hydrophobic and a good correlation was found between the compounds hydrophobicity and their rejection. As the filtration continued until the membrane saturation, an increase in membranes hydrophilicity was observed. Hence, in the latter stage of filtration, the role of hydrophobic interactions faded-off and the role of molecular and spatial dimensions emerged instead in MPs rejection. To test the suitability of the membranes for the ease of cleaning and repeated use, the sacrificial PEMs and foulants were completely removed, followed by re-coating of PEMs on the cleaned membrane. The higher MPs rejection observed in salt-annealed membranes compared to the non-annealed counterparts (52-82% against 43-69%), accompanied with still low ion rejection, confirm the high potential of PEM post-treatment to achieve better performing PEM-based NF membranes.

Keywords

Nanofiltration, Polyelectrolyte multilayers, Thermal annealing, Salt-annealing, Micropollutants.