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Improved antifouling ability of thin film composite polyamide membrane modified by a pH-sensitive imidazole-based zwitterionic polyelectrolyte

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Abstract

In this work, poly[1-vinyl-3(2-carboxyethyl) imidazolium betaine] (PVCIB), as a zwitterionic polyelectrolyte, was tethered onto a commercial thin film composite polyamide (TFC PA) membrane. First, polyvinyl imidazole (PVI) was grafted onto the TFC PA membrane surface by free radical graft polymerization method at various grafting times. Afterwards, one of PVI-modified membranes was betainised using 3-bromopropionic acid to obtain PVCIB brushes on the membrane surface. Evaluation of membrane performance through desalination process indicated that despite decrease of salt rejection, water flux increased from 73.4 L/m^2.h in the PA membrane to 91.6 L/m^2.h in the PA-PVCIB membrane. Antimicrobial assessment using Escherichia coli showed that PVCIB-modified membrane was able to inhibit bacterial growth by about 98.8%. Antifouling and cleaning abilities of membranes were investigated using BSA and lysozyme at various pH values. It was revealed that hydrophilic PVCIB brushes considerably improved protein-resistant property of the TFC PA membrane. However, considering pH-dependent behavior of PVCIB (zwitterionic at alkaline pH or polyelectrolyte at acidic pH), hydration repulsion or electrostatic repulsive forces, respectively, made a contribution to fouling mitigation. Accordingly, PA-PVCIB membrane exhibited remarkable antifouling ability to resist non-specific protein adsorption at neutral and alkaline pHs, whereas both PA-PVI and PA-PVCIB membranes exhibited marked resistance to the positively charged lysozyme adhesion at acidic pH.