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Performance Evaluation of Polyethyleneimine/Polyethylene Glycol Functionalized Reduced Graphene Oxide Membranes for Water Desalination via Forward Osmosis

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Abstract : Forward osmosis (FO) process has stood out as an energy-efficient technology for water desalination and purification, although the practical application of FO for desalination still relies on RO-based Thin Film Composite (TFC) and Cellulose Triacetate (CTA) polymeric membranes which have a low performance. Recently, graphene oxide (GO) laminated membranes have been considered an ideal selection to overcome the bottleneck of the FO-polymeric membranes owing to their simple fabrication procedures, controllable thickness and pore size and high water permeability rates. However, the low stability of GO laminates in wet and harsh environments is still problematic. The recent developments of modified GO and hydrophobic reduced graphene oxide (rGO) membranes for FO desalination have demonstrated attempts to overcome the ongoing trade-off between desalination performance and stability, which is yet to be achieved prior to the practical implementation. In this study, acid-functionalized GO nanosheets cooperatively reduced and crosslinked by the hyperbranched polyethyleneimine (PEI) and polyethylene glycol (PEG) polymers, respectively, are applied for fabrication of the FO membrane, to enhance the membrane stability and performance, and compared with other functionalized rGO-FO membranes. PEI/PEG doped rGO membrane retained two compacted d-spacings (0.7 and 0.31 nm) compared to the acid-functionalized GO membrane alone (0.82 nm). Besides increasing the hydrophilicity, the coating layer of PEG onto the PEI-doped rGO membrane surface enhanced the structural integrity of the membrane chemically and mechanically. As a result of these synergetic effects, the PEI/PEG doped rGO membrane exhibited a water permeation of 7.7 LMH, salt rejection of 97.9 %, and reverse solute flux of 0.506 gMH at low flow rates in the FO desalination process.

Keywords : desalination, forward osmosis, membrane performance, polyethyleneimine, polyethylene glycol, reduced graphene oxide, stability
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