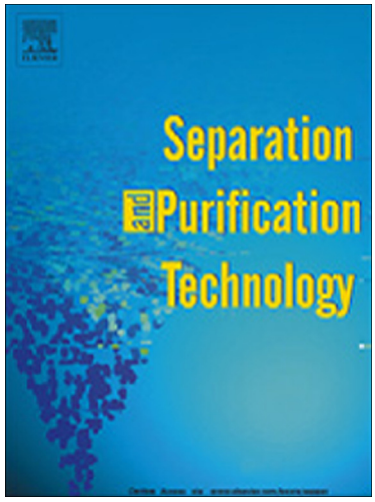

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Integration of Forward Osmosis and Membrane Distillation for Sustainable Wastewater Reuse

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Abstract

This study focuses on the performance of an integrated forward osmosis (FO) and membrane distillation (MD) process for wastewater reuse. FO worked as a pretreatment barrier to remove most contaminants in the feed water and MD was used to recover the draw solutes from FO effluent and simultaneously produce high-quality reusable water. A unique three-channel FO-MD membrane module was designed and built to test water flux and contaminant removal in bench-scale experiments. It was found that the integrated FO-MD system possessed inherent flux balancing mechanism that enabled a stable and equal water flux for both FO and MD membranes for effective recovery of draw solution over long-term experiments. The FO-MD system was able to achieve more than 3 logs (> 99.9%) removal of ammonium, COD, arsenic, and combined solutes in both synthetic and real wastewaters. Such a synergistic integration of FO and MD membrane processes offers three major advantages. First, the upstream FO process removes most contaminants and foulants from the feed solution, thus potentially diminishing the fouling and wetting problem for the downstream MD process. Second, the downstream MD process successfully recovers the draw solution for the FO process, enabling a constant water flux for FO. Third, the synergistic removal capability of FO and MD enabled the production of extremely high-quality product water. Additional benefits of the integrated process also include ambient pressure operation and potential use of renewable low-grade heat as the energy source.

Keywords
Forward osmosis; membrane distillation; wastewater reuse; ammonium; arsenic

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