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Water Reclamation from Synthetic Winery Wastewater Using a Fertiliser Drawn Forward Osmosis System Evaluating Aquaporin-Based Biomimetic and Cellulose Triacetate Forward Osmosis Membranes

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Abstract : This study examined the performance of two commercial forward osmosis (FO) membranes; an aquaporin (AQP) based biomimetic membrane, and cellulose triacetate (CTA) membrane in a fertiliser is drawn forward osmosis (FDFO) system for the reclamation of water from synthetic winery wastewater (SWW) operated over 24 hr. Straight, 1 M KCl and 1 M NH_4NO_3 fertiliser solutions were evaluated as draw solutions in the FDFO system. The performance of the AQP-based biomimetic and CTA FO membranes were evaluated in terms of permeate water flux (Jw), reverse solute flux (Js) and percentage water recovery (Re). The average water flux and reverse solute flux when using 1 M KCl as a draw solution against controlled feed solution, deionised (DI) water, was 11.65 L/m²h and 3.98 g/m²h (AQP) and 6.24 L/m²h and 2.89 g/m²h (CTA), respectively. Using 1 M NH_4NO_3 as a draw solution yielded average water fluxes and reverse solute fluxes of 10.73 L/m²h and 1.31 g/m²h (AQP) and 5.84 L/m²h and 1.39 g/m²h (CTA), respectively. When using SWW as the feed solution and 1 M KCl and 1 M NH_4NO_3 as draw solutions, respectively, the average water fluxes observed were 8.15 and 9.66 L/m²h (AQP) and 5.02 and 5.65 L/m²h (CTA). Membrane water flux decline was the result of a combined decrease in the effective driving force of the FDFO system, reverse solute flux and organic fouling. Permeate water flux recoveries of between 84-98%, and 83-89% were observed for the AQP-based biomimetic and CTA membrane, respectively after physical cleaning by flushing was employed. The highest water recovery rate of 49% was observed for the 1 M KCl fertiliser draw solution with AQP-based biomimetic membrane and proved superior in the reclamation of water from SWW.

Keywords : aquaporin biomimetic membrane, cellulose triacetate membrane, forward osmosis, reverse solute flux, synthetic winery wastewater and water flux
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