Which active layer from commercial thin-film composite reverse osmosis membranes yields the highest osmotic water flux?

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Commercial thin-film composite (TFC) reverse osmosis (RO) membranes do not yield high osmotic water fluxes when used for osmotically driven membrane processes due to their high structural parameters. The objective of this work was to demonstrate that the polyamide active layers from commercial membranes can provide high osmotic water flux if the overall structural parameter of the TFC membrane is reduced. We achieved this reduction in structural parameter by physically separating the nonwoven polyester backing layer of commercial TFC membranes, and recomposing the TFC membrane using a robust, woven polyester mesh with low structural parameter. Using this approach, we evaluated the osmotic water flux obtained by using different active layers from commercial TFC membranes that ranged from seawater desalination membranes to tight nanofiltration membranes.

Testing comprised water permeation and sodium chloride salt rejection tests using a direct flow cell. Additionally, osmotic water flux was measured at different draw solution hydraulic pressures, using the TFC membranes (as received and recomposed) and a home-built osmotic process testing apparatus. Finally, data were compared to reported TFC membranes for ODMP in literature.

Results show that the highest osmotic water fluxes are obtained using an active layer from a commercial TFC RO membrane for brackish water desalination. Seawater desalination provided high resistance to water flow. Tight nanofiltration membranes led to high solute reverse flux decreasing the driving force. Additionally, it was confirmed that TFC RO membranes yield higher osmotic water fluxes when used as recomposed membranes. These findings support the idea that high water flux ODMP can be obtained by judicious selection of both the mesh backing and the active layer.

Keywords: thin-film composite membrane, osmotically driven membrane process, reverse osmosis