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Construction and validation of a long-channel membrane test cell for representative monitoring of performance and characterization of fouling over the length of spiral-wound membrane modules

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ABSTRACT

A long-channel membrane test cell (LCMTC) with the same length as full-scale elements was developed to simulate performance and fouling in nanofiltration and reverse osmosis spiral-wound membrane modules (SWMs). The transparent LCMTC enabled simultaneous monitoring of SWM performance indicators: feed channel pressure drop, permeate flux and salt passage. Both permeate flux and salt passage were monitored over five sections of the test cell and were related to the amount and composition of the accumulated foulant in these five sections, illustrating the unique features of the test cell. Validation experiments at various feed pressures showed the same flow profile and the same hydraulic behaviour as SWMs used in practice, confirming the representativeness and suitability of the test cell to study SWM operation and fouling. The importance to apply feed spacers matching the flow channel height in test cell systems was demonstrated. Biofouling studies showed that the dosage of a biodegradable substrate to the feed of the LCMTC accelerated the gradual decrease of membrane performance and the accumulation of biomass on the spacer and membrane sheets. The strongest permeate flux decline and the largest amount of accumulated biomass was found in the first 18 cm of the test cell. The LCMTC showed to be suitable to study the impact of biofilm development and biofouling control strategies under representative conditions for full-scale membrane elements.

Keywords: Feed spacer; RO spiral-wound module; NF; Permeate production; Membrane performance; Biofouling

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