The techno-economic case for coupling advanced spacers to high-permeance RO membranes for desalination

K.Y. Toh [a,] Y.Y. Liang [a,b,c,] .J. Lau [c], G.A. Fimbres Weihs [d,e]

a Faculty of Chemical and Process Engineering Technology, College of Engineering Technology, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300 Gambang,
Kuantan, Pahang, Malaysia

b Centre of Excellence for Advanced Research in Fluid Flow (CARIFF), Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300 Gambang, Kuantan, Pahang, Malaysia

c Advanced Membrane Technology Research Center, School of Chemical and Energy Engineering, Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia

d CONACyT–Instituto Tecnológico de Sonora, Departamento de Ciencias del Agua y Medio Ambiente, Cd. Obregón, Sonora 85000, Mexico

e The University of Sydney, School of Chemical and Biomolecular Engineering, NSW 2006, Australia

Abstract:
Innovations in advanced materials in recent years have produced great improvements in the permeance of reverse osmosis (RO) membranes for desalination. This work presents a simplified techno-economic analysis for a representative advanced spacer and a high-permeance RO membrane under typical feed and operating conditions. The results agree with common trends for specific energy consumption (SEC). For high-permeance membranes, advanced spacers are more effective than conventional spacers in improving flux in the region close to the inlet, due to a fast decrease in Reynolds number along the channel. The total cost for seawater RO (SWRO) and brackish water RO (BWRO) could be reduced by 7.5% and 32%, respectively by increasing the membrane permeance to 10 L/m2.h.bar regardless of the spacer type used. However, as feed velocity has negligible effects on total cost for high-permeance membrane systems, further cost reductions with larger membrane permeances are limited due to significant concentration polarisation and lower mass transfer. Nevertheless, when operating SWRO at constant recovery, those levels of cost reduction can be achieved with an advanced spacer at half of that membrane permeance value. This highlights that more cost-effectiveness can be gained by improving the spacer efficacy than by increasing membrane permeance.

Keywords: Spiral wound module; Advanced spacer; Permeance; Economic analysis; Operating conditions

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