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Comprehensive performance assessment of spacers in spiral-wound membrane modules accounting for compressibility effects

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Abstract

Net-type spacers are essential components of the spiral-wound membrane (SWM) modules employed in reverse osmosis (RO) desalination plants. Despite progress made in designing SWM modules in recent years, key issues related to feed-spacer characteristics (particularly spacer material properties in conjunction with their geometry), which affect module performance and membrane integrity, have been neglected by the research community. This paper focuses on the effect of *compressive stresses,* imposed on membrane spacers and envelopes during SWM-module fabrication to achieve module compactness and resistance to deformation during operation. A comprehensive method is presented (involving experimental and computational tools) which allows to quantify compressive stress effects, on the characteristics of spacer-filled membrane channels, and further to assess their impact on the key SWM-module operating parameters and on overall RO process performance. The method is demonstrated by assessing the performance of 26-mil commercial feed-spacer in an appropriate range of compressive stresses; it is interesting that modest nominal applied pressure, at the level of 1 to 2 bar, tends to cause significant feed-spacer compression, channel-gap reduction and membrane indentations impairing the active layer. The novel method is considered most helpful for selecting appropriate feed-spacer material and geometric characteristics, for a membrane of particular mechanical properties.

Keywords : Spiral-wound membrane module, water desalination, feed spacer compression, membrane indentation, spacer properties assessment, comprehensive method, optimum spacer

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1. Introduction