

3D CFD study on hydrodynamics and mass transfer phenomena for SWM feed spacer with different floating characteristics

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ABSTRACT

Enhancing the efficiency of reverse osmosis (RO) applications through the design and modification of spacer geometries for spiral wound membrane (SWM) modules remains a challenging task. In this work, four 3D feed spacer geometries with different degrees of “floating” characteristics are studied using computational fluid dynamics (CFD) simulations to investigate the mechanisms that result in shear stress and mass transfer enhancement. The modelled data reveal that the floating ratio (R_f) is not a determining factor for mass transfer enhancement, as the transport mechanism is more strongly dependent on other geometric characteristics, such as a 2- or 3-layer design. The λ_2 analysis confirms our hypothesis, as the middle filament in a 3-layer design disrupts the formation of the large streamwise vortex located downstream of the intersection between the top and bottom filaments at Re_h 200. This explains why 3-layer spacers (both woven and non-woven) show lower Sherwood number (Sh) than a 2-layer woven (2LW) spacer at Re_h 200. However, at a smaller Re_h (<100), the vortical flow for 2LW is rather weak as a result of reduced membrane region with fluid mixing caused by creeping flow. This has led to the smaller Sh of 2LW compared to the 3-layer spacer.

KEYWORDS

CFD; Spiral wound module; Floating spacer; Mass transfer

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