Coupled effects of circular and elliptical feed spacers under forced-slip on viscous dissipation and mass transfer enhancement based on CFD

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ABSTRACT

Combining unsteady state shear strategies and a novel spacer geometry for spirally wound membrane modules may lead to greater flux enhancement than only optimising the spacer geometry. In this paper, CFD is employed to simulate the effect of different spacer profiles (circular and elliptical) and configurations (2- and 3-layer) on flux enhancement generated by unsteady forced-slip. Data analysis shows that a similar Strouhal number is observed for all spacer filaments under consideration, regardless of profile shape. Although a submerged spacer leads to relatively larger pressure losses, implementing forced-slip with that geometry results in the largest flux increase (40%) compared to other configurations under consideration. This is associated with the shedding of vortices near the membrane surface, coupled with vortex flow cross-over from regions of high concentration (near the membrane) to low concentration regions in the bulk. However, the flow instabilities that improve mass transfer are weakened in channels with smaller void fraction, leading to smaller flux enhancement. The results therefore suggest that the simple circular profile is preferred for maximising vortex-shedding-induced permeate flux enhancement.

KEYWORDS

CFD; Unsteady slip velocity; Elliptical spacer; Mass transfer enhancement; Viscous dissipation

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