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Pressure drop across membrane spacer-filled channels using porous media characteristics and computational fluid dynamics simulation

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ABSTRACT

The presence of spacers in membrane modules generates turbulence which enhances the mass transfer through the membrane. However, spacers increase the pressure drop in the flow channels which increases the operating cost. Previous approaches used empirical correlations to estimate the pressure drop across spacer-filled channels in membrane modules. In this study, a different approach is proposed for accurate pressure drop prediction by treating the spacer as a porous media and using Darcy–Forchheimer's model for flow in porous media. The pressure drop is predicted using Darcy–Forchheimer's model and computational fluid dynamics simulation which is validated using experimental data available in the literature. This study focuses on the effect of spacer filament diameter and porosity on the permeability coefficient, and pressure drop. The critical Reynolds number is calculated to identify the transition between Darcy and non-Darcy flow through the spacer-filled channels. It is found that the permeability coefficient increases with the spacer filament diameter and porosity. This study also proposes a correlation to calculate the permeability coefficient based on the spacer porosity and filament diameter.

Keywords: Membrane spacer; Pressure drop; Porous media; Computational fluid dynamics simulation

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