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Modelling of fluid flow distribution in multichannel ceramic membrane: application to the filtration of produced water

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Abstract

Multichannel ceramic membranes are considered as one of the most promising process for separating oil and particles from produced water. The aim of this work is to show (i) the influence of the permeability contrast between the support of the membrane and the selective layers and (ii) the impact of fouling on the fluid flow distribution for different ceramic membrane geometries. A theoretical model is developed to simulate the filtration of a simplified produced water (PW) matrix in both circular and square multichannel ceramic membranes.

Under several assumptions, the problem can be considered as first two-dimensional. Therefore, the model consists of Darcy's equation for fluid flow in the porous medium coupled with a resistance-in-series model for selective layer fouling. These are solved in the porous medium domain, which consists of a multichannel membrane composed of a large macroporous region (i.e. the support of the membrane) and several small microporous regions (i.e. the selective layers of the channels).

The results show that, for filtration with pure water, the contribution of the channels to total permeate flux can be drastically non-homogenous and depends on the permeability ratio between the macroporous and the microporous regions. For membranes with low permeability contrast, the contribution of the inner channels is negligible. For filtration of PW, fouling also significantly influences the pressure fields and spatial distribution of permeate velocity among the channels. It progressively homogenizes the flux in all the channels through the