Exploring the interactions between hydrodynamics and fouling in membrane distillation systems - A multiscale approach using CFD

Amigo, J., Urtubia, R., & Suárez, F. (2018). Exploring the interactions between hydrodynamics and fouling in membrane distillation systems–A multiscale approach using CFD. Desalination, 444, 63-74. <10.1016/j.desal.2018.07.009> Accessed 28 Mar 2021.

Abstract

Membrane distillation (MD) is a promising desalination technology that uses hydrophobic membranes to distill water. However, fouling occurrence is one of its main challenges for long-term operation. In this work, a three-dimensional computational fluid dynamic (CFD) model is developed to investigate the interactions between hydrodynamics and fouling in MD systems. The model describes mass, heat and species transport in MD modules; and uses a novel post-processing routine to detect fouling-prone regions on the membrane by comparing the induction time of salts and the residence time near the membrane. The model is validated with experimental results previously reported, and then is used to investigate how different hydrodynamic conditions affect the induction time and residence time; in one unobstructed module and in two spacer-filled modules (woven-square and diamond spacers). In the unobstructed module, the most fouling-prone region is located at the beginning of the feed channel. In the spacer-filled modules the fouling zones are evenly distributed in small isolated regions throughout the feed channel. Model results show that diamond spacers are more effective to mitigate fouling because they increase induction times. The proposed methodology only considers scaling formation at the membrane surface. Therefore, future research should also incorporate membrane wetting..

Keywords

Computational fluid dynamics, Direct contact membrane distillation, Permeate-gap membrane distillation, Residence time, Induction time.