Available online at www.sciencedirect.com
ScienceDirect
Desalination 222 (2008) 482–488
DESALINATION
www.elsevier.com/locate/desal

CFD modeling of porous membranes

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Received 25 December 2006; accepted 3 January 2007

Abstract

Membrane filtration has become firmly established as a primary technology for ensuring the purity, safety and efficiency of treatment of water or effluents. Water desalination is one of the major applications of this technology around the world. Several researches have been performed to develop and design membrane systems in order to increase the process accuracy and performance. In this research, the laminar fluid flow in porous tubes, a mode of crossflow filtration tubular membrane, is simulated numerically using the computational fluid dynamics (CFD) techniques. A two-dimensional numerical solution of the coupled Navier–Stokes, Darcy's law and mass transfer equation has been developed using control volume based finite difference method. Case study was performed for a microfiltration process. Prediction of the growth rate of the concentration polarization boundary layer along the length of tubular membranes has been performed. Effects of various operating conditions (e.g. geometrical dimension, required membrane surface area, Reynolds number and fouling) on the performance of membrane are studied and some comments on designing of such membranes are suggested.

Keywords: Membrane filtration; Water desalination; Computational fluid dynamics (CFD)

1. Introduction

Over the past two decades, membrane filtration processes have played a more and more important role in industrial separation process. Many studies have focused on the best ways of using a particular membrane process. Computational fluid dynamics techniques may provide a lot of interesting information for the development of membrane processes. Numerous improvements of the technology have allowed membrane selection for a particular process to be done more easily and more quickly. The development of this technology is because of the increasing number of different types of applications of these processes in different domains, particularly in the industrial sector. Membrane filtration is used in a broad range of applications [1].

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Presented at the conference on Desalination and the Environment. Sponsored by the European Desalination Society and Center for Research and Technology Hellas (CERTH), Sani Resort, Halkidiki, Greece, April 22–25, 2007.

0011-9164/06/$– See front matter
doi:10.1016/j.desal.2007.01.152