Fabrication and characterization of high-strength PVDF/nonwoven fabric electrospun composite membranes for direct contact membrane distillation

Kuiling Li^{a,b}, Jiang Chang^c, Deyin Hou^{a,b,*}, Chunli Ding^d, Jun Wang^b

^aKey Laboratory of Drinking Water Science and Technology, Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, Beijing 100085, PR China, Tel. +86 10 62917207; Fax: +86 10 62917207; email: dyhou@rcees.ac.cn (D. Hou)

^bState Key Laboratory of Environmental Aquatic Chemistry, Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, Beijing 100085, PR China

^cLaboratory of Environmental Technology, Institute of Nuclear and New Energy Technology, Tsinghua University, Beijing 100084, PR China

^dSchool of Chemical Engineering and Technology, Hebei University of Technology, Tianjin 300130, PR China

Received 9 April 2017; Accepted 27 September 2017

ABSTRACT

The polyvinylidene fluoride (PVDF) nanofibers composite membranes were fabricated for membrane distillation using polyester nonwoven fabric as a substrate via electrospinning. The influences of nonwoven fabric and electrospinning time on membrane morphology, hydrophobicity, pore size and pore size distribution, porosity, mechanical strength and permeability were evaluated. All the electrospun composite membranes had a three-dimensional bead-fiber interconnected open structure and a rough membrane surface with water contact angle of greater than 140°. The composite membranes obtained high-mechanical strength because of nonwoven fabric substrate, which was important for industrial application. The resultant membranes were tested through direct contact membrane distillation (DCMD) using 3.5 wt% sodium chloride solution as feed, and the highest permeate flux was up to 54.0 kg/m² h at feed temperature of 80°C. The anti-fouling properties of the fabricated membrane were investigated by DCMD experiment with mixed solution including sodium chloride, calcium chloride and humic acid, and the composite membrane presented excellent anti-fouling performance. During sodium chloride solution concentration process, it was demonstrated that the permeability and hydrophobicity of the composite membrane can maintain well after repeated use and rinse. The results suggested the potential of the electrospun PVDF/nonwoven fabric composite membrane for membrane distillation application.

Keywords: Membrane distillation; Hydrophobic surface; Electrospinning; Polyvinylidene fluoride; Nonwoven fabric; Mechanical strength

* Corresponding author.