Free Surface Electrospun Polyvinylidene Fluoride Membranes for Direct Contact Membrane Distillation

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***Abstract*— Direct Contact Membrane Distillation (DCMD) is a desalination process similar to traditional distillation and reverse osmosis. In DCMD, a porous hydrophobic membrane is used to separate nonvolatile components such as salt, and other impurities from seawater. However, the DCMD process employs a temperature gradient instead of a pressure gradient to drive the separations of chemical species. With an increasing need for potable water, DCMD can be used to purify of the earth's most abundant source of water, ocean water. Current techniques for producing chemical separation membranes are overall very expensive and often involve hazardous chemicals; therefore, industrialization of these membranes has been greatly restricted. Free surface electrospinning may offer an answer to these limitations. Free surface electrospinning is capable of producing membranes in large quantities while maintaining high porosity and controllability over pore size. Membranes are produced for direct contact membrane distillation (DCMD) of seawater by means of free surface electrospinning. A solution of polyvinylidene fluoride (PVdF) in dimethylacetamide (DMAc) was electrospun over a range of high voltages and working distances to control desirable properties of the membrane such as fiber diameter, pore size and porosity. The membrane morphology and properties were characterized by scanning electron microscopy, stress-strain measurements and contact angle measurements. It was observed as the applied voltage is increased, the fiber diameter of the membrane decreases. In addition, the pore size of the membrane appears to display a linear relationship with fiber diameter. In addition, we examined the productivity and efficiency of commercial and manufactured electrospun membranes. In order to investigate the mechanisms responsible for the productivity of the process, various temperature gradients and flow rates were studied. It was determined that an increase in temperature gradient leads to an increase in productivity. This observation suggests that higher temperature gradients provide a higher driving force for water vapor transport through the membrane. The current theoretical model (dusty gas model) was considered to explain the relationship between productivity, and the membrane properties and operating conditions. This research hopes to further develop a safer, more efficient method for producing membranes with unique properties, in particular, for applications in DCMD that will ultimately lead to high productivities of desalination processes.**