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Using macromolecules as osmotically active compounds in osmosis followed by filtration (OF) system

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ABSTRACT

Finding a suitable osmostically active solute is the most important problem in forward osmosis (FO). Even though there are a number of osmotically active compounds that exist, the major problem occurs during the separation of product water from the solute. Osmotically active macromolecules (polyethylene glycol [PEG] and humic acid [HA]) were investigated in this research as possible draw solutes for FO. Cellulose triacetate FO membranes (Hydration Technology Innovations, LLC) and several ultrafiltration and nanofiltration membranes were used in osmosis and filtration steps of the system, respectively. Molecular weights (MW) of PEG were selected as 2 k, 10 k, and 20 kDa for 400 and 600 g/L concentrations. HA solutions were prepared in concentrations ranging from 200 to 800 g/L. Increased MW resulted in higher water permeation when PEGs were used. The relationship between the reflection coefficient and the viscosity was investigated for PEG/water separation by membrane filtration. The combined effect of the osmotic pressure and the viscosity of the PEG solutions was found to be greater than the effect of the reflection coefficient on the permeability.

Keywords: Forward osmosis; Polyethylene glycol; Humic acid; Reflection coefficient; Viscosity; Osmotic pressure; Permeability

1. Introduction

Membrane-based seawater desalination has been one of the most important freshwater production technologies, as it is a relatively low-energy process. However, increasing energy demands and the adverse effect of increasing CO_2 emissions are pushing scientists and engineers to establish a more energy-independent seawater desalination process. Forward osmosis (FO) has become an important study subject for the researchers in the last 5–10 years, as it theoretically offers a less energy-intensive process than reverse osmosis (RO), for seawater desalination. The working principle of FO is that water is transferred from a low osmotically active solution to a high osmotically active solution with no energy input. However, product water has to be separated from osmotically active solute (draw solution) in order to get usable/potable water.

Several research groups proposed different osmotically active solutes to validate the FO system as an energy-efficient process. Some of the important studies about FO systems are given in Table 1, which also

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