Fouling behavior investigation of a thermally modified RO membrane

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ABSTRACT

The main aim of present study is to investigate performance and fouling/cleaning behavior of reverse osmosis membranes and study heat treatment effect(s)as a membrane surface modification method on the membranes separation performance. For this purpose, performance of the reverse osmosis membranes as permeation flux, and Na and Mg rejections was investigated using response surface methodology (RSM) as functions of four main variables including trans-membrane pressure (TMP, bar), operating temperature (T, °C), cross flow (CF, L·h^{-1}) and total dissolved solids (TDS, mg·L^{-1}). Also, another RSM design was used to study the membrane fouling/cleaning behavior, i.e. the response of permeation flux recovery, vs. the variables of cross flow (CF, L·h^{-1}), pH and cleaning time (t, min). Effects of the membrane surface modification via the heat treatment on its fouling resistance and cleaning performance were also investigated. The membranes were modified via washing with deionized water followed by immersing in deionized water at 70°C for 3 h and then maintaining in deionized water at 4°C and dark ambient until evaluation. The membranes' fouling resistance during 20 h operation and their fouling/cleaning behavior using synthetic foulant down to 80% of their initial permeation fluxes were determined at the experimentally obtained optimum conditions of fouling/cleaning cycles for both the modified and non-modified membranes. The optimum performance of the membrane with permeation flux of 59.1 kg·m^{-2}·h^{-1} and Na and Mg rejections of 99.3 and 95.0% was identified at TMP, T, CF and TDS of 17 bar, 35°C, 1200 L·h^{-1} and 10000 mg·L^{-1}, respectively. Also, the optimum permeation flux recovery was determined as 94% at CF of 250 L·h^{-1},pH of 10 and cleaning time of 45 min. Permeation flux decline of the non-modified membrane was about 20%, while that of the modified membrane was found very lower as 3%. Also, the solutes rejection values were slightly increased from 99.3 to 99.4% and from 95.0 to 95.2% for Na and Mg, respectively for the modified membrane. In addition, it took about 3 h for the non-modified membrane and approximately 12 h for the modified membrane to be fouled as BSA added as foulant by 200 mg·L^{-1} BSA to the sodium chloride and magnesium sulfate aqueous solution of 10000 mg·L^{-1}. Cleaning of the fouled membranes was performed and permeation flux recovery for the non-modified membrane was measured as 94.0% and for the modified membranes as 94.1%.

Keywords: Reverse osmosis membrane; Fouling/cleaning behavior; Heat treatment; Experimental design

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