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Experimental investigation of the effect of ion concentration and its valence on reflection coefficient and solute permeability of NF membranes

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ABSTRACT

The objective of this manuscript is to investigate experimentally and theoretically the effect of ion (cation and anion) valence and concentration on the rejection coefficient and solute permeability of NF270 membrane. The experimental data of solute rejection vs. permeate flux is usually fitted to Spiegler–Kedem equation to determine the reflection coefficient and the solute permeability. In doing so, many problems may arise such as inaccurate numerical fitting, the discrepancy in the results when the different initial guess is made and sometimes no result is obtained. The current research work overcomes these problems by transferring the Spiegler–Kedem equation to a one-parameter equation. This is done by first using the flux equation to determine the rejection coefficient and use this data in the Spiegler–Kedem equation to determine the solute permeability. The success of this procedure was confirmed by comparing its results with those available in open literature where an excellent agreement was found. Moreover, the values of the reflection coefficient and the solute permeability that some researchers could not determine were found. The interaction between the solutes especially at high concentrations was taken into account when the osmotic pressure was calculated. The experimental results showed that σ is inversely proportional to the concentration. P_s, however, are proportional to the concentration until a certain concentration is reached after which the effect diminishes. The results also show that as the valence of the cation increases both σ and P_s increase. The results showed that $AlCl_3$ has the highest value of σ and NaCl has the lowest value. The values of σ follow the following order: $\sigma_{AlCl_3} > \sigma_{MgCl_2} > \sigma_{Na_2SO_4} > \sigma_{NaCl}$. The dependence of P_s on the solute type follows the following order $P_{s,NaCl} > P_{s,Na_2SO_4} > P_{s,MgCl_2} > P_{s,AlCl_3}$.

Keywords: Nanofiltration; Membrane; Reflection coefficient; Permeability; Rejection

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