ROLE OF ACTIVE LAYER IN THE PERFORMANCE OF AROMATIC AND SEMI-AROMATIC NANOFILTRATION MEMBRANES FOR WATER PURIFICATION

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Nanofiltration (NF) membranes that differ in molecular weight cut off (MWCO), active layer chemistry, porosity and pore size distribution are available for different applications. These membranes are typically made of three layers: the active layer, polysulfone support layer and a fabric for mechanical strength. It has been proven that the performance of an NF membrane is almost entirely dependent on the active layer, which can be made of polyamide, polypiperazine amide, cellulose acetate or polyethersulfone. Polyamide, which is considered fully aromatic (FA) and polypiperazine, which is considered semi-aromatic (SA), are the most commonly used active layers in NF membranes for water treatment. Several studies evaluated commercially available NF membranes for ion rejection, effect of pH, temperature, pressure but very few have attempted to explain their performance based on the membrane active layer chemistry.

This study is focused on understanding the difference in performance between fully aromatic (FA) and semi-aromatic (SA) membranes for the removal of typical ions of concern in water purification. Four commercially available membranes, two each of FA and SA types were selected for this study. Fourier Transform Infrared (FTIR) spectroscopy was used to substantiate that the selected membranes are truly representative of FA and SA membrane type without any coating or other surface modifications. Membrane performance was analyzed in terms of ion rejection and permeate flux. Membrane volume charge densities as a function of electrolyte concentration were analyzed by measuring their zeta potential as function of pH and electrolyte composition and concentration. The membrane mean pore size was determined using the membrane potential technique [1]. Membrane potential data were analyzed using the steric, electric and dielectric exclusion (SEDE) model [2]. Also, SEDE model was used to calculate the dielectric constants for different electrolyte composition and compare them for FA and SA membranes.

The ion rejection and permeate flux for all four membranes was studied for different feed composition using a SEPA cross flow NF cell at a fixed transmembrane pressure and temperature. The feed composition was selected such that it is representative of the acid mine drainage (AMD) typically found in Pennsylvania, which is characterized by high sulfate concentration and low pH. The resulting ion rejection and permeate flux were compared for the four membranes with goal of understanding the difference in the performance of FA and SA membranes as a function of the active layer chemistry.

The experimental results indicate that the rejection of sulfate was in all cases above 98% but the rejection of the counterions was significantly better for the fully aromatic membranes. Major disparity was observed in the rejection of sodium and chloride ions between FA and SA membranes even when they had the same MWCO’s. This disparity was studied in terms of the electronegativity of the four membranes and the results will be presented at the conference.