105e Role of Foulant-Foulant Adhesion in Organic Fouling of Reverse Osmosis Membranes

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Evolution of organic fouling layer on the membrane surface is induced by intermolecular adhesion between the bulk foulants and the foulants on the membrane surface. Therefore, quantifying the intermolecular adhesion force is essential to the molecular-level understanding of fouling mechanisms. In this study, atomic force microscopy (AFM) in conjunction with a colloid probe was utilized to measure the intermolecular adhesion forces under various solution chemistries. The foulant-foulant adhesion force was quantified from the force versus separation distance curves measured during the retraction of the colloid probe from the fouled membrane surface. Based on the AFM force measurements, solution chemistries that result in a greater adhesion force were determined to be lower pH, higher ionic strength, presence of calcium ions, and higher mass ratio of acidic polysaccharide-like to humic-like foulants. The adhesion force quantified from AFM force measurements was further correlated to the flux-decline behavior monitored during fouling experiments performed using a crossflow reverse osmosis test unit. Solution chemistries identical to those used for AFM force measurements were employed in the fouling experiments to allow direct comparison of fouling rate to adhesion forces. A remarkable correlation was obtained between the adhesion forces and the fouling rate under all solution chemistries investigated. Based on this study, it is concluded that molecular-level understanding of organic fouling mechanisms can be achieved through determining the foulant-foulant adhesion forces and the factors affecting the extent of adhesion forces.