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Bench-Scale Assessment of Low Pressure Membrane Fouling: Characterization and Examination the Role of Organic Nitrogen Compounds

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Abstract
The primary goal of this research was to improve understanding of the fouling of low pressure hollow fiber membranes used in drinking water treatment. The major difference of this study compared to other reported studies was the use of a hollow fiber membrane module at operating conditions mimicking those of full-scale practice. Two poly(vinylidene-fluoroethylene) based hollow fiber membranes (A and B) were tested. Different types of fouling indices (total, hydraulic irreversible, chemical irreversible) developed based on a resistance in series model were used to assess membrane performance. Data from bench-scale and full-scale plants were compared to validate the use of fouling indices. The impact of dissolved organic nitrogen (DON) on membrane fouling was demonstrated with model waters containing humic substances and several model organic nitrogen compounds. Three different natural water sources normalized to the same organic content were tested. Fouling indices

determined from the resistance in series model approach were more applicable for natural waters than for model waters. Fouling was proportional to throughput for both raw and pretreated water and at different flux rates. Pretreatment (coagulation) reduced hydraulic irreversible fouling. Most fouling was reversed by hydraulic and chemical cleaning. Specific flux and fouling indices of the bench-scale system were higher than those of the full-scale system but the fouling index ratios were comparable suggesting a similar fouling nature. A minimum of a few days of testing is recommended for longer-term membrane performance assessment. The impact of high DON concentration on membrane fouling was insignificant. Membrane fouling was dependant on foulant properties other than, or in addition to, molecular size and the DON/DOC ratio. With three different natural water sources normalized to a similar organic content, membrane fouling was specific to membrane type and water source. High initial total and hydraulic irreversible fouling rates did not lead to high chemical irreversible fouling rates. It is not possible to generalize the impact of different water sources on membrane fouling. Membrane surface anlyses showed that hydraulically irreversible organic foulants were detected as mostly hydrocarbons/polysaccharides, humic substances and peptide/protein. Humic substances and peptide/protein were found to be organic foulants regardless of their molecular weight and origin. Chemical cleaning with chlorine solution was effective in removing all inorganic foulants and most organic foulants.