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Transparent exopolymer particle (TEP) fouling of ultrafiltration membrane systems

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ABSTRACT

An abundant form of extracellular polymeric substances (EPS) called transparent exopolymer particles (TEP) was recently regarded by Berman and Holenberg (T. Berman and M. Holenberg, Don't fall foul of biofilm through high TEP levels, Filtrat. Separat., 42 (2005), 30-32) as a major initiator of biofilm formation on membrane surfaces, which can eventually lead to biofouling. The TEP method applied here was an adapted version of the spectrophotometric technique developed by Passow and Alldredge (U. Passow and A.L. Alldredge, A dye-binding assay for the spectrophotometric measurement of transparent exopolymer particles (TEP), Limnol. Oceanogr., 40(7) (1995) 1326-1335). The main modifications were to the calibration procedure. TEP can be visualized by staining with alcian blue, a dye specific for acidic polysaccharides. The amount of TEP can be semi-quantified by measuring the absorbance of the dye that complexed with polysaccharides in water samples. Since TEP is a very complex polysaccharide, a commercially available polysaccharide: Gum Xanthan was used to standardize the amount of alcian blue dye bound to TEP and therefore express concentrations of TEP in terms of Xanthan equivalents per liter (μg X_{eq}/L). For the calibration, TOC measurements were made in order to relate the TOC removed by filtration to the amount of Xanthan (μg) retained in the filter. Biopolymer LC-OCD analyses were also employed for some of the samples in order to support the TEP results. Using the modified TEP method, the presence of TEP was assessed in the feed water and at various points along the treatment lines of two integrated membrane systems (IMSs) treating surface water and secondary wastewater effluent. Results showed that significant amounts of TEP were present in surface water (~990 μg GX/L) and secondary wastewater effluent (~270 μg GX/L). TEP removal efficiencies of 100% were measured for ultrafiltration (UF). TEP (>0.4 μm) removal efficiencies of ca. 70% were measured with in-line coagulation employing a high coagulant dose (10 mg Al^{3+}/L) in surface water. Significantly lower TEP removal efficiencies (ca. 27%) were observed with in-line coagulation employing a low coagulant dose (1.5 mg Al^{3+}/L) in secondary treated effluent. Biopolymer LC-OCD analyses also revealed removal of high molecular weight biopolymers by UF and in-line coagulation in both IMS.

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