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Nanomechanical characterization of recalcitrant foulants and hollow fiber membranes in ultrafiltration systems

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ABSTRACT

Long-term nanomechanical changes of polymeric ultrafiltration (UF) membranes caused by fouling/cleaning agents in water treatment are not well established in the literature. The goal of this study was to investigate the nanomechanical properties of polymeric UF hollow fiber membranes operating at a pilot-scale for 449 d and subjected to a low-quality feed (i.e., high turbidity/TOC content). Quantitative nanomechanical mapping technique was used to measure the deformation, dissipation, modulus, adhesion, and roughness of the polymeric structures of commercial Aquaflex virgin membranes, harvested membranes, and foulant layers. Results indicated that the recalcitrant and heterogeneous nature of the foulants absorbed on harvested membranes showed low elastic properties, and high modulus, adhesion, and roughness. The strong affinity of these foulants towards membrane surface would alter membrane characteristics and influence subsequent fouling behaviour. The cleaning process and extended operation did not significantly affect the nanomechanical properties of membranes. Despite the low-quality feed, the three modules were only subjected to 37 chemical-enhanced backwashes and filtered a total volume of 2.155 m^3. These results indicate the importance of operating conditions (i.e., frequency of backwash/cleaning/disinfection steps) and feed quality on the long-term changes of UF membranes and would assist in identifying research directions that are necessary to minimize membrane fouling/ageing.

Keywords: Quantitative nanomechanical mapping; Ultrafiltration; Hollow fiber membranes; Fouling; Chemical cleaning

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