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Relative Contributions of Organic and Inorganic Fouling during Nanofiltration of Inland Brackish Surface Water

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ABSTRACT

Bench-scale nanofiltration (NF) experiments were performed with two commercially available membranes having different ion rejection characteristics to assess dominant fouling mechanisms during inland brackish surface water desalination and the role of rejection on flux decline. The Foss Reservoir in the state of Oklahoma, USA was used as a representative natural brackish surface water source in these experiments. Both nanofilters rejected divalent cations to a very high extent (Mg > 94% and Ca > 92%) but exhibited substantially different rejections of monovalent cations (e.g. Na removals of 60% and 97%). A model solution formulated to have a similar ionic composition as the natural water but with no added natural organic matter (NOM) was also employed to isolate mineral scaling effects. The low monovalent ion rejecting membrane was predominantly fouled by NOM with only limited contributions from calcium carbonate scaling. In contrast, electron microscopy along with infra-red and X-ray photoelectron spectroscopy revealed that both NOM and gypsum were major foulants for the membrane that highly rejected both mono- and divalent ions. The exacerbated flux decline for the more salt-rejecting nanofilter was attributed to the synergistic effects of NOM and gypsum on fouling coupled with the formation of a very compact organic foulant layer due to greater extent of Ca-NOM interactions and the higher ionic strength of the concentration polarization layer. These results demonstrate that the relative contributions of NOM and mineral scaling to flux decline during brackish surface water NF depends on membrane ion rejection characteristics. Hence, optimal membrane selection needs to balance total dissolved solids concentration of the product water with the need to minimize fouling.

Keywords. Desalination; gypsum fouling; membrane surface characterization; brackish surface water; autopsy

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