

FOULING OF NANOFILTRATION MEMBRANES BY ORGANICS, COLLOIDS AND THEIR COMBINATIONS IN CROSS-FLOW FILTRATION: EFFECTS OF THE PRESENCE OF VARIOUS IONS ON MEMBRANE-FOULANT NON-ELECTROSTATIC INTERACTIONS

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The presence of macromolecules such as organic and colloidal foulants in the feed has been reported to result in membrane fouling. Fouling is aggravated when the organics and colloids co-exist in the feed due to synergistic effects. In addition, the presence of ions has been observed to promote organic fouling as the ions (especially Ca²⁺) act as a bridge binding foulants to the membrane (membrane-Ca²⁺-foulant complexation). Different cations have been reported to have different effects on membrane fouling. However, there are no clear explanations for the fluctuations in the fouling trends. Mostly, the deviations have been linked to the affinity of the cations to bind foulants to the membrane (membrane-foulant interactions) and also complex organic foulants. Membrane fouling in the presence of Na⁺, Ca²⁺ and La³⁺ as model cations is systematically investigated in more detail in this study. Sodium alginate, latex and silica are used as model organic and colloidal foulants. Specifically, more attention is paid on the effects of the presence of various cations on membrane-foulant as well as foulant-foulant non-electrostatic interactions, which determine initial and later membrane fouling, respectively. These interactions were computed from contact angles of membranes and foulants based on the Lifshitz-van der Waal and acid-base interaction energies. Fouling (especially organic fouling) was exacerbated in the presence of cations due to organic complexation and the reduction in foulant–membrane repulsive interactions. Initial and later membrane fouling related well with membrane-foulant as well as foulant-foulant interactions. Membrane-foulant interactions were more attractive for fouling in the presence of La³⁺, intermediate for Ca²⁺ and least for Na⁺ for all fouling types. This correlated well with alginate and latex fouling trends where fouling was severe in the presence of La³⁺ and least in the presence of Na⁺. However, there was insignificant effect for the addition of cations on silica fouling showing that not only membrane-foulant non-electrostatic interactions control flux decline. For combined fouling, different observations were made. However, fouling was highest for fouling in the presence of Ca²⁺. Fouling was not only influenced by membrane-foulant interactions but also competition for cations between organic and colloidal foulants. It was concluded from these experiments that the extent of membrane fouling is controlled by the affinity of foulants for the membrane surface. These affinity interactions are dependent on the presence of various cations in the feed water.