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Scaling and Fouling in Reverse Osmosis Wastewater Desalination –Operando Studies with Small-Angle Neutron Scattering

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The treatment of water for potable use is one of the great challenges of our time. Reverse osmosis (RO) desalination is a widely used technology for the treatment of sea and wastewater. A main problem is scaling and fouling of the membrane surface, which prevents the optimal use of this technology [1]. Our goal is to investigate these phenomena at the microscopic level using operando SANS techniques under most realistic conditions in combination with H2O/D2O contrast variation. We will present mineral scaling as well as silica and protein (BSA) fouling on the surface of polyamide membranes with the following results: (i) Aqueous silica dispersions form a crystalline cake layer of simple cubic order. The cake layer could be removed at larger crossflow. Only in one case did we observe irreversible cake layer formation, which has the characteristics of an unstable phase transition from otherwise first-order liquid-solid phase transitions [2]. (ii) Organic fouling of BSA dissolved in a model wastewater solution is determined by the immediate formation of stable organo-mineral colloids, i.e., composite particles of about micrometer size that increase only in number density. Their composition was about 50% protein and 50% minerals, mainly calcium phosphate and carbonate, as analyzed in previous in vitro SANS measurements [3].
[1] S.E. Bone et al, Joule 4 (2020) 1-23.
[2] V. Pipich et al, Membranes (MDPI) 11 (2021) 413.
[3] V. Pipich et al, Langmuir 29 (2013) 7607-7617.

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