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Operando SANS for gaining potable water via reverse osmosis desalination –exploration of colloidal silica fouling

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Operando SANS experiments of reverse osmosis (RO) desalination gaining potable water from sea and wastewater have been realized by us. Two cells are designed for pressure up to 50 bars and a tangential cross-flow of the feed up to 36 L/h. One cell is equipped with a membrane whereas the other cell is not (EC, empty cell) to measure the feed solution alone. Basically, we will present fouling experiments of inorganic silica nanoparticles, a topic which is intensely discussed in literature. Silica of 250 Å radius and 1.09 % volume fraction (ionic strength 10 mM) were dissolved in water (feed solution). Essential results are observation of a reflection peak of a simple cubic lattice representing a so-called cake layer on top of the membrane. The peak is continuously increasing and slightly shifting to larger Q indicating compaction of the cake layer. The distance of the silica colloids evaluated from the peak position Qm corresponds with their diameter. Another relevant parameter is the silica volume fraction at three positions of the RO devise, namely away from the membrane in the EC, in front of the membrane and of the cake layer. From the cake layer concentration we estimate a thickness of the cake layer, which increases from 4 to 16 micron when considering the silica volume fraction of simple cubic crystals as 52 vol%. The silica volume fraction shows about a twice larger value in front of the membrane than in the EC indicating strong concentration polarization.

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