

9th International Conference and Expo on

Separation Techniques

September 13-14, 2018 | Zurich, Switzerland

In situ physicochemical and electrochemical characterizations of membrane compaction, desalination and calcium fouling

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A bench-size flatbed module replicating specifications of industrial spiral wound modules incorporates electrodes for electrical impedance measurements of an *in situ* membrane and channeling system. The operation of the module in parallel with desalination plants generates data that after deconvolution yield indicators pre-empting rapid-flux-decline as the usual indicator of irreversible fouling. So the module affords life-saving warnings for plants as did canaries for miners in past centuries. The deconvolution further facilitates modelling of membranes and those nanostructures within effecting separation, such as a negative carboxyl-rich outer-layer and a juxtaposed positive amine-dominated inter-layer comprising the polyamide active region of the thin-film-composite polyamide reverse osmosis membrane. During the compaction phase salt in the feed neutralized the bipolar structure except at the junction where a nanometer-thick layer depleted of ionized salts electrochemically generated in concert with verifiable changes in the transmembrane electrical potential (TMEP). The modelling additionally verified presences of the active, substrate and support layers as well as manifestations of flux-dependent inductive and generative phenomena. Studies of calcium carbonate fouling correlated deteriorations in the ionic-barrier properties with the expected declines in salt-rejection and flux. The correlations and increases in TMEP were consistent with Ca²⁺ binding to paired -COO- groups in the carboxyl-rich outer-layer which diminished ionic-barrier properties of the depletion layer thereby explaining the decline in salt-rejection. More generally -COO-Ca-OOC- bonds can displace intermolecular hydrogen bonding and reduce sites that can bind the hydrogens of water. Such diminishes water-selective properties of the layer thereby explaining flux decline.

Biography

Terry Chilcott has specialized in Biophysics at the School of Physics, University of New South Wales and latter in industrial membranes at the UNESCO CMST at UNSW and presently in Membrane Science at the School of Chemical and Biomolecular Engineering at the University of Sydney. He is also a co-inventor of a unique impedance spectrometer commercialized by Inphaze Pty Ltd. He has some 50 publications in top international journals and some 50 peer reviewed papers delivered at international conferences.

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