TRANSIENT MEMBRANE POTENTIAL AFTER CONCENTRATION STEP: A NOVEL METHOD FOR ADVANCED CHARACTERIZATION OF ION-EXCHANGE MEMBRANES

Andriy Yaroshchuk, ICREA & Polytechnic University of Catalonia – BarcelonaTech
andriy.yaroshchuk@upc.edu
Marc Fernández de la Bastida, Polytechnic University of Catalonia – BarcelonaTech
Edxon E.Licón, Polytechnic University of Catalonia – BarcelonaTech

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Electrically-driven membrane processes find ever more versatile applications. Ion-exchange membranes are central elements of these processes. For their optimization, it is important to have detailed information on the transport and equilibrium properties of ion-exchange membranes, in particular, separate information on the equilibrium (partitioning) and kinetic (diffusivity) properties of membranes with respect to ions.

Stationary techniques of membrane characterization (membrane potential, Hittorf technique, DC electrical resistance) provide information only on ionic permeabilities, which are products of partitioning and diffusion coefficients. Non-stationary diffusion is well-known to provide information on the partitioning and diffusion coefficients of a diffusing species via a single time-resolved measurement. In principle, this classical technique can be applied to ion-exchange membranes but the typical use of pure solvent in the receiving compartment implies large trans-membrane concentration differences and strongly non-linear diffusion. This complicates considerably the interpretation.

In this communication, we present an alternative scenario of non-stationary-diffusion that can be implemented with moderate to small concentration differences. An ion-exchange membrane is sandwiched with a relatively thick porous support and put in a two-compartment stirred cell. The salt concentration in one compartment is kept stationary. The other compartment initially contains solution of the same concentration. At the start of the measurement, this compartment is rapidly emptied and filled up with a solution of a different concentration. The electrical response to this is tracked with a pair of indicator electrodes. This response is time-dependent because of progressive redistribution of applied concentration difference between the membrane and the porous support and the different ion perm-selectivities of those two media. The rate of signal relaxation is primarily controlled by the diffusion permeability of the membrane but is also affected by the salt partitioning coefficient. From the initially-constant signal one can determine the ionic perm-selectivity of the membrane. Thus, instead of just one parameter (perm-selectivity) available from the conventional measurements of stationary membrane potential we obtain information on 3 important properties of the membrane.