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Electro-Convective and Non-Equilibrium Electro-Osmotic Instability of Electric Conduction from an Electrolyte Solution into a Charge Selective Solid

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Electro-convection is reviewed as a mechanism of mixing in the diffusion layer of a strong electrolyte adjacent to a charge-selective solid, such as an ion exchange (electrodialysis) membrane or an electrode. Two types of electro-convection in strong electrolytes may be distinguished: bulk electro-convection , due to the action of the electric field upon the residual space charge of a quasi-electro-neutral bulk solution, and convection induced by electro-osmotic slip, due to electric forces acting in the thin electric double layer of either quasi-equilibrium or non-equilibrium type near the solid/liquid interface. According to recent studies, the latter appears to be the likely source of mixing in the diffusion layer, leading to 'over-limiting' conductance in electrodialysis. Electro-convection near a uniform charge selective solid/liquid interface sets on as a result of hydrodynamic instability of one-dimensional steady state electric conduction through such an interface. We discuss instabilities of this kind appearing in the full electro-convective and limiting non-equilibrium electro-osmotic formulations. The short- and long-wave aspects of these instabilities are discussed along with the wave-number selection principles and possible sources of low frequency excess electric noise experimentally observed in these systems.