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Equilibrium electro-osmotic instability in concentration polarization at a perfectly charge-selective interface

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Equilibrium electroosmotic instability in concentration polarization at a perfectly charge-selective solid, such as ion-exchange membrane or metal electrode, previously deemed impossible, is possible if one takes into account the finite electrical conductivity of the solid. A simple model for electro-convective diffusion of ions in the depleted diffusion layer predicts a supercritical transition to instability in the vicinity of the limiting current, as opposed to the subcritical transition for the previously studied non-equilibrium instability related to the extended space charge. The linear stability analysis in this model yields the division of the parameter space into domains in which each instability mechanism with its characteristic signatures dominates. Identification of the particular instability mechanism for a given system requires a detailed experimental study of the vicinity of the instability threshold in terms of both the voltage versus current dependence and flow visualization.

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