Desalination and Water Treatment
www.deswater.com

8 (2009) 221–224
August

doi: 10.5004/dwt.2009.735

Electric-field-driven transport of valence-asymmetric salts within stagnant fluid films

Maria Diná Afonso*, Vítor Geraldes

Technical University of Lisbon, Instituto Superior Te´cnico, Department of Chemical and Biological Engineering, Av. Rovisco Pais, 1, 1049-001 Lisbon, Portugal
Tel. +351 21 8417595; Fax +351 21 8499242; email: dina.afonso@ist.utl.pt

Received 20 December 2008; Accepted 15 July 2009

ABSTRACT

For many decades, the concentration polarization (CP) of uni-univalent salts arising within stagnant fluid films adjacent to charged surfaces in the presence of an electric field has been described by a simplistic model, designated here as classical theory. Barry [1] demonstrated that for a uni-univalent electrolyte the CP equation obtained by the aforementioned theory could also be derived from the Nernst–Planck equations. Here, as an extension of Barry's work, we deduce a CP equation based on the Nernst–Planck equations applicable to steady transport of valence-asymmetric salts (salts containing ions of distinct valences, e.g., Na_2SO_4, $CaCl_2$, $FeCl_3$) within stagnant fluid films in the vicinity of charged surfaces and in the presence of an electric field. It is shown that the expression derived

$$C_b - C_m = \frac{i\delta}{FD_x}\left(t_1^m - \frac{z_1 D_1}{z_1 D_1 - z_2 D_2}\right)$$

matches the classical CP equation for similar conditions, despite some deceptive hypothesis assumed by the latter.

Keywords: Concentration polarization; Electrodialysis; Nernst–Planck equations; Transport numbers; Valence-asymmetric salts

* Corresponding author.