Current Topics in Biophysics, 2007, 30 (suppl. B) 59

INFLUENCE OF THE EXTERNAL FORCES ON THE SPATIAL STRUCTURE OF CONCENTRATION BOUNDARY LAYERS

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In most cases, spontaneously occurring transport processes lead to creation of local non-homogeneity in solutions called concentration polarization leading to the temporal-spatial evolution of thermodynamic flows and forces. One of the effects of the temporal-spatial evolution of the concentration boundary layers is the evolution of the concentrations field, which causes that solutions concentrations at interfaces: membrane/ solution in the stationary state (C_i, C_e), are crucially different from concentrations in the initial moment (C_h, C_l). These concentrations fulfill conditions $C_i < C_h$ and $C_e > C_l$. Concentration profiles in CBLs may be registered with optical methods. It means that these layers, by reducing the concentration gradient across the membrane, limit both the volume and solute flows, which kinetics, on the phenomenological level, is controlled by the concentration Rayleigh number. In the case of the nonelectrolyte solutions transport through a neutral membrane, the concentration polarization consists in formation of the concentration boundary layers (CBL) at both sides of this membrane, which can be treated as a pseudomembrane. The thicknesses of this layers, denoted by δ_l and δ_h, may be described by the following system of equations

$$\upsilon_1\delta_l^4 - \upsilon_2\delta_l - \upsilon_3 = 0$$
$$\kappa_1\delta_h^4 - \kappa_2\delta_h - \kappa_3 = 0$$

where

$$\upsilon_1 = g\,(\partial\rho/\partial C)\{\zeta_{sD}\omega_m\Delta\pi + ½J_v[C_h(1 - \zeta_{sD}\sigma_m) - C_l(1 + \zeta_{sD}\sigma_m)]\},$$
$$\kappa_1 = g\,(\partial\rho/\partial C)\{\zeta_{sD}\omega_m\Delta\pi + ½J_v[C_l(1 - \zeta_{sD}\sigma_m) - C_h(1 + \zeta_{sD}\sigma_m)]\},$$
$$\upsilon_2 = ½J_vR_{Cl}\rho_l\nu_lD_l,\ \upsilon_3 = R_{Cl}\rho_l\nu_lD_l^2,\ \kappa_2 = ½J_vR_{Ch}\rho_h\nu_hD_h,$$
$$\kappa_3 = R_{Ch}\rho_h\nu_hD_h^2,\ J_v = \zeta_{sL}L_p(\Delta P - \zeta_{sO}\sigma\Delta\pi),$$

g – gravitational acceleration, ($\partial\rho/\partial C$) – the variation of density with concentration; ζ_{sL}, ζ_{sO}, ζ_{sD} – polarisation parameters of layers; L_p, σ_m, ω_m – parameters of membrane, ect. The nonlinear equations for thickness of concentration boundary layers can be used to numerical calculation in linear regime of the hydrodynamical stability.