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An accurate simplified data treatment for the initial adsorption kinetics in conditions of laminar convection in a slit: Application to protein adsorption

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Abstract

We present the derivation of a simple approximation for the original expression of the adsorption rate [Langmuir 10 (1994) 3898] in conditions of laminar flow in a slit, to relate the measured initial kinetic constant k with the interfacial kinetic constant ka and the transport-limited Lévêque constant kLev. The same method of derivation is applied here to get a simple approximation of the average kinetic constant □k□ [Biomaterials 20 (1999) 1621]. For the local value, at distance x from the entrance of the slit, we propose k(x)/ka=(u-1)(au-1)/(bu+1), where u=k(x)/kLev, a=0.452, b=-0.625, with a maximal error of 1% in comparison with the exact solution. For the average value over the length of the slit, we propose □k□/ka=(U-1)(A--1)/(BU+1), where U=□k□/□kLev□, A=0.203, B=-0.273, with a maximal error of 0.03%. These approximations lead to an easy determination of the adsorption constant and diffusion coefficient D of the solute, as appropriate plots of experimental data provide ka and D2/3 as the intercepts of the curve with the ordinate and abscissa axes, respectively. It is pointed out that the linear approximation k-1=ka -1+kLev -1 would lead to the overestimation of both the diffusion coefficient and adsorption kinetic constant. As an example, the application to the analysis of experimental data for adsorption of α-chymotrypsin onto mica plates is provided.

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Keywords

Convection-diffusion, Electrochemistry, Interfacial reaction, Protein adsorption