The accuracy of the stagnant film equation in the study of electrophoretic migration of solutes near an ultrafiltration membrane—a numerical study

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ABSTRACT

In membrane separation processes, the film equation is frequently used since it is a fast and easy way to predict the permeate velocity. In this work, the applicability of the film equation, based on a convective–diffusive–electrophoretic migration model (CDE), is evaluated using an in-house code. CDE model accounts for the transport of charged solutes in the boundary layer over a charged membrane. Two versions of the film equation were developed: CDE I—non-linear electric potential and total rejection of components; CDE II—uniform electric field and transmission of components through the membrane. The Sherwood number profiles, along the membrane length, for bovine serum albumin and lysozyme were determined by film equations. The permeate velocities, concentrations and rejection coefficients, obtained by solving numerically the conservative equations, were used as input to film equations. The Sherwood number profiles, determined by CDE I, are independent of the electric potential at the membrane surface, for low values of electric potential. The Sherwood number profiles, determined by CDE II, are independent of the electric field, for low values of electric field. In these ranges, Sherwood number profiles are identical to those in an impermeable cell and the film equation can be used to make accurate predictions.

Keywords: Film equation; Convective–diffusive–electrophoretic migration model; Mass transport; Protein separation; Computational fluid dynamics

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