Modeling Two-Phase Electrophoresis

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Introduction

Two-phase electrophoresis is a separation method that combines aqueous two-phase partitioning with electrophoresis and has promise for large scale recovery of biological products [1]. Aqueous two-phase systems formed by adding two polymers, like dextran and polyethylene glycol, to water provide some separation of dissolved species due to differences in solubility of solutes between the phases. The separating ability of these systems is limited, however, because both phases are mostly water and partition coefficients of most solutes are not very different from one. Applying an electric field perpendicular to the phase interface can improve the separation obtained by directing charged species into one phase or the other. The phase interface acts as a deterrent to convective mixing caused by ohmic heating, potentially allowing for large scale application of electrophoresis. We have demonstrated two-phase electrophoresis separations of proteins in both batch and flow devices.

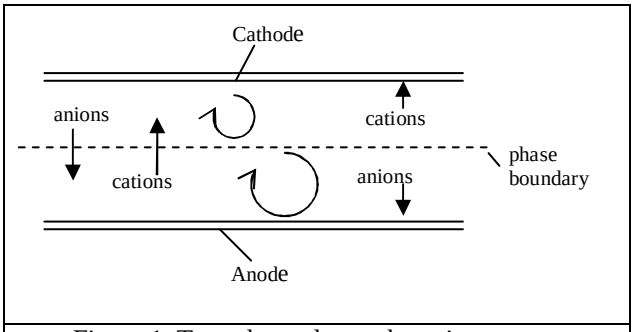

Figure 1: Two-phase electrophoresis concept.

Use of COMSOL Multiphysics

Modeling two-phase electrophoresis, especially in a flow device, is complicated because the concentration of a component at a given time and position depends on the applied electric field, the phase partitioning, and the two-phase flow pattern. In this poster we show that COMSOL multiphyisics is well suited to handle this complex problem. For a batch device we used the DC and the Electrokinetic Flow application modes to calculate results in agreement with our experiments. Even though the stiff-spring boundary condition was imposed to ensure equilibrium at the phase interface, the applied electric field was strong enough to cause migration across the interface. For a flow device, we added the Incompressible Navier-Stokes application and obtained results in qualitative agreement with our experiments. The level set method was used together with the Navier-Stokes equations to establish the calculated interface within the flow device. Modeling results presented on the poster will include protein separations as well as the effects of varying flow rates, electric field strength, and phase properties on directing a protein from one phase into another.

Reference

1. **R. D. Oehler and W. M. Clark**, -Lactamase Recovery from E. coli Cell Lysate via Two-Phase Electrophoresis, *Biotechnol. Prog.*, **12**, 873-876 (1996) .