

30a Combining Previous Theoretical Analyses into an in Silico Predictive Global Model for Microfiltration of Complex Suspensions and Macromolecular Solutions

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Most unit processes currently used in the chemical and biotechnology industries such as distillation, extraction, chromatography, electrophoretic separations, have associated with them well-tested and widely used predictive models. There are practical and economic reasons for using such models, including optimizing design and operation conditions for maximum product yield and purity at minimum cost (for bioprocessing) or for maximum permeation flux (for water treatment). Although pressure-driven membrane technology is extensively used in industry today, it suffers from a lack of theoretical understanding. This is, in part, due to the enormous challenges associated with filtering complex industrial fluids and a lack of understanding of the transport and fluid mechanical processes involved.

Many theoretical advances have been made during the past 20 years in several disparate fields that when combined into a comprehensive iterative model provides the opportunity for predicting practical membrane performance. These advances include new understanding of the behavior of (i) suspended particles moving in laminar flow through porous ducts and depositing onto porous membrane surfaces with subsequent buildup of porous cakes or into pores, (ii) transport through such cakes or pores that have been blocked or narrowed, (iii) electrostatic forces involved with charged species such as proteins or colloids in solutions of different ionic strength, etc.

In this presentation we will summarize a global approach using recent theoretical advances from many groups around the world to address the lack of predictive capability. Then, we will test this preliminary model with feeds containing simple binary biological components, followed with complex real fluids (transgenic whole goat milk). The hope is that these early attempts will form the basis of and can be used as a template for future more complicated in silico models. Refining and extending the in silico predictive model to other complex fluids and under different fluid mechanical regimes is currently underway in our laboratory.