Spectral element simulation of ultrafiltration

A spectral element method for simulating stationary 2-D ultrafiltration is presented. The mathematical model is comprised of the Navier-Stokes equations for the velocity field of the fluid and a transport equation for the concentration of the solute. In addition to the presence of the velocity vector in the transport equation, the system is coupled by the dependency of the fluid viscosity on the solute concentration and by a concentration-dependent boundary condition for the Navier-Stokes equations at the membrane surface. The spectral element discretization yields a nonlinear algebraic system for the unknowns at the mesh nodes. This system is solved via a technique combining the penalty method, Newton-Raphson iterations, static condensation, and a solver for banded linear systems. In addition, a smoothing technique is used to handle a singularity in the boundary condition at the membrane. The performance of the spectral element code when applied to several ultrafiltration problems is reported. (C) 1998 Elsevier Science Ltd. All rights reserved.

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