Pore Scale Analysis of Reaction Dependent Viscosity Variations for Subsurface Engineered Systems

Scientific Achievement

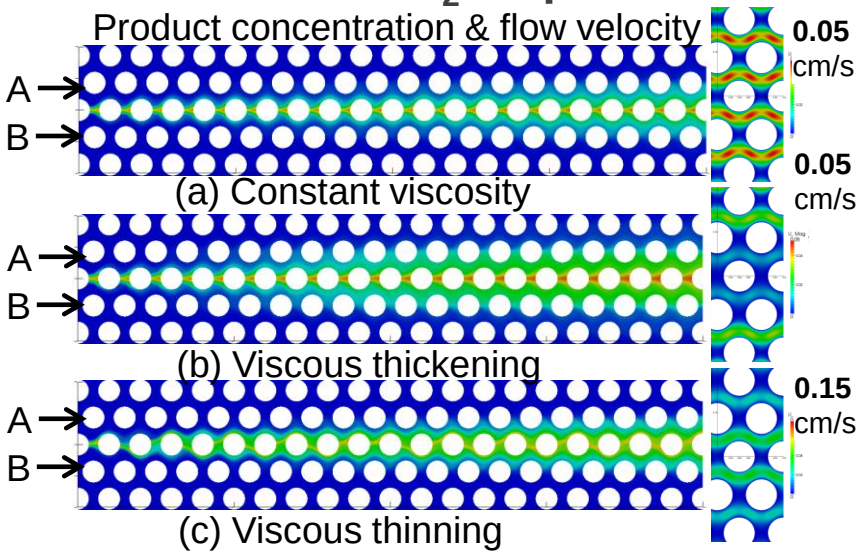
Developed a computationally powerful & highly parallelized pore-scale model to examine flow in porous media with chemical reaction dependent viscosity

Significance and Impact

Pore scale simulations on high performance computers suggest that mixing-induced chemical reactions can alter fluid properties (e.g., viscosity and density) and shear rate enabling engineered solutions for CO_2 sequestration

Research Details

- More reaction product was formed when fluid viscosity increases with increasing product concentration (viscous thickening) than the opposite case (viscous thinning)
- Enhanced mixing at pore scale leads to enhanced reaction rates at high local ratio of reaction rate to flowrate (Da) and lower porosity
- Flows with viscous thinning reactions can become unstable at high Da, leading to enhanced mixing and reaction rates under high Peclet number and higher porosity



Comparison of reaction product (A+B -> C) concentration and flow velocity in the loosely packed array for different viscosity variations. Hot (or cool) color depicts high (or low) concentration and velocity. Onset of Instability is shown in (c).

S.M. Davison, H. Yoon, and M.J. Martinez, Advances in Water Resources, 38, 70-80 (2012)

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