Numerical Simulation of Denitrification in Unsaturated Porous Media

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In this talk, we present our work on developing a finite element code to simulate the denitrification process in unsaturated porous media. We are interested in solving the Richards equation which governs the flow of water in unsaturated porous media and the transport equation which describes the convection, diffusion and reaction processes of a set of chemical species and microbes.

Specifically, the mixed finite element is employed to discretize the flow equation, where both water flux and pressure head are treated as primal solutions. To solve the linearized system, we adopt a block-diagonal preconditioner based on the algebraic multigrid method, whose convergence is independent of the mesh discretization parameter. As the transport equation is usually convection-dominated, using a standard Galerkin finite element method leads to substantial oscillation at sharp gradients. Consequently, the streamline upwind Petrov-Galerkin method is used to alleviate the oscillation. After benchmarking the resulting code with classical benchmark problems, we will further demonstrate its ability in simulating the denitrification process.