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Modeling Uranium Bioreduction by Multispecies Biofilms

In oxidized groundwater, soluble uranium (U[VI]) has the potential to rapidly disperse and lead to wide-spread contamination. In this work, we develop and discuss two models to investigate the use of in-situ microorganisms, in the form of bacterial biofilms, as an effective treatment technology for uranium contaminated soil and groundwater.

The first model is a reactive transport model that describes uranium bioreduction in porous media. This model is a multiscale model developed first by describing microbial processes at the mesoscale, then upscaling these processes to the macroscale (reactor scale). Processes included in the mesoscale model are hydrodynamics and transport of substrates in the reactor, two biofilm and suspended bacteria species and their respective growth kinetics in the pore space through consumption of appropriate substrates coupled with the bioreduction of uranium, attachment of suspended cells to each of the biofilms, detachment of biofilm cells, and cell lysis.

The second model is a traditional chemostat model of the system described above, which is used to investigate the importance of specific reaction kinetics on the overall effectiveness of uranium bioreduction.