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Potential of Iron Nanoparticles for Remediation of Organic Contaminants in Groundwater

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The potential of nanoscale zerovalent iron (NZVI) particles for remediation of chlorinated hydrocarbons has been investigated for the last two decades. Due to their small size and large specific surface area, NZVI particles can reduce the contaminants more rapidly compared to granular zerovalent iron (ZVI) particles. However, the main concern of NZVI application is its rapid aggregation and deposition. Our previous study shows that straining is a significant retention mechanism during transport of NZVI particles, even though its surface is modified with carboxymethyl cellulose (CMC-NZVI). Moreover, deposition of CMC-NZVI increases significantly with decrease in flow rate (relevant for groundwater flow). Considering these factors, application of NZVI as a stationary barrier in front of the contaminated plume was proposed here.
The main objective of this study is to evaluate the potential of NZVI for remediation of different organic contaminants in the aquifer as a stationary barrier. In order to achieve this objective, first all the contaminants that can be degraded by NZVI and their functional groups are identified. The amount of ZVI and reaction times, that are required for transforming 1 L of 100 mg/L contaminated water were calculated based on literature data. A typical groundwater flow of 0.05 cm/min is considered for further analysis. Approximate length of NZVI barrier was calculated based on the reaction time and groundwater flow rate, to ensure adequate interaction time between NZVI and the contaminants to complete the reaction. A hypothetical homogeneous aquifer conditions were considered where CMC-NZVI is injected through the injection well in front of a contaminated plume. Fate and transport of CMC-NZVI was calculated through the porous media, where the parameters for CMC-NZVI transport was adopted from our previous study. Fate and transport of few specific contaminants such as nitro-explosive (i.e. 1,3,5-trinitro-1,3,5-triazine (RDX)) or chlorinated hydrocarbon (Trichloroethylene (TCE)) are calculated and compared in the presence and absence of CMC-NZVI barrier. Reaction rate with CMC-NZVI and required parameters for solute transport were adopted from literature. Amount of NZVI and reaction time required for complete reaction, estimated length of NZVI barrier, fate and transport of contaminant in the presence and absence of CMC-NZVI barrier would be discussed during the presentation.