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Transport of carbon colloid supported nanoscale zero-valent iron in porous media

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The use of nano zero-valent iron (nZVI) for environmental remediation is an emerging technology for in situ remediation of contaminated groundwater. Due to its high surface area and high reactivity nZVI is able to dechlorinate organic contaminants and render them to less harmful substances. Carbo-Iron is a newly developed material consisting of activated carbon particles (d50 = 0.6 – 2.4 μm) that are doted with nZVI particles. These particles combine the sorption capacity of activated carbon and the reactivity of nZVI. Additionally the main limitation for nZVI delivery, a limited mobility due to fast aggregation and sedimentation of nZVI in dispersions and soils, might be solved. According to transport theory, particles with a diameter of approximately 1 μm are more mobile than unsupported nZVI particles in sandy aquifer systems. Results from column tests and a two dimensional laboratory aquifer test system are presented:
Column tests using columns of 40 cm length were filled with sand. A particle suspension was pumped against gravity through the system. Results show, addition of a polyanionic stabilizer such as Carboxymethylcellulouse (CMC) is required to enhancing mobility. Ionic strength and pH concentrations in an environmental relevant range do not interfere significantly with transport, but particle size was found to be crucial.
Another experiment was performed in a two dimensional aquifer test system. The test system contains a sand filled container with a inner size of 40 x 5 x 110 cm and seven ports on each side. A constant flow of water was applied from the left to the right side through all ports and the middle port was fed with a Carbo-Iron suspension. Results show a transport through the laboratory aquifer within few exchanged pore volumes, and breakthrough of Carbo-Iron at the outlet. Deposits of immobile Carbo-Iron were found to be decreasing with distance from the injection port. No gravity effects were observed.
Results suggest high mobility of carbon supported nZVI under environmental relevant conditions. Carbo-Iron might be helpful to deliver nZVI into contaminated aquifers. There 1D and 2D results support the design of a field test and application of Carbo-Iron for nZVI delivery.