Nanoparticles for Permeable reactive barriers: Production and application of mobile particles

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Description

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Permeable reactive barriers have been recognized as a cost-effective technology for in-situ groundwater remediation. Placement of the barrier underground is the biggest challenge in this technology, consuming most of scientific and financial resources, so far. Injecting engineered nanoparticle suspensions to create a reactive barrier in soils has shown potential to overcome this challenge. Nanoparticles will deposit on aquifer sand, and then adsorb and/or react with groundwater contamination. Injection can be made using wellbores, thus reducing the costs of the barrier placement. However, nanoparticles have low mobility and are transformed (and thereby lose their capacity to react) in the close vicinity of the injection zone.

We have designed and produced Goethite nanoparticles to adsorb heavy metals in contaminated groundwater. Our colloidal suspensions show high stability and mobility in different sediment types. Laboratory tests with aquifer materials and numerical simulations were combined in order to understand how different hydrological and hydrogeochemical parameters affect the particle mobility when injected in porous media. The final nanoparticles are stable over days, facilitating transport from the place of production to the injection sites, and therefore minimizing on-site modification. By adjusting the concentrations of the injected suspensions and the injection flowrates, a desired mass of nanoparticles can travel in aquifers without accumulating near the wellbore or clogging pores. For example, a radius of influence of 4 meter was achieved at an injection rate of 60l/min. At such scale, the number of drilling and completion activities are lowered and stable, cost-effective reactive barriers can be placed. We thus present an applicable technology for the creation of in situ adsorption barriers for heavy metals in groundwater.