Next Generation of Nanoremediation: nZVI Application Enhanced by DC Electric Field

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The use of zero-valent iron nanoparticles for contaminated groundwater remediation is a standard method for in situ removal or stabilization of chlorinated hydrocarbons, selected inorganic anions, heavy metals and others. The effectiveness of this method depends on the geological and hydrogeological conditions which affect both the reactivity of nanoparticles with contaminants and their migration in groundwater. In the case of low permeability, the migration of nanoparticles is very limited and the efficiency of the method might be reduced. The application of nanoparticles supported by DC electric field of certain field intensity leads to a significant increase of total efficiency of this combined remediation technique.

It was first confirmed in the laboratory, but also afterwards during a long-term monitoring event at the site (Horice, Czech Republic). The first field experiment was conducted on the test polygon of cathodes and anodes. These results showed a significant improvement of efficiency of this method compared with the conventional use of nanoiron particles. Then the pilot system was extended to nine test polygons which sufficiently covered existing contamination hotspots at the site. Within 3 years of running the enhanced remediation system, cleanup of the site was achieved. Another successful implementation of the method took place in a different environment at site Spolchemie. At this site the method was used to establish a geochemical barrier to limit contaminant outflow from the site. In principle the method is based on electrochemical reactions occurring in the surrounding electrodes to increase the reductive conditions.

This research has shown a positive effect on the efficiency and longevity of the use of nano zero valent iron particles. In economical comparison of the method with the conventional use of nanoiron, cost savings are around 40% and at least 2-fold iron active time are confirmed. Technically the method requires regular monitoring and, depending on the groundwater conditions, regular renewal of anodes due to their oxidation. From an ecological perspective the method leads to significantly improved results in reducing contaminant concentrations and increasing the effective time of the method.