INTEGRATED ZERO-VALENT IRON AND DARK OXIDATION PROCESSES FOR IN-SITU REMEDIATION OF EXPLOSIVES IN GROUNDWATER

Beth C. Fleming
U.S. Army Engineer Research and Development Center
Waterways Experiment Station

Christian J. McGrath
U.S. Army Engineer Research and Development Center
Waterways Experiment Station

The Army, in addition to other DoD and governmental agencies, is actively seeking effective remediation technologies that can be applied to the in-situ treatment of explosives-contaminated groundwater. Microbiological treatment techniques appear to be successful for RDX cleanup, but are less successful for TNT and other explosives. Previous studies indicate great promise for technologies involving reactions with zero-valent metals in the treatment of groundwaters contaminated with nitroaromatics and chlorinated solvents. However, particularly in the case of nitroaromatics, enhancements to the process are needed to achieve more complete contaminant degradation. The application of Fenton's process and potassium permanganate in combination with zero-valent iron (ZVI) potentially will be capable of providing an in-situ treatment alternative for explosives and other recalcitrant organic contaminants.

Oxidation processes are being evaluated as an enhancement to ZVI reduction of explosives. Ongoing research at the U.S. Army Engineer Research and Development Center (ERDC) Waterways Experiment Station (WES) indicated that TNT and RDX can be rapidly and completely reduced in zero-valent iron systems, but complete mineralization does not occur. Fenton's reagent treatment (i.e., oxidation of organic compounds by hydroxyl radicals generated in reactions between hydrogen peroxide and ferrous iron) and potassium permanganate were evaluated in combination with ZVI treatment to destroy explosives.

Bench-scale, batch experiments involved evaluation of the effects of ZVI reduction followed by Fenton oxidation and potassium permanganate on TNT- and RDX-spiked solutions. The ERDC WES has performed preliminary studies which indicate concentrations of 20 ppm TNT can be reduced by ZVI in less than 3 hours. Determination of the reaction intermediates and end products associated with both the ZVI treatment alone and in combination with Fenton's treatment and potassium permanganate is under investigation. Preliminary evaluations of application of zero-valent iron metal reduction and oxidation processes to site soils indicate this technology is promising. Dynamic column studies will be evaluated to more closely mimic in-situ applications of the combined technologies.

Beth C. Fleming
U.S. Army Engineer Research and Development Center
Waterways Experiment Station
Phone: (601) 634-3943
Fax: (601) 634-3833
Email: Fleminb@wes.army.mil
Christian J. McGrath
U.S. Army Engineer Research and Development Center
Waterways Experiment Station