Degradation of Toxic Organics by Nanosized Metallic Systems and by Hydroxyl Radical Reaction

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The Challenges of DNAPLs

Chloro-organics contamination of groundwater and soil is quite widespread in various locations. We have successfully evaluated highly toxic organics as DNAPL is lost to the aqueous phase. The mass transfer between these phases may have potentially be used to mobilize the DNAPL from the sediment. Laboratory packed column studies to simulate groundwater flow demonstrate fast and complete dechlorination of TCE in soluble and as DNAPL form, and selected PCBs. Because of the diversity of chemicals present in hazardous waste and Superfund sites, the development of integrated, post-effective technologies (both oxidative and reductive systems) is important for solving various remediation problems.

Oxidative Destruction of TCE Using OH- or Hydroxyl Radicals

The reaction mechanism for hydroxyl radical attack on TCE: TCE + OH. → CO₂, Organic Acids

Reductive Dechlorination of TCE

Systems Used

- Chelate-Nano: Standard Fenton Reaction, Modified Fenton Reaction
- Nanomaterial-Bonded: Fe/Pd, Fe/Ni, Bimetallic nanoparticles

Reductive Dechlorination of Polychlorinated Biphenyls (PCBs)

The technology enhancement: on-site generation of chelate and H₂O₂.

Conclusions

- Demonstrated fast and complete dechlorination of TCE and selected PCBs by non-metall-based reductive process. Demonstrated further breakdown of biphenyl by chelate-modified Fenton reaction.
- Developed an in-situ polymerization functionalization method to enhance the metal capture and immobilization as well as the control of nanoparticle size and distribution through high loading of chelate groups inside membrane pores.
- Quantified the role of dopant metal (Pd) and the effect of dopant coating content in terms of bimetallic nanoparticle reactivity.
- Demonstrated TCE-DNAPL could be dechlorinated by chelate-modified Fenton reaction at neutral pH environment.
- Both oxidative and nanotechnology-based treatments of TCE in column studies simulating groundwater flow demonstrated >95% TCE removal using minimal chemical dosing.

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