Perchloroethylene (PCE) Degradation Using Fine Metal Particles

S. Harendra and C. Vipulanandan

Center for Innovative Grouting Material and Technology (CIGMAT)
Department of Civil and Environmental Engineering
University of Houston, Houston, Texas 77204-4003
Phone: (713) 743-4250 Email: cvipulanandan@uh.edu, ps_harendra@yahoo.com

Abstract:

In this study, perchloroethylene (PCE) was degraded using Fe and Fe-Ni bimetallic fine metal particles prepared by the solution method. PCE solubility was increased up to 1000 mg/l using cetyl trimethyl ammonium bromide (CTAB) and sodium dodecyl sulfate (SDS) surfactants and then degraded. Fe-Ni bimetallic particles degraded PCE faster compared to the Fe particles.

Introduction:

Perchloroethylene (PCE) is a colorless, nonflammable liquid which is widely used in dry cleaning, textile industries, degreasing metal parts and as an ingredient in the manufacturing of various chemicals such as chlorofluorocarbons, lubricants solvents. PCE is a DNAPL with a water solubility of 120 mg/l. The maximum contaminant level for perchloroethylene in drinking water is 5 ppb (USEPA, 749-F-94-020a).

In the ground water PCE can persist for decades and travel in plumes with the ground water flow [1]. Microorganisms in the soil and ground water slowly breakdown PCE over time [1]. Because of its lower solubility, immiscibility, relatively slower rates of dissolution and high density it is extremely difficult to remedy PCE. PCE contaminated soil may be cleaned by excavating the soil, incinerating it and disposing of the ash in a landfill. PCE contaminated ground water has been remediated using methods such as pump and treat, bioremediation and phytoremediation. The method of remediation depends upon the PCE concentration, access to contaminated site, cost of disposal and other site specific factors.

Objective:

The overall objective of this study was to investigate the potential of using nano particles to rapidly degrade PCE solubilized in two surfactant solutions.

Production of Nano particles:

Fine Fe particles were produced by the solution method using $FeCl_3$ solution and reducing it by using $NaBH_4$ under inert atmosphere. Bimetallic Fe-Ni particles were produced by using $FeSO_4$ and $NiCl_2$ in the same manner as mentioned above.

Reduction of PCE:

PCE solubility was increased using CTAB and SDS surfactants. 45 g/l Fe particles prepared by solution method was used in PCE degradation and the results are shown in

Fig.1.100 g/l Fe-Ni bimetallic particles used in degrading PCE and the results are shown in Fig.2.

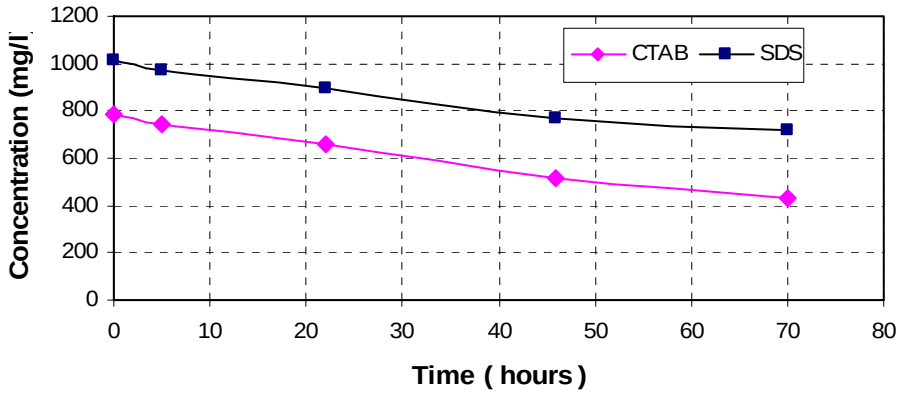

Figure 1: Degradation of PCE solubilised in surfactants using 45 g/l Fe particles prepared by solution method

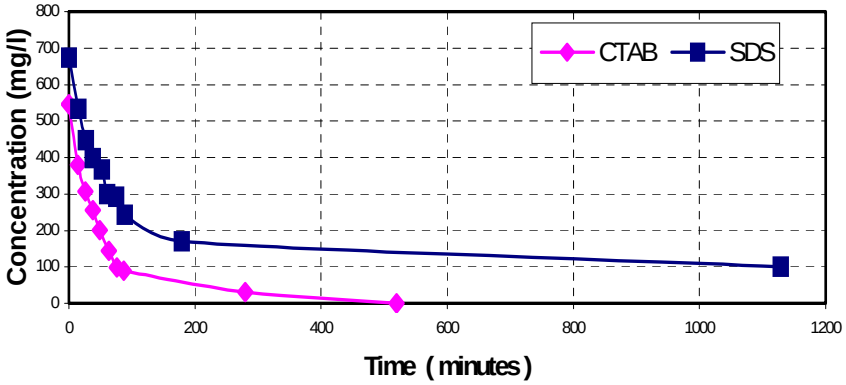

Figure 2: Degradation of PCE solubilised in surfactants using 100 g/l Fe-Ni particles prepared by solution method

Conclusion:

Compared to the Fe particles, Fe-Ni bimetallic particles showed faster degradation of PCE. The amount of Fe-Ni bimetallic particles needed to completely degrade 550 mg/l of PCE within 8.5 hours was 100 g/l.

Acknowledgement:

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References:

1) Technical outreach service for communities (TOSC), Hazardous fact sheet (PCE), pp1-2