Degradation of Surfactant Solubilized Carbon Tetrachloride (CCl_4) with Fe/Ni Bimetallic 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) 743-4278
Email: ps_harendra@yahoo.com, cvipulanandan@uh.edu

Abstract: In this study, carbon tetrachloride (CCl_4) was degraded using Fe-Ni bimetallic fine metal particles prepared by the solution method. CCl_4 solubility was increased up to 8000 mg/L using cetyl trimethyl ammonium bromide (CTAB) and sodium dodecyl sulfate (SDS) surfactants and then degraded.

1 Introduction

Chlorinated hydrocarbons such as carbon tetrachloride (CCl_4), chloroform ($CHCl_3$), and trichloroethylene are the most frequently found contaminants in soil and groundwater (Maithreepala et al. 2004). Because they are prevalent in contaminated sites and are highly toxic to human beings and ecosystems, studies have been conducted to elucidate the kinetics and mechanisms of dechlorination of these compounds in the contaminated sites. The rapid dechlorination of low concentrations of chlorinated hydrocarbons in the presence of Fe (II) species, acting as environmental reductants under anoxic conditions (James et al. 2000; Harendra and Vipulanandan, 2008) have been investigated.

Carbon tetrachloride was formerly used for metal degreasing as a dry-cleaning fluid, fabric spotting fluid, fire-extinguisher fluid, grain fumigant and reaction mechanism ((Donglin et al. 1998). Carbon tetrachloride is used as a solvent for the recovery of tin-plating waste and in the manufacture of semiconductors. It is used as gasoline additives, refrigents, metal degreasing and as catalyst in the production of polymers. Carbon tetrachloride is also used as a chemical intermediate in the production of fluorocarbons and some pesticides (Jan et al 2004).

2 Objectives

The overall objective of this study was to investigate the potential of using fine particles to rapidly degrade CCl_4 solubilized in two surfactant solutions.

3 Production of bimetallic particles

Bimetallic particles were produced by solution method using $FeSO_4$ and $NiCl_2$ and reducing it by $NaBH_4$ under an inert atmosphere. The mean size of particle size was 812 nm. 200 g/L Fe/Ni particles prepared by solution method.

4 Analysis and Discussions

The solubilization kinetics is shown in Fig. 1.Using the surfactants up to 8000 mg/L (10 times more than the water solubility) of CCl_4 were solubilized. The amount of CCl_4 solubilized by various surfactants was different and had the following trend in 10g/L of surfactant solutions; CTAB > SDS (Fig 1). CCl_4 degradation by Fe/Ni nanoparticles is shown in Fig 2. 8000 mg/L CCl_4 solubilized in CTAB was completely degraded in 60 hrs.

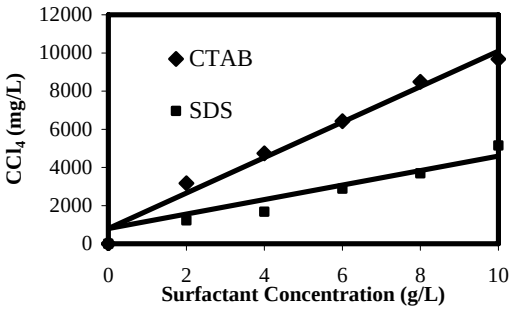

Fig 1: Solubilization of CCl_4 in 10 g/L surfactant solutions

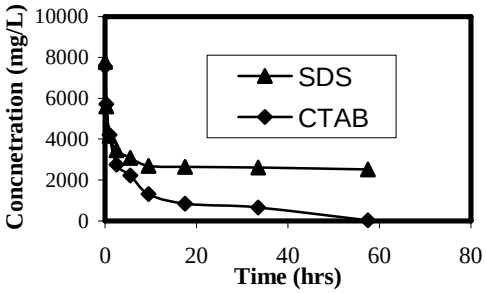

Fig 2: Degradation of CCl_4 solubilized in CTAB and SDS using 200 g/L Fe/Ni particles.

5 Conclusions

Total of 8000 mg/L of CCl_4 solubilized in 10 g/L of CTAB was completely degraded by 200 g/L of Fe/Ni particle in 60 hrs and this was not the case with the SDS system.

6 Acknowledgements

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7 References

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