Abstract

Tianbo Xu, Ph.D. Purdue University, August 2005. Effect of Zero Valent Metals and Water Miscible Solvent on Reductive Dechlorination of Polychlorinated Biphenyls. Major Professors Loring Nies, Linda Lee

The use of polychlorinated biphenyl (PCBs) was discontinued in 1970's; however, PCB contamination of soils and sediments remains widespread. Many physical, chemical, and biological methods have been developed and evaluated for PCB degradation in past three decades. But due to PCB's low aqueous solubility, to be recalcitrance and environmental persistence, environmental PCB remediation continues economically prohibitive. The use of zero valent iron (ZVI) dechlorination of PCBs has been reported in several solution systems, but the effectiveness of ZVI to degrade PCBs sorbed in sediments and soils has not been addressed in the literature to date. This research is to identify a ZVM-cosolvent system that will be economically feasible for the dechlorination of PCBs in environment. To achieve this goal, the role of nano-scale ZVMs (Fe^0, Zn^0, Al^0, Fe/Pd, Fe/Ag, Fe/Cu, Fe/Pt) and cosolvents (THF, ethanol, and acetone) on the mechanism and kinetics of PCB dechlorination was examined in soil-free and Aroclor 1242 contaminated sediment systems. Fe, Zn, and Al degraded high chlorinated congeners to low chlorinated congeners. Bimetal, except for Fe/Pt, completely degraded 2,3,4,6-PCB with varied rate constants. The reaction pathway was driven by ZVMs or bimetals rather than by cosolvent. Nano-scale palladized (0.5%) Fe in 30% acetone completely dechlorinated Aroclor 1242 to biphenyl and chloride in less than one minute in a soil-free system, and in less than three days in a sediment system. Biphenyl and chloride recoveries were 90 ± 2 % and 74 ± 14 %, respectively, in the soil-free system and 82.2 ± 4.5% and 56 ± 15%, respectively, in the sediment system. Only small amounts of low chlorinated intermediates observed in the test of Aroclor 1242 with Fe/Pd indicates that the Pd as a catalyst lowers the activation energy of all the PCB congeners to a similar level. Bench-scale feasibility tests of in-situ injection and ex-situ mixing of an acetone-Fe/Pd slurry as a tool for PCB remediation was also conducted and will be discussed.