Removal of Tetrachloroethylene (PCE) from Groundwater by Coupled NZVI@MgAl-LDHs Composite and PCE-Degrading Microbial Consortium

Qing Wang (qwang@issas.ac.cn), Xin Song (xsong@issas.ac.cn), and Shiyue Tang (sytang@issas.ac.cn) (Institute of Soil Science, Chinese Academy of Sciences, Nanjing, China)

Background/Objectives. In situ bioremediation has been proven to be a cost-effective remediation technology for chlorinated-solvent contaminated groundwater. However, the bioremediation process has some limitations, such as low dechlorination rates and long cleanup times, toxicity to the dechlorinating bacteria due to occurrence of contaminants in high concentration. In this study, removal of tetrachloroethylene (PCE) from groundwater by coupled NZVI@MgAl-LDHs composite and PCE-degrading microbial consortium were studied to address the above mentioned issues. To the best of our knowledge, no study has been performed by using layered double hydroxides (LDHs) as a support of nano zero-valent iron (NZVI) to prepare multifunctional materials for the removal of chlorinated hydrocarbons in groundwater. The degradation efficiency and the mechanisms of PCE removal by the coupled NZVI@MgAl-LDH composite and PCE-degrading consortium were explored.

Approach/Activities. The acclimated microbial consortium was enriched through gradient culture under anaerobic conditions using anaerobic activated sludge from a wastewater treatment plant. The composition of the acclimated microbial consortium were identified through 16S rRNA analysis. The NZVI@MgAl-LDHs composite was prepared by co-precipitation method, and the corresponding physico-chemical properties were determined using transmission electron microscope (TEM), energy dispersive X-ray spectra (EDS), Brunauer Emmett Teller (BET) adsorption, X-ray diffractometry (XRD), and Fourier transform infrared spectroscopy (FTIR). To evaluate PCE removal efficiency and the associated mechanisms, microcosm experiments were conducted by the coupled NZVI@MgAl-LDHs composite and the enriched PCE-degrading consortium.

Results/Lessons Learned. The enriched PCE-degrading consortium consisted of 44.5% Clostridium and other potential PCE degraders. It was found that PCE could be completely degraded within 5 days at the initial concentration of PCE 2.5 mg/L, and that the highest PCE biodegradation was observed with the neutral pH at the temperature of 30 °C. The NZVI@MgAl-LDHs composite exhibited a specific surface area of 56.4 m^2/g as the MgAl-LDHs were coated on the surface of NZVI particles. The microcosm experiments results showed that 10 mg/L PCE can be removed completely within 4 h when adding 2 g/L NZVI@MgAl-LDHs, faster than that by NZVI solely. The degradation rate constants of PCE decreased with the initial pH decreased. The common groundwater anions including NO_3^-, Cl^-, CO_3^{2-}, and SO_4^{2-} inhibited the degradation efficiencies of PCE slightly by NZVI@MgAl-LDHs. In our next step, the degradation efficiency and the mechanisms of PCE by coupled NZVI@MgAl-LDH composite and PCE-degrading consortium will be studied, especially the interrelation between particles stability and cytotoxicity.