NITRATE AND SULFATE ASSISTED BIODEGRADATION OF PETROLEUM HYDROCARBONS: TREATABILITY STUDY AND PILOT SCALE RESULTS

Paula Chang (paula.chang@erm.com) (ERM, Scottsdale, Arizona)
David Abranovic (david.abranovic@erm.com) (ERM, Scottsdale, Arizona)
Richard A. Brown (dick.brown@erm.com) (ERM, Ewing, New Jersey)

Petroleum hydrocarbons (HCs) were discovered in groundwater at the Minnesota Air National Guard facility in Duluth, Minnesota. The base is located in the Precambrian bedrock of the Duluth area, which has been scoured by glaciers that deposited 5 to 10 meters of glacial till, a red soil that varies from clay to silt, over the bedrock. Bench treatability studies of the anaerobic biodegradation of HCs using nitrate and sulfate as electron acceptors were conducted with soil and groundwater from the base.

The potential for the biodegradation of HCs under anaerobic conditions is promising, given the limited water solubility of oxygen and the high use rate of oxygen under natural groundwater conditions. Anaerobic conditions, such as nitrate reducing and sulfate reducing conditions, have the potential to increase the degradation rate of HCs through the greater solubility of their salts and the higher ratio electron acceptor to electron donor (Reinhard, 1994). This treatability study evaluated the effectiveness of combined nitrate and sulfate reduction versus sulfate reduction alone for biodegradation of site HCs (benzene, toluene, ethylbenzene, and total xylenes [BTEX], gasoline range organics [GRO] and diesel range organics [DRO]). In the sulfate and nitrate amended treatments, BTEX was degraded within eight weeks of the initiation of the study. No GRO or DRO were detected during week 13 in the nitrate and sulfate amended treatment bottles. In treatments where only sulfate was added, benzene, DRO and GRO lingered past week 13 of the study. All of the treatment bottles were respiked with nitrate and sulfate at week 13, and the pattern of complete HC degradation in the nitrate and sulfate amended treatment was repeated within the next 13 weeks.

These results suggest that the addition of nitrate and sulfate as co-amendments are an effective remediation alternative for impacted groundwater. A field scale pilot test was conducted in October of 2006 to collect site-specific remediation parameters for a full-scale application. Because of the fine-grained materials comprising the shallow aquifer at these sites, the nitrate and sulfate was delivered in solution using a patented Wavefront^{TM} pressure pulse technology (PPT). Pressure pulsing was performed using a specialty in-line pump, which delivers a periodic low-frequency porosity dilation wave causing dilation of the pore throats allowing for an increased fluid flow rates and more homogeneous electron acceptor distribution. The remedial parameters that were evaluated included: distribution of the amendment and degradation of the electron acceptors and HCs, and effectiveness of the PPT.

Biographical Sketch: Ms. Paula Chang has over 16 years of experience as a groundwater remediation specialist. With an M.S.E. in Civil and Environmental Engineering from the University of Michigan, and a Bachelors degree in Geology from Wellesley College, she is based in Scottsdale, Arizona, where she serves as a technical resource for the application of biological and chemical reduction technologies to remediate recalcitrant compounds in

groundwater. Her current project work includes the oversight of several pilot and full-scale enhanced in situ bioremediation and chemical reduction projects for treatment of chlorinated solvents, HCs, and metals.