Successful Denitrification Using Food-Grade Lecithin

Jack Sheldon (jack.sheldon@anteagroup.com) (Antea Group, West Des Moines, IA, USA)
Kirby Smail (kirby.smail@anteagroup.com) (Antea Group, Pella, IA, USA)
Josephine Molin (josephine.molin@peroxychem.com) (PeroxyChem, Philadelphia, PA, USA)

Background/Objectives. Considerable attention is given to petroleum and chlorinated solvent remediation, but we only a see a limited number of nitrate remediation projects across the country each year. Under optimized conditions, bioremediation of nitrate using an electron donor (carbon source) has proven to be highly successful. Specifically, in situ denitrification (ISD) using a food grade carbon source was implemented for cleanup of two hot spot locations with elevated nitrate at a former railroad property in Kansas. The site was leased to an agricultural company for fertilizer distribution and following a flood event, nitrate and ammonia concentrations exceeded the state standard of 10 mg/L ammonia + nitrate. The site was remediated under the Kansas Voluntary Cleanup and Property Redevelopment Program. A discussion of the site conditions and upfront investigation, details of the remedy approval process, a description of the injection process with lessons learned, and a summary of remediation performance results will be provided.

Approach/Activities. A thorough understanding of the groundwater geochemistry and microbial profile were important to developing the remediation approach. Molecular Biological Tools (MBTs) were employed and were critical in understanding the presence of denitrifying bacteria and ammonia oxidizing bacteria as well as functional genes involved in denitrification/nitrification processes. A food grade lecithin formula was selected and injected by direct push technology at over 70 locations. Lecithin is an ideal candidate to support denitrification. At proper dosing, the lecithin can be used to create a slightly reducing condition that optimizes denitrifying conditions. The lecithin formula had a combination of hydrophilic and hydrophobic phospholipids, fatty acids, complex carbohydrates, and simple sugars and traces of inorganic nutrients. Through biodegradation of the amendment, hydrogen was released and utilized by the subsurface bacteria to reduce the nitrate. The denitrification process proceeds through steps to nitrite, nitric oxide, nitrous oxide, and ultimately, nitrogen gas. Nitrite is often the only detectable intermediate. The monitoring program focused on reductions in nitrate concentrations, detections of nitrite and ammonia, and changes in geochemistry/field parameters.

Results/Lessons Learned. Groundwater sampling in the two hot spot areas was completed quarterly for 18 months and the concentrations of nitrate were reduced to below the state standard. A No Further Action determination was achieved for the site. This presentation will discuss the importance of good geochemical analysis and collection of field parameters to explain target compound changes. Lessons learned from the field will described including the need for careful mixing of the lecithin formula and the keys to good injection practices limiting daylighting and achieving distribution around the injection points.