Surfactant Flushing Column Study to Optimize Field Performance

Jeff Roberts (JRoberts@siremlab.com) (SiREM, Guelph, ON, Canada)
David Alden (david.alden@tersusenv.com) (Tersus, Wake Forest, NC)
Heather Lord (HLord@maxxam.ca) (Maxxam, Mississauga, ON)
Bryce Reiter (bryce.reiter@advisian.com) (Advisian, Saskatoon, SK)

Background/Objectives. Surfactant flushing is a proven technology for removing non aqueous phase liquids (NAPLs) from soils. However, the type of surfactant and operation to optimize performance is often not considered prior to field implementation. All surfactants are not the same and performance can be greatly optimized by performing laboratory-based studies prior to field implementation. Treatability testing is essential for sites with particularly aggressive or extensive pollution. Treatability studies discard inefficient techniques and thus improve efficiency for the environmental restoration effort. They further help reduce uncertainty, minimize risks, and are a key component in achieving cost-effective results. Based mostly on empirical experience, practitioners have concluded that NAPL solubilization was a necessary first step in the mobilization process and that surfactant concentration, up to a point, was generally proportional to performance. These surfactant systems are like surfactants typically found in household cleaning systems, such as laundry detergent or shampoo, and only lower the interfacial tension (IFT) by about an order of magnitude. In household cleaning systems this is sufficient because mechanical energy can be added to laundry or shampooing to mobilize the trapped oil. However, in a porous medium without the aid of mechanical agitation the IFT must be reduced by three or four orders of magnitude to reach our goals. Technology developed at the University of Oklahoma, originally focused for enhanced oil recovery at petroleum reservoirs and subsequently adapted to the environmental arena, can lower the IFT sufficiently to allow physical mobilization of residual NAPL with the limited production of thermodynamically stable emulsions. These high efficiency surfactants at lower concentrations help remove NAPL by lowering the energy of the area of contact between the oil and water.

Approach/Activities. This work describes a laboratory-based treatability test with the objective of selecting and optimizing a scalable and efficient surfactant system and water flush operation for removing crude oil from soils from a site in Western Canada. Soil and groundwater samples from the site were used in phase behavior tests, batch sorption tests and column studies simulating one-dimensional flow surfactant flooding to optimize performance prior to field implementation and evaluation. Results from these tests will be used to design future field pilot tests that will aid in selecting the most effective technique to remediate the Site.

Results/Lessons Learned. Optimization of a surfactant formulation to achieve ultra-low interfacial tension required combining surfactants and electrolytes. The use of polymers to increase the viscosity of the flooding front was tested for sweep efficiency to further reduce required volume of surfactant for target NAPL recovery. Modified laboratory testing and reporting procedures were required to ensure the data obtained were appropriate for identifying the optimum system. Selecting an optimized surfactant blend minimized required flush water and is expected to reduce the costs for produced effluent fluids capture and treatment.