

## Optimizing In Situ Remediation Amendments Using Innovative Surfactant System Formulations

Gary Birk, P.E. (gary.birk@tersusenv.com) and **David Alden** (david.alden@tersusenv.com)  
(Tersus Environmental, Wake Forest, NC, USA)

Jeffrey H. Harwell, Ph. D. (jharwell@ou.edu) (University of Oklahoma, Norman, OK, USA)

Mark Hasegawa, P.E. (mark.h@hasegawa.ca) (Hasegawa Engineering, Lethbridge AB, Canada)

**Background/Objectives.** Surfactants, polymers and solvents are key chemicals in designing products that are injected during groundwater remediation activities. Although these ingredients should all be compatible with health and environmental requirements, their function varies according to each technology's objective. For example, practitioners have concluded that NAPL solubilization with surfactants was a necessary first step in the mobilization process and that surfactant concentration, up to a point, was generally proportional to performance. When, rather than NAPL recovery its destruction is pursued, surfactants aid in creating complex water-ZVI suspensions in oil continuum or to disperse solids or non-water soluble amendments, such as vegetable oils, sands, iron or activated carbon into aquifers.

**Approach/Activities.** 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 LNAPL with the limited production of thermodynamically stable emulsions. This talk will focus on the use of artfully formulated surfactant blends that reduce solubilization and simply allow LNAPLs in saturated soils to become mobile. Surfactant studies targeted to specific technology objectives has allowed the group to formulate surfactant packages that allow field technicians to create their own EVO's in the field while significantly reducing droplet size, lowering overall costs and carbon footprint by procuring oils locally.

**Results/Lessons Learned.** The presentation will include results and lessons learned from innovative surfactant formulations as well as the latest field implementation where selecting an optimized surfactant blend minimized required flush water for NAPL recovery and costs for produced effluent fluids treatment from sites in the U.S. and South America.