

**SURFACTANT-ENHANCED *IN SITU* CHEMICAL OXIDATION (S-ISCO®) FOR  
DESTRUCTION OF PETROLEUM PRESENT AS NON-AQUEOUS PHASE LIQUIDS (NAPLS)**

**Daniel Cassidy\***

Western Michigan University  
Department of Geosciences  
1187 Rood Hall  
Kalamazoo, MI 49008-5241  
Voice: 269-387-5324  
Fax: 269-387-5513  
[daniel.cassidy@wmich.edu](mailto:daniel.cassidy@wmich.edu)

**William Guite**

**George Hoag**

**John Collins**

**Dan Socci**

**Jeff Ayers,**

VeruTEK Technologies  
Bloomfield, CT

Petroleum contamination often exists as non-aqueous phase liquids (NAPLs). However, oxidants used for *in situ* chemical oxidation (ISCO) (e.g., persulfate, hydrogen peroxide, permanganate) only react in the aqueous phase. Contaminant destruction is limited by the low surface area of NAPL and mass-transfer limitations. As such, multiple ISCO injections are commonly required to meet soil and groundwater cleanup criteria at NAPL-contaminated sites and in most cases are not achievable.

Surfactant-Enhanced *In Situ* Chemical Oxidation (S-ISCO®) has been developed by VeruTEK Technologies to overcome these mass transfer limitations. S-ISCO® involves the co-injection of chemical oxidants and catalysts with VeruSOL®, a mixture of cosolvents and plant-based, non-ionic surfactants. Emulsions with the proper surfactant mixture transforms large masses of NAPL into micelles which are nanometers to micrometers in diameter. This increases the surface area between NAPL and water by many thousands to millions of times, allowing the oxidants to react with and completely destroy the micelles of NAPL before the oxidants are exhausted or transported away with the groundwater.

Laboratory data will be presented showing the ability of VeruSOL® to emulsify NAPL, and the ability of catalyzed persulfate and hydrogen peroxide to destroy the NAPL. In addition, results from both *in situ* and *ex situ* field-scale applications will be presented.

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