Terra Systems Core Competencies

Customer Driven EVO Formulations

Terra Systems, Inc. Research and Treatability Lab is adjacent to manufacturing, which allows us to develop new formulation requirements, formulate them in the lab, and test them in manufacturing.

The development cycle typically begins when a client approaches us with a site where traditional carbon substrates have not worked effectively. This can be due to low pH, high groundwater flowrates, high concentrations of competing electron acceptors or other technical challenges.

Typically, the new product development cycle includes:

- ✓ Literature research
- ✓ Formulation design
- ✓ Laboratory testing of the formulations
- ✓ A treatability study using groundwater and saturated soil from the actual site.
- ✓ A pilot test
- ✓ Modification to the product design and composition based on the lab and field results
- ✓ Full scale implementation.

Examples of successful products developed using these approaches are:

Description	Product	Year
An emulsified oil/zero valent iron product with superior injectability for anaerobic and abiotic reduction.	SRS®-Z_{VI}	2013
A large droplet emulsified vegetable oil product with a proprietary anionic emulsifier for high groundwater flowrates, fractured bedrocks, and permeable reactive barriers.	SRS®-FR	2011
A small or large droplet emulsified vegetable oil product with a proprietary reductant to accelerate metals reduction in a mixed chlorinated plume.	SRS®-M	2010

In the above cases, a customer approached Terra Systems and challenged us to "*develop a better mousetrap*" than their current approach for the site.

SRS®-M; Coronado, CA: The site is contaminated with >20 mg/L TCE and >50 mg/L hexavalent chromium. Conventional EVO supported reduction of the hexavalent chromium over 80 days in a microcosm study, but not dechlorination of the TCE after 140 days. In combination with bioaugmentation and a new formulation of SRS® with a proprietary abiotic reductant, the hexavalent chromium was reduced within one day and complete biodegradation of the TCE occurred in 35 days. Field pilot and full-scale injections showed that the combination of SRS®-M and bioaugmentation culture could reduce the hexavalent chromium completely and biodegrade the TCE to ethene.

SRS®-Z_{VI}: The client had chosen a competing product containing zero valent iron (ZVI) and carbon. Customer wanted better injectabilty and radius of influence (ROI). Injection tests showed that the competing product was difficult to inject and had a ROI of 2.5 feet. Terra Systems developed SRS®-Z_{VI}, which combines 60% SRS® and 40% ZVI plus a stabilizer to keep the ZVI in suspension. The SRS®-Z_{VI} was able to achieve a 5 feet ROI and daily injection rates almost four times the area of the competing product.

SRS®-C; Millington, TN: The remediation design was to install a permeable reactive barrier (PRB) with wells on 75 feet spacings across the downgradient edge of the plume at the property boundary. A combination SRS®-SD and SRS®-FR were used to achieve the maximum radius of influence with the SRS®-SD and the longevity in PRB with the SRS®-FR.

SRS®-FR; High Groundwater Flow Rate Aquifer in Wichita, KS: The site was a highly permeable sandy aquifer with a groundwater flow rate estimated to be 1.9 ft/day. A previous injection of sodium lactate did not result in dechlorination of TCE. Injection of the SRS®-FR and bioaugmentation culture promoted the dechlorination of the TCE to cis-DCE, VC, and ethene. The TOC lasted between three to nine months.

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