

# Application of an All-in-One ISCO Technology for the Treatment of Hydrocarbons, BTEX and MTBE at a Former Retail Petrol Station in Italy

**Alberto Leombruni** ([alberto.leombruni@dgextern.com](mailto:alberto.leombruni@dgextern.com)) (Evonik Operations GmbH)  
Michael Mueller and Brant Smith (Evonik Active Oxygens, LLC)

**Background/Objectives.** Klozur® CR is a combined remedy treatment technology consisting of Klozur® SP (sodium persulfate) and PermeOx® Ultra (extended-release calcium peroxide). Klozur CR is a single, all-in-one formulated product that can be readily applied to either source areas or plumes impacted with a wide range of contaminants, e.g. TPHs commingled with CVOCs. Klozur CR destroys contaminants in both soil and groundwater by promoting three modes of action: activated persulfate chemical oxidation, aerobic bioremediation, and anaerobic oxidation. This thermodynamically powerful reagent provides self-activating sodium persulfate oxidation technology, utilizing the alkalinity generated by the calcium peroxide component. High pH, or alkaline, activated persulfate is capable of destroying a wide range of contaminants, including PAHs, BTEX, TPHs, phenols, chlorinated solvents, chlorobenzenes, haloalkanes, pesticides, energetics, and many others. Following the initial chemical oxidation phase, Klozur CR will continue to release oxygen (used as an electron receptor for aerobic bioremediation) for up to a year. This is a result of the slow hydration of the engineered calcium peroxide. Diffusion and transport of oxygen downgradient will support contaminant reductions in plume areas, treating the contaminants of concern (COCs). As a result of the persulfate oxidation with organic compounds, generated sulfate ions can be utilized by sulfate reducing bacteria as an electron acceptor under anaerobic conditions to degrade COCs via a process called anaerobic oxidation.

**Approach/Activities.** This technology has been successfully applied at several sites in Italy within the past few years. Most of these sites are current and former Petro stations located throughout Italy. This presentation will discuss the broader program using specific sites as case studies. One of these specific sites was at a densely populated urban area site in northern Italy. The site was characterized by historical contamination of various toxic compounds. The site, a dismantled former petrol station, was impacted by the storage of fuels which has resulted in groundwater contamination, including hydrocarbons (C<12 ~ 2000 µg/L), benzene (~ 500 µg/L), ethylbenzene (~ 380 µg/L) and MtBE (~ 13000 µg/L). Two injection campaigns were carried out 15 months apart, and a total of 4800 kg of Klozur CR (in a 25% aqueous solution) was injected onsite.

**Results/Lessons Learned.** The combined remedy of ISCO followed by bioremediation has proven successful in treating petroleum hydrocarbon contamination. With regard to the northern Italy site, following 18 months after the first application, the concentrations of contaminants had reached and maintained concentrations below the remediation goals in all monitoring piezometers in the treatment area. TPHs were reduced by greater than 80 percent, while MtBE was reduced by greater than 90 percent. Monitoring data confirmed sustained elevation of oxidation-reduction potential (ORP) and dissolved oxygen (DO) as necessary subsurface conditions to support treatment.