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Experience. Reputation. Results.

ISCO TECHNOLOGY REVIEW

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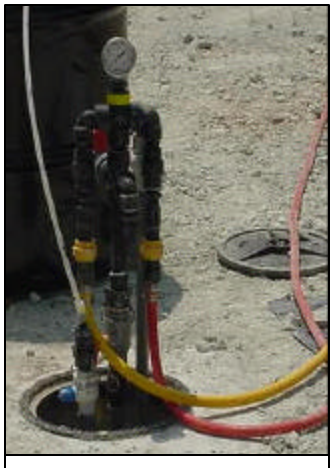


GCI Injection Head

GCI COMPLETES LARGEST ISCO PROJECT TO DATE

Geo-Cleanse International (GCI) has successfully completed the largest known in-situ chemical oxidation (ISCO) treatment program at a former manufactured gas plant (MGP) in Savannah, Georgia. The ISCO process was based on a site specific modified Fenton's reagent (FR) chemistry that combined hydrogen peroxide with other reagents to destroy organic compounds. The treatment area covered approximately 5 acres adjacent to the Savannah River and was impacted with MGP residuals from 5 to 50 ft-bgs. Treatment at this site was broken down into three distinct phases: bench-scale, pilot-scale, and full-scale. The general goals for the program were to treat by-product like material (BPLM) to the extent practicable and to be more cost effective over other technologies. BPLM is defined as "free phase contamination" measured as BTEX and PAHs.

Bench-scale testing indicated that BPLM could be oxidized in native soils and groundwater. The pilot treatment program consisted of the installation of injectors in a 50-ft by 50-ft treatment area that extended from 5 to 50 ft-bgs. Throughout the course of the pilot, weekly soil samples were taken and analyzed from the different treatment intervals and it was determined that a 22:1 oxidant to contaminant mass ratio would treat BPLM to the extent practicable. The extensive data that was collected during the pilot (both field and analytical), proved that field data can provide "proof of treatment" and can be utilized for site closure. This innovative methodology eliminated the need for expensive post-treatment analysis of soil following the full-scale treatment and formed the basis for site closure.

GCI began the full-scale ISCO treatment program in January 2004 and completed in February 2005. Throughout this period, GCI installed 1,283 injectors for both treatment and monitoring of the program. GCI injected ~ 490,000 gallons of 50% hydrogen peroxide at a 6-12% concentration into these injectors over the course of the program. To complete the program, GCI mobilized seven treatment vehicles and 15 specialists to the site. They worked 7 days a week over 13 months to inject to 28 locations simultaneously and conduct daily monitoring. Each day, GCI sampled and analyzed groundwater from all of the injectors within an active treatment region for various physical and geochemical parameters, including VOCs and peroxide concentration. Based on the millions of data points collected, documentation was provided to terminate the treatment and provide the basis for site closure. All in all, GCI delivered the oxidant to contaminant ratio, achieved and sustained PID headspace measurements below 50 ppm, and maintained stable peroxide in each of the injectors. These criteria exhibited that treatment to the extent practicable was achieved at this site.

Large Scale ISCO Project

"GCI met the criteria...exhibiting that treatment to the extent practicable was achieved at this site."

EXPERIENCE PROVES VALUABLE AT A COMPLEX MGP SITE

GCI is the most experienced chemical oxidation company when it comes to the treatment of MGP residuals using modified Fenton Reagent. To date, GCI has completed a multitude of applications, from bench-scale to full-scale. GCI has evaluated the ability of FR to oxidize coal tar and other BPLM in a variety of different lithologies, such as sands, silts, fractured bedrock, etc.

MGP residuals are extremely recalcitrant compounds that are typically found as highly sorbed and free phase material. One of the more popular selections for remediation of these compounds is excavation and off-site disposal. However, many sites have impacted materials that are either not accessible for excavation due to surficial constraints or have impacts below the water table which can require additional expensive engineering controls. In cases such as these, ISCO is rapidly becoming a proven cost effective alternative.

GCI recently completed a pilot and full-scale ISCO treatment program at a former MGP site in Augusta, GA. The pilot indicated that treatment to the extent practicable was achieved with a 21:1 oxidant to contaminant ratio (98% reduction in BTEX and PAH compounds). However, the lithology for the full-scale was complex, with BPLM located in a highly permeable seam overlain by impacted tight clays. The lithology was an issue for both oxidant delivery and off-gas migration and venting. The oxidant delivery was slow due to pore space clogging by BPLM and gases generated as a result of the injection.

Based on our experience with coupling technologies, GCI overcame the delivery and off-gassing issues by designing and building a three-fold system to relieve the site from subsurface pressure and to actively capture and treat NAPL and wastewater. Our wastewater collection system allowed gases, mounding NAPL, and impacted groundwater to be collected and treated at our on-site wastewater treatment system. GCI installed vent wells that were screened in the vadose zone underneath and around surficial structures to protect structures during the injection. These vent points were connected to a soil vapor extraction system that helped direct the flow of gases and maintain site controls. Finally, GCI harnessed the exothermic nature of FR to desorb BPLM. GCI used a vacuum truck equipped with a multiple port manifold system to extract the liberated BPLM from the injectors and treat it in the wastewater treatment system.

By applying this innovative multi-faceted approach, GCI was able to deliver reagents to the subsurface more rapidly in a cost effective manner, enabling the client to meet both their scheduling and treatment goals.

BPLM Extraction Equipment

GCI overcame the delivery and off-gassing issues at the Augusta site by creating a wastewater collection system, a ventilation system, and by using BPLM extraction.

Water Collection System

Augusta MGP Treatment Program

ISCO BOOSTS BIO-REMEDIATION TIMEFRAMES AND SUCCESS

GCI completed an ISCO treatment program using modified Fenton's Reagent to target chlorinated hydrocarbons underneath a building at an inactive facility in Pinellas Park, Florida. The overall goal of the treatment program was to significantly reduce concentrations of both free-phase DNAPL and dissolved PCE and TCE in groundwater in order to facilitate post-treatment bio-remediation. In order to achieve this goal, a volume of oxidant was calculated to significantly reduce contaminant mass but not cause complete mineralization of the contaminants (about 5,000 gallons of 50% hydrogen peroxide).

Sixty dual function injectors were installed at this site to deliver FR during the ISCO treatment program and bio-enhancing substrates after the completion of the ISCO injection. The treatment began with the injection of a hydrogen peroxide solution (between 3 and 12%) along with a catalyst containing both activators and inhibitors. Daily process monitoring of each of the injectors indicated that subsurface conditions were appropriate for an effective FR reaction. One significant observation was the generation of chloride ions, one of the breakdown products observed when targeting chlorinated hydrocarbons. Following the injection of the initial allotted volume of oxidant, chloride concentrations were still elevated, signifying that the destruction of source material was still occurring. Based on these results, an additional 2,000 gallons of 50% hydrogen peroxide were injected to further enhance source reductions. ISCO treatment was responsible for a reduction in the source area of 88%, including the destruction of DNAPL.

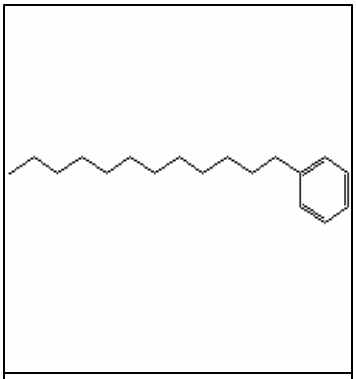
Following a FR injection, dissolved oxygen concentrations in groundwater are elevated. In this highly aerobic environment, microbes use oxygen as electron acceptors to transform organic carbon to carbon dioxide, further reducing any remaining dissolved phase contamination. The site then returned to the more conducive anaerobic conditions to degrade the remaining residuals. By coupling FR with bio-augmentation using suitable amendments, remediation goals can be achieved in quicker timeframes and at a lower cost than using one technology alone.

ADVANCES IN ISCO
Oxidation of Dodecylbenzene using Fenton's Reagent

GCI recently completed a bench test and a pilot ISCO treatment program to determine the ability of Fenton's reagent to break down free-phase branched dodecylbenzene (DDB) at a manufacturing facility in Kansas City, Kansas. Branched DDB is an insoluble LNAPL that was used at this facility to manufacture soaps and detergent but was discontinued due to its inability to degrade in water treatment plants.

GCI was able to completely remove visible free-phase DDB using Fenton's reagent in beakers during the bench test and free phase thicknesses were reduced in all monitoring wells during the pilot treatment. Based on these results, DDB has proven to be susceptible to oxidation via Fenton's reagent by following a similar pathway to that of benzene where the hydroxyl free radicals perform an electrophilic attack on the pi-bonds within the aromatic structure.

"Free phase thicknesses (of DDB) were reduced in all monitoring wells."



Chemical Structure of Dodecylbenzene

GOING FORWARD WITH GCI IN 2006

Current Projects

- GCI is currently performing an ISCO injection using Fenton's reagent at a former MGP site in New Hampshire, with impacted materials at the fractured bedrock interface.
- GCI is also performing an ISCO injection using Fenton's reagent inside an active manufacturing facility in CT where unsaturated soils and groundwater are impacted with chlorinated compounds.

Upcoming Conferences

GCI will be presenting two posters at the Remediation of Recalcitrant Compounds Conference in Monterey, CA in May 2006.

Look for GCI at the Remediation of Recalcitrant Compounds Conference in Monterey, CA in May 2006

Please Visit Our Revised Website
www.geocleanse.com

EXPERIENCE
REPUTATION
RESULTS

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ABOUT GCI

Since 1995, Geo-Cleanse International, Inc. (GCI) has established a reputation as the premier in-situ chemical oxidation company. GCI consistently provides quality service and ensures that the goals of our treatment programs are achieved. We have the most experience of any chemical oxidation firm and were the first to commercially apply oxidants for a successful NAPL remediation. Our experience, together with independently published results of our work, and an experienced staff of professionals, keeps GCI at the top of the industry.

As the chemical oxidation field continues to evolve, GCI has expanded our services to incorporate the advances occurring within the industry, as well as our own proprietary technologies. GCI offers a variety of different chemical oxidation services to our clientele, including bench testing, pilot-scale applications, and full-scale applications. The Geo-Cleanse® Process can effectively treat a wide variety of contaminants in a range of lithologies. To date, GCI has field experience on over ninety sites in twenty-seven states, Canada, and the Netherlands. GCI has experience remediating a wide variety of contaminants including petroleum, pesticide, coal tars, and chlorinated hydrocarbons. In addition, GCI currently has the most experience in treating manufactured gas plant (MGP) residuals.

Geo-Cleanse services include:

- Fenton's Reagent Chemistry Injection
- Sodium and Potassium Permanganate Injections
- In-Situ Treatment of Heavy Metals
- Bio-enhancement / Surfactant Injection

If you would like a free site evaluation, please contact us by phone or email or by visiting our website at www.geocleanse.com.

A typical GCI treatment program