In Situ Chemical Oxidation

Areas of Expertise

- Sodium and potassium permanganate
- Sodium persulfate (alkaline, iron, heat, and peroxide activated)
- Fenton's reaction
- Solid peroxygens
- Ozone
- Perozone (ozone and hydrogen peroxide sparging)

Key AECOM Attributes

- Global ISCO Experience
- Client-focused Solutions
- Leaders in Technology and Service
- In-house bench-scale, pilot-scale, and full-scale capabilitie

AECOM operates a remediation treatability laboratory to support technology evaluation and development efforts companywide. An ISCO treatability study provides an opportunity to evaluate the effectiveness of a single oxidant on target contaminants at a variety of dose concentrations, or compare a suite of oxidants for performance and efficiency. Information learned from an ISCO treatability study at the bench-scale level can be utilized in the design of pilot or full-scale applications. Testing services relevant to ISCO include flask or stirred reactor studies and column studies.

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Overview

In situ chemical oxidation (ISCO) is a remediation technology that introduces oxidants to the contaminated subsurface by injection or mechanical mixing. Removal of subsurface soils or groundwater and treatment with oxidants above ground is considered *ex situ* chemical oxidation. Effective chemical oxidation may be achieved using a strong oxidant only, or in combination with other chemicals that function as catalysts. The oxidants chemically react with contaminants, and convert them to non-toxic end products such as carbon dioxide and water.

In situ chemical oxidation is an attractive option at many hazardous waste sites, because:

- Complete contaminant destruction is possible
- Rapid treatment times are achievable
- It is a green and sustainable remedial option when compared to higher energy consuming options such as pump and treat
- In-house bench-scale testing is available
- It is an innovative remedy, compatible with mechanical and biological cleanup approaches

Chemical oxidation effectiveness, especially ISCO, is dependent on achieving contact between the contaminant and delivered oxidant. Challenges to successful implementation are presented by subsurface heterogeneities, preferential flow paths, the presence of non-target consumptive demand by naturally occurring organic compounds, dissolved metals (such as ferrous iron), and the potential for formation of undesirable reaction byproducts (such as sulfate or manganese dioxide). Although a chemical oxidation reaction is relatively simple, not all oxidants react effectively with any given contaminant; therefore, selection of the appropriate oxidant is critical to successfully achieving the remediation endpoint.

Understanding these challenges and staying current with advances in state of the art chemistries and delivery methods is critical to adapting to the inherent limitations of ISCO and oxidant delivery to the subsurface. AECOM has developed expertise in applying chemical oxidation technologies appropriately, effectively, and safely. We specialize in the design, implementation, and data interpretation for all available oxidants and field distribution technologies on the market today.

AECOM has completed hundreds of ISCO projects for various contaminants and a variety of hydrogeologies in the U.S., Brazil, Canada, Israel, Italy and Mexico. We were the first firm to gain regulatory approval and implement ISCO in Mexico and the first to design and implement it in Israel.

In Situ Chemical Oxidation *(continued)*

Our Approach

AECOM has extensive experience with chemical oxidation technologies, and is adept at providing ISCO design, application, performance monitoring, and post application long-term monitoring utilizing AECOM personnel and equipment. Our experience applying chemical oxidation technologies includes applications for a wide range of contaminants. From preliminary design and testing through full-scale implementation, AECOM is a one-stop shop for chemical oxidation projects.

Target contaminants include petroleum organics (gasoline and diesel range), chlorinated ethenes (PCE, TCE, DCE, and vinyl chloride), large molecular size organic compounds (C-56 to C-60 range), pesticides, manufactured gas plant (MGP)-associated organic residuals, 1,4-dioxane, and others. Remedial action objectives range from reduction of contaminant concentrations to groundwater cleanup target levels without land use restrictions, to attainment of elevated or risk-based cleanup goals.

Sites that have been well characterized, and for which defined remedial goals are understood prior to project planning initiation, have a high success rate; therefore, AECOM begins each project with the development of a conceptual site model (CSM). At this stage, AECOM's scientists and engineers evaluate the site geochemical/hydrogeological setting, identify risk factors, and establish remedial action objectives and cleanup goals towards achieving site closure with client and regulatory consensus. Where a CSM already exists, evaluation and recommendations for refinement are offered or incorporated.

Identification of ISCO as an appropriate remedial alternative typically involves performing a laboratory bench-scale treatability test. The data and understanding gained from bench testing typically becomes incorporated into an ISCO field treatability or pilot study, which, if shown to be effective, can be implemented as the first stage of the full-scale remedy.

With our focus on the needs of the client's site, AECOM avoids endorsing specific products or proprietary approaches to remedial problems. We believe that sound and objective consulting must include the consideration of all available options and pride ourselves on having a diverse working knowledge of technology options and the experience to evaluate them on many levels, including technical feasibility, cost, and practicality. Based on site-specific remedial objectives, AECOM applies ISCO technology to fit into the overall remediation approach for the site. For example:

- At a Department of Defense site, where lithology was well characterized and the end targets of alternative (elevated) cleanup goals agreed upon, AECOM implemented a properly designed ISCO pilot study of sodium persulfate that reduced TCE below the stated goals. By adjusting our approach to be slightly more aggressive in the source area, we were able to exceed the cleanup goals and were asked to return to the site for additional treatments in an attempt to attain groundwater cleanup standards. AECOM returned for a re-injection event and subsequently met stricter cleanup goals, which alleviated the environmental concerns and simplified the client's property transfer.
- Using modified Fenton's reaction, AECOM was able to meet site cleanup goals for BTEX compounds at an active retail service station site. The site had a comprehensive set of assessment data and a pilot study was performed to assess the technology's effectiveness. The results indicated that rebound would occur following oxidation of the organic matter in the silty sands and migration of sorbed-phase contaminants into groundwater. Therefore, an aggressive injection plan was implemented to include a multiple injection event strategy to mitigate rebound and achieve cleanup goals.
- AECOM is using periodic sodium permanganate floods into fractured bedrock to address a PCE and TCE source area at a former plating facility located at the northeastern edge of the Appalachian Mountains. A thorough initial site characterization, in concert with a bench-scale testing effort at our in-house treatability studies laboratory, led to the successful field application of sodium permanganate, utilizing AECOM injection equipment and personnel. Immediate decreases in contaminant concentrations were observed, and steady decreases in contaminant concentrations continue.

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