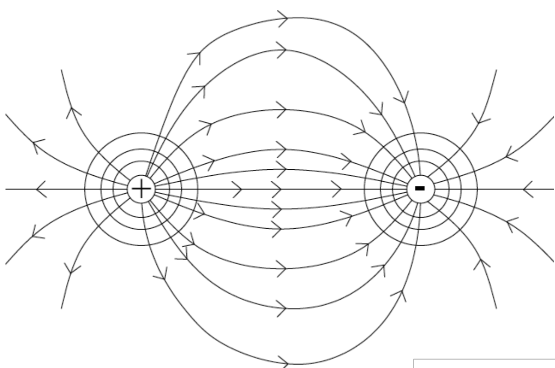
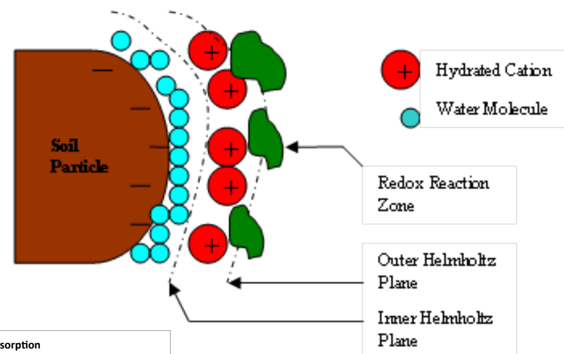
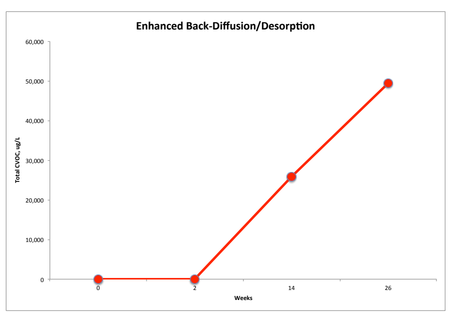
E-Redox-I: Electrically Induced Redox Reactions

E-Redox-I is a patented technology developed by Advanced Environmental Technologies, LLC (AET, Fort Collins, CO). Field applications of ***E-Redox-I*** have demonstrated the sustainability and cost-effectiveness of this technology in enhancing the degradation of a number of recalcitrant contaminants in matrices including groundwater, soil, and sediments.

E-Redox-I technology generates and sustains a low-voltage gradient electric field in between electrodes, uniformly inducing redox reactions within the impacted matrices. The soil/sediment particles within the matrices become "micro-electrodes" within the induced electric field, triggering and sustaining numerous redox reactions. The following reactions occur within the ***E-Redox-I*** electric field: 1) contaminants within the matrix are susceptible to these redox reactions, and are rapidly degraded or transformed (e.g., in chlorinated VOCs treatment, via both biological hydrogenous and abiotic beta-elimination dechlorination pathways); 2) the electrical field shifts surface charges of matrix particles, helps desorb contaminants from material such as clay for fast mass removal (see figure below); 3) microbial activities within the electric field can also be by the redox reactions, which further enhances contaminant degradation/transformation; and 4) in cases of ZVI application, the weak electrical field by ***E-Redox-I*** is observed to rejuvenate and avert passivated ZVI, resuming its reductivity. ***E-Redox-I*** is typically applicable to hoxidized contaminants such as chlorinated solvents (e.g., TCE), oxidized metals (e.g., Cr^{6+}), oxyanions (e.g., nitrate), among others.







Applications

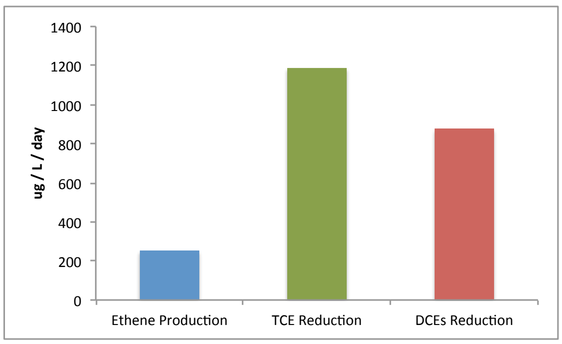
- Organic contaminants
    - Examples: Chlorinated solvents, PAHs
- Inorganic contaminants
    - Examples: Perchlorate, nitrate, metals
- Stand-alone technology for treating a variety of contaminants *in situ* and *ex situ* applications
- Integration with other remediation technologies to achieve significant enhancement
- Restoration and enhancement of permeable reactive barriers (includes depassivation of ZVI)

Advantages

- Implementable in wide-range of matrices, including low permeable zones
- Requires very low energy input
- Effective as stand-alone treatment
- Synergistic to other remediation technologies (e.g., electron acceptor amendments, injections of carbon)
- Easily integrated with renewable energy sources (e.g., solar panels, wind turbine)
    - Allows application in remote locations
    - Sustainable

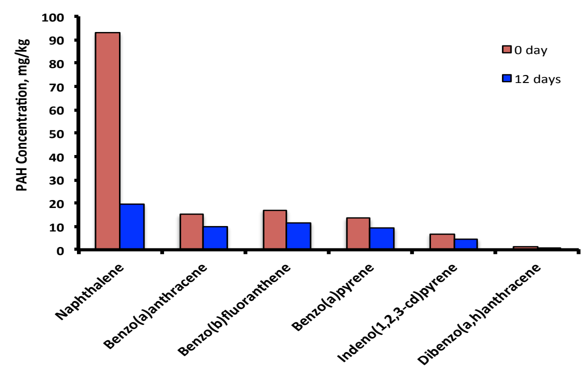
CASE STUDY 1: TCE-contaminated Groundwater

A field application of the E-Redox-I technology was conducted at a chlorinated solvent-contaminated site located in Utah, where TCE, DCEs, and vinyl chloride are the primary contaminants of concern. The E-Redox-I system was applied to groundwater sediments, and results indicated enhanced back diffusion, which would result in high reduction rates indicated by high production of ethene. After 47 days, the ethene production was 15 times higher than the baseline concentration, which resulted in equivalent TCE and DCEs reduction rates of 1187 and 876 μg/L/day, respectively.



CASE STUDY 2: PAH-contaminated Industrial Site

A field application of the E-Redox-I technology was conducted at a PAH-contaminated industrial site located in southeast China, where previous applications of chemical oxidants were not effective in reducing PAH concentrations. The E-Redox-I system was applied to soils containing high concentrations of PAHs. After a treatment period of 12 days, results show ~79% decrease in naphthalene and >50% removal of total PAHs. Data also indicated the cleavages of higher polyaromatic rings and a trend of tentative shift towards compounds of less recalcitrance such as naphthalene.



Contaminant Mobilization by E-Redox-I

Enhanced back-diffusion and mobilization of organic contaminants can occur within an electric field produced by E-Redox-I systems. Within the electric field, localized redox reactions at the soil/sediment particle surface can cause contaminant desorption, and localized "micro-conductor" reactions may produce localized increases in basicity that increase organic contaminant solubility. Contaminant reduction and removal can be maximized by integrating E-Redox-I with water and vapor phase removal methods (e.g., dual-phase extraction).

About Us

Advanced Environmental Technologies, LLC (AET) is a technology innovator and implementer, specializing in sustainable treatment solutions for wastewater, contaminated soils, groundwater, and sediments. Our patented and patent-pending technologies focus on remediation of a variety of recalcitrant contaminants, wastewater treatment, and low-value compounds to energy conversion. We provide both technologies and specialized services to project owners and engineering companies by offering innovative and sustainable solutions for environmental remediation, wastewater treatment, and bioenergy.

AET

Advanced Environmental Technologies, LLC
4025 Automation Way, Suite F4
Fort Collins, CO 80525, USA
Tel: +1-970-449-9711
E-mail: info@aetecs.com
URL: www.aetecs.com