# Electrochemically assisted Bio-Remediation Processes

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**Abstract**
Chlorinated aliphatic hydrocarbons (CAHs) are common groundwater contaminant due to their improper use in the past. In recent years, more sustainable remediation and cost-effective technologies involves groundwater's indigenous microorganism such as the Dehalorespiring microorganisms. Dehalorespiring microrganisms are able to reduce CAHs as perchloroethylene (PCE) and trichloroethylene (TCE) to ethylene via reductive dechlorination (RD) while aerobic dechlorinating microorganisms oxidized low chlorinated compound such as cis-dichloroethylene (cDCE) and vinyl chloride (VC) into non harmful products. The integration of reductive dechlorination and aerobic dechlorination results an efficient approach for the complete mineralization of high chlorinated compounds, which usually led to a build-up of VC. This research project focuses on the development of novel in situ bioelectrochemical process (BES) based on the use of microorganisms attached to solid carbon electrodes (to be inserted within the contaminated aquifer) that catalyze the reductive and/or oxidative biotransformation of chlorinated aliphatic hydrocarbons in the groundwater into harmless end-products. In the proposed process, the electrodes, consisting of granular and electrically conductive materials (e.g., graphite granules) have a twofold function: they act as physical supports for the growth/attachment of specialized "electroactive" consortia (i.e., capable of engaging in extracellular electron transfer with them) and act as direct electron donor/acceptor for the microbial degradation of target contaminants. The bioelectrochemical process has several potential advantages compared to conventional bioremediation methods based on the subsurface supply of chemicals (as electron donor or acceptors) to stimulate biodegradative reactions. One of them is that the rate of contaminant reduction/oxidation can be directly monitored/controlled through current and voltage measurements. Moreover, the proposed process potentially allows to specifically co-localize the electron donor/acceptor and the contaminant degrading microorganisms in well-defined positions within the contaminated subsurface (e.g., in permeable barriers placed within the contamination plume), thereby increasing the effectiveness of the remedial action). The presentation will be focused on the development of a sequential reductive/oxidative bioelectrochemical process in which two microbial electrolysis cells (MECs) were connected in series. In the first MEC, named reductive reactor, a graphite granular cathode has been used as working electrode while in the second oxidative MEC, a titanium MMO anode was used as working electrode. In the reductive reactor, the cathode chamber supplies the reducing power necessary to the dechlorinating biomass to perform the reductive dechlorination reaction while in the oxidative reactor, the titanium-metal mixed oxides anode ensured the oxygen evolution necessary for the aerobic dechlorination. Both reactors were equipped with a graphite internal counterelectrode which allowed for a simple, flexible and cost-effective configuration of the process.

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