# TCE Removal Using Microbial Electrochemical Cells

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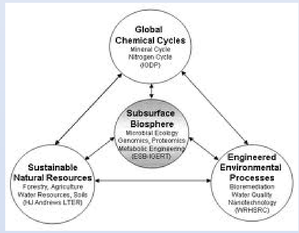
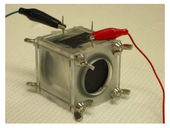



## Background

**TCE**, Trichloroethene, is a toxic chlorinated hydrocarbon that has been seeping into and contaminating groundwater systems. Current engineered approaches for the bioremediation of chlorinated contaminants typically involve the addition of $H_2$ or $H_2$ generating organic substrates. Some problems often associated with this approach are the extensive competition for the carbon source and $H_2$ between dechlorinators and other microorganisms, the accumulation in the subsurface of large amounts of fermentation products with resulting deterioration of groundwater quality and possible aquifer clogging due to excessive biomass growth. The **objective** of this research is to investigate the possibility of using a microbial electrochemical system (MES) to remove TCE and generate electricity at the same time. This approach could potentially overcome some problems associated with the use of fermentable carbon sources and/or $H_2$.

## Methods



•Single Chamber MES construction
- Anode: carbon cloth with well-developed electricity generating biofilm.
- Cathode: plain carbon cloth painted with carbon powder
- Anode and cathode separator: non-conductive cloth

• MES operation
- Substrate: acetate
- Initial TCE concentration: 22 µmol
- Inoculation: dechlorinating bacteria
- Control reactor: not inoculated with dechlorinating bacteria

## Conclusions

•Dechlorinating bacteria enriched with lactate can dechloriate TCE to DCE and VC using acetate as electron donor.
• Dechlorinating bacteria on the electrode can dechloriate DCE to VC at an applied voltage of 0.3 V.
•Electricity can be generated with the removal of TCE in a single chamber MFC. However, DCE and VC accumulation was observed.
• Further study is needed to investigate the conditions for full dechlorination of TCE to ethane using microbial electrochemical systems.

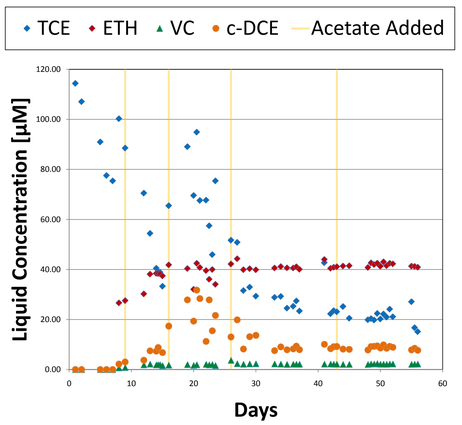



***Figure 1:*** Liquid concentration of TCE, VC, DCE and ethane in control reactor (without inoculation of dechlorinating bacterial culture). This result indicates that some bacteria on the MFC anode can dechlorinate TCE to ethane, but at a very slow rate.

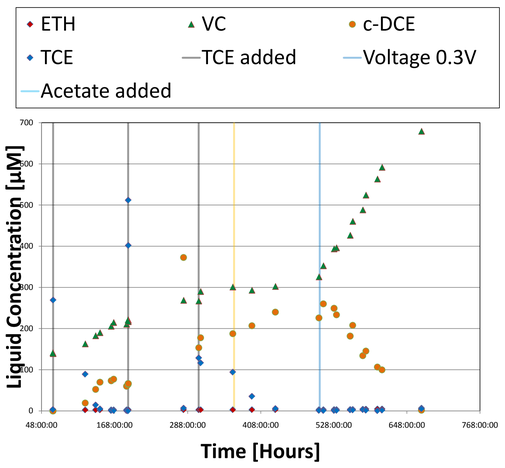



***Figure 2:*** Liquid concentration of TCE, VC, DCE and ethane in reactor 2 over a period of 13 days. There was a build up of DCE and VC with no applied voltage (before 528 h). Once a voltage (0.3 V) was added, DCE began to covert into VC (after 528 h) . No hydrogen was detected at this applied voltage.

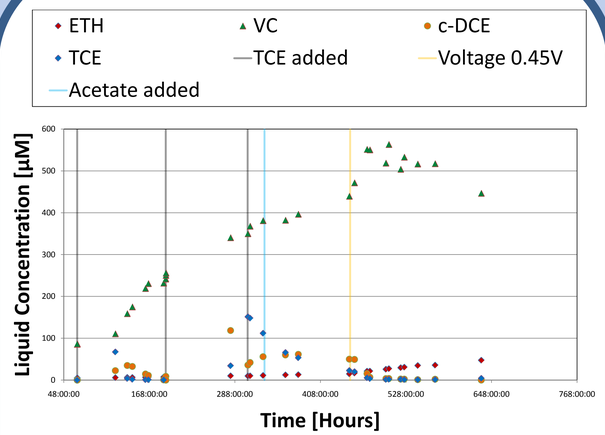



***Figure 3:*** Liquid concentration of TCE, VC, DCE in reactor 3 over a period of 14 days. There was a VC build up at applied voltage of 0.3 V (from 48h to 460h). When the applied voltage increase to 0.45 V (after 460h), there was a jump in VC concentrations and then steadily decreased as ethene concentrations started to rise. There was a small amount of $H_2$ detected in the head space at the applied voltage of 0.45V initially, but did not increase over time. This reactor is still running and may show a continued decrease of VC concentrations.

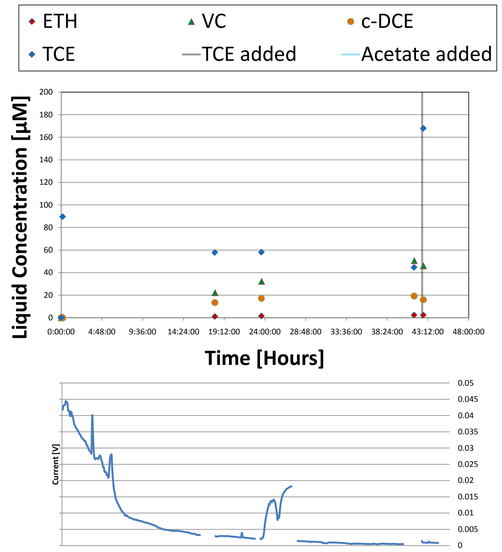



**Figure 4:** TCE removal and electricity generation using a MFC with a new anode (with a well developed electricity generating biofilm) and a cathode with a well developed dechlorinating biofilm. The voltage produced decreases as TCE was removed. Further experiments are needed to demonstrate the relationship between TCE removal and current output.