Development of Effective Aerobic Cometabolic Systems for the In-Situ Transformation of Problematic Chlorinated Solvent Mixtures

Cleanup
CU-1127

Background:

Oregon State University's research involving microorganisms stimulated by propane or butane has demonstrated the potential for transforming a broad range of chlorinated aliphatic hydrocarbon (CAH) mixtures that have been problematic with other cometabolic substrates. Microcosm studies conducted with subsurface solids and groundwater from contaminated Department of Defense (DoD) sites have shown that propane and butane-utilizers are often absent in the subsurface or have long lag periods before effective stimulation is achieved. Thus the implementation of effective in-situ treatment systems at many sites likely will require bioaugmentation.

Objective:

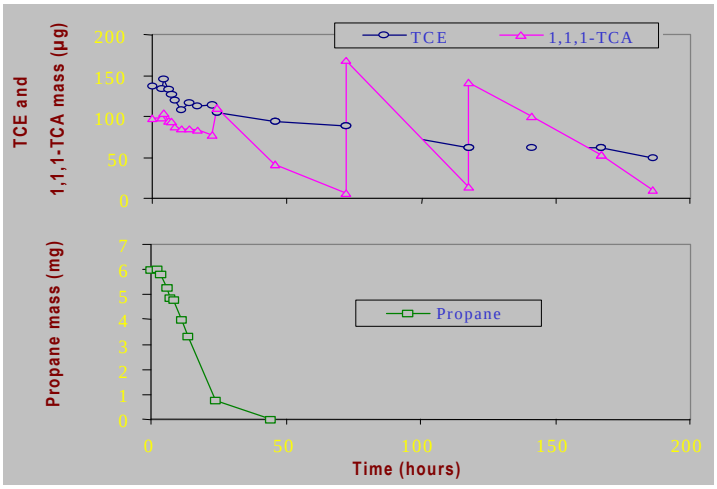
The project's objective is to remediate trichloroethylene (TCE) and other chlorinated organic compounds in soil and groundwater. The goal of the proposed research is to demonstrate the potential of using propane and butane-utilizing microorganisms to transform problematic CAH mixtures. The demonstration will be aimed towards creating in-situ bioreactive passive barriers in contaminated aquifers. The proposed work will demonstrate effective methods to create passive treatment barriers through both bioaugmentation and the use of a subsurface delivery system.

Summary of Process/Technology:

The technical approach for this project consists of the following four components: (1) laboratory studies to select the bioaugmentation approach and to develop kinetic information for single substrate (propane or butane) and mixed substrate addition (propane and phenol, for example) for the transformation of CAH mixtures; (2) exploration of molecular probe methods for tracking the bioaugmentation and biostimulation in laboratory and field studies; (3) field demonstrations to evaluate the bioaugmentation approach; and to determine the effectiveness of treating problematic mixtures of 1,1,1-trichloroethane (TCA), 1,2-dichloroethene (DCE), and TCE using propane or butane as a single cometabolic substrate and mixed cometabolic substrates propane or butane with phenol or toluene in the latter stages in the field tests; and (4) modeling evaluations of the laboratory studies and field demonstrations, including simulations to aid in the design of field demonstration tests.

Benefit:

The primary benefit from this project will be a field-documented in-situ cometabolic process that transforms problematic mixtures of CAHs. This technology will be a new in-situ application of aerobic cometabolism for complex CAH mixtures. In addition, a bioaugmentation methodology for in-situ cometabolism will be developed to possibly be used as a remediation alternative for sites where natural attenuation or biostimulation will not work. This technology may be used as a passive process that can be applied in deep aquifers or in a stratigraphy with multiple clay lenses.



Results from microcosms comparing TCE and TCA transformation with a propane culture fed propane

Accomplishments:

Laboratory efforts have focused on the following: (1) demonstrating the ability to grow butane and propane mixed cultures in a media formulation; (2) bioaugmenting the culture into soil/groundwater microcosms; and (3) evaluating substrate uptake and CAH transformation. Propane-utilizers were easily stimulated after not being fed propane for 1 year and very effectively transformed 1,1,1-TCA.

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REVISED 6/8/00