SERDP
Strategic Environmental Research and Development Program

Cleanup
CU-1124

An Innovative Passive Barrier System Using Membrane-Delivered Hydrogen Gas for the Bioremediation of Chlorinated Aliphatic Compounds

Background:

This goal of this research is to develop an innovative passive barrier remediation technology that will reduce the costs, risks, and time required for contaminated site cleanup. The proposed research will characterize the performance of a novel passive barrier that relies on the use of an innovative membrane technology for the controlled dissolution of hydrogen (H_2). The research will employ special woven hollow-fiber membranes for the passive dissolution of H_2. in order to accelerate the in-situ bioremediation of groundwater contaminated with chlorinated compounds.

Objective:

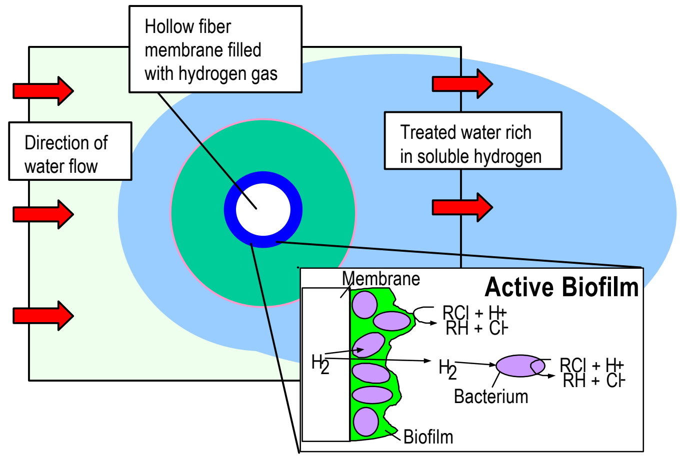
The objective of this project is to examine the gas transfer behavior and performance of hollow fiber membrane curtains that are installed as passive barriers. The proposed research will assess the suitability and effectiveness of the membrane for delivering H_2 to accelerate the in-situ remediation of chlorinated organic compounds like trichloroethene and perchloroethene.

Summary of Process/Technology:

The proposed research will investigate the behavior of the membranes in a systematic way to determine what factors control the overall remediation process. These tasks include the following: (1) the study of the gas dissolution behavior of membranes, (2) the evaluation of the impact of gas composition changes and condensation, (3) the evaluation of impact of biofilm growth on gas transfer, (4) the evaluation of solvent transformation, (5) the development of mathematical models, and (6) the development of pilot reactor studies.

Benefit:

Passive barrier remediation systems are an attractive treatment option for the transformation of contaminated groundwater. H_2 appears to be an effective electron donor for the biodegradation of halogenated aliphatics when it is sufficiently bioavailable. However, it is difficult to provide sufficient H_2 to organisms because of its low solubility. Gas permeable membranes, used as a passive treatment barrier, could be used to provide H_2 as an electron donor for in-situ bioremediation. This method of H_2 delivery would be expected to provide controlled levels of bioavailable H_2 that should provide the same benefits as cathodically-derived H_2, without the associated problems. In addition, the project will yield the engineering data required to complete a cost analysis and transition the membrane-module remediation system technology into field-scale application.



The proposed remediation scheme for this project utilizes a biofilm

Accomplishments:

The column reactors have been designed and currently are being constructed. Membrane modules for use in the column reactors have been designed and will be constructed once the column reactors are complete (to ensure correct sizing). A recirculating-gas loop has been designed and constructed to control the partial pressure of H_2 at a very low and constant level in the membranes. A model has been built incorporating both halorespiration and methanogenesis and the subsequent competition for H_2. This model is applicable to the batch system. A model for the column system currently is under development.

Contact Information:

Dr. Michael Semmens
University of Minnesota
Department of Civil Engineering
Room 122, Civil Engineering Building
500 Pillsbury Drive, SE
Minneapolis, MN 55455-0116
Phone: (612) 625-9857
Fax: (612) 626-7750
E-mail: semme00I@maroon.tc.umn.edu

REVISED 6/8/00