

Pre-Proposal

Laboratory Experiments to Support Injection Design for Distributing Non-Aqueous Phase Liquid Reagents in the Subsurface

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Introduction

Use of non-aqueous phase liquid (NAPL) substrates has been applied at numerous sites to induce bioremediation of contaminants over a relatively long (months-to-years) duration with a single injection of the substrate. The cost and implementability of this type of biostimulation treatment for large-scale plumes are strong functions of the effectiveness in distributing the substrate around an injection point. Key factors in the effectiveness of the injection are the radial injection distance and the mass distribution of substrate delivered within this radius. Empirical field data and some laboratory data are available for polylactate and vegetable oil substrates. However, these data do not address several issues related to application of NAPL substrates on a large scale at the Hanford Site, specifically at the 100-D Area. A targeted series of laboratory tests are proposed to address these issues and augment the planned field demonstration of in situ biostimulation in the 100-D Area. These laboratory tests will focus on determining the most effective injection approach to (1) maximize the radial extent of substrate distribution under conditions representative of the Ringold Formation and (2) account for injection in wells rather than through drive points where the effect of the well screen and the filter pack on the emulsion distribution are not well known and may have contributed to the poor results for distribution of organic substrate in the recent field test of the polysulfide technology in the 100-K Area of Hanford.

Proposed Approach

A series of experiments are proposed to refine the injection approach for use of NAPL substrates to induce biostimulation on a large scale in the Hanford 100-D Area. Experiments will be conducted in the Environmental Molecular Sciences Laboratory's Subsurface Flow and Transport Experimental Laboratory. Studies will use one-dimensional (1-D) and radial flow cells similar to those used for recent studies of polymer-enhanced iron particle injection. Laboratory results will directly support the injection test design for the field test of in situ biostimulation at the Hanford 100-D Area and will provide results relevant to application of NAPL substrates at other Hanford locations and other DOE sites where site conditions favor treatment using standard injection wells.

Monitoring during the test will include key operational and effectiveness parameters such as the injection pressure and flow rate and a post test assessment of NAPL distribution (e.g., in the well/well screen, filter pack, and in the sediment within the flow cell as a function of distance). The experimental matrix for the laboratory test will include variations in the following elements:

- Injection pressure and flow rate.
- Simulated well screen and filter pack configuration for comparison to baseline tests with no well or filter pack.

- Flow cell sediment packing with both uniform particle size (e.g., use of Accusand) and several variations using representative Ringold formation particle size distributions.
- Testing of two types of NAPL substrates with the following emulsion formulation alternatives.
 - Variation in the weight percentage of substrate to water in the emulsion over the range in this parameter reported in literature and vendor information.
 - Variation in the emulsion droplet size via the emulsion-homogenization technique based on the range in this parameter reported in literature and vendor information.
- Testing in 1-D and radial flow cells as appropriate to address the specific goals of each treatment.

Schedule, Budget, and Deliverables

The proposed laboratory testing can be completed within a period of one year. This will allow sufficient time to gather information necessary to support refining the injection approach for the field test of in situ biostimulation at the Hanford 100-D Area. To meet the current treatability test schedule, these laboratory tests should be initiated by early November 2007. A formal Pacific Northwest National Laboratory (PNNL) report describing the laboratory tests will be provided as a deliverable.

The budgetary estimate for this proposed work is \$200K.