Advancements to the EZVI Technology: Optimization of Biotic and Abiotic Processes and Improved Implementability for *in situ* DNAPL Destruction.

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Background/Objectives: The remediation of dense non-aqueous phase liquids (DNAPLs) can be complicated by the associated physical and chemical properties of the contaminants. DNAPLs are compounds that have specific gravities greater than water (> 1 g/cm^3), low water solubility, and therefore, a hydrophobic physical chemistry. The presence of DNAPL at a site can act as an ongoing source of contaminant to groundwater for decades. The potential effectiveness of ZVI for remediation of groundwater impacted by chlorinated solvents has been documented since the early 1990s. The chemical transformation with ZVI occurs via aqueous-phase reactions on particle surfaces and therefore involves at least three steps: (a) adsorption of the substrate to reactive sites on the ZVI particle surface, (b) reaction at the surface, and (c) desorption of the transformation product. In the absence of interspecies competition by catabolites, the kinetics of PCE transformation via α- and/or β-elimination reactions (and, to a lesser degree, hydrogenolysis and hydrogenation reactions) is therefore directly related to reactive surface area. The ZVI mediated transformation processes described above are relevant for dissolved phase contaminant destruction, as the ZVI requires a hydrogen donor (*e.g.* H_2O) for the abiotic reactions to proceed. Because DNAPL is not in the dissolved phase and has a hydrophobic physical chemistry, injection of ZVI slurries into source areas will not provide direct destruction of source material. Likewise, crude mixtures of ZVI and carbon substrates (oils) are equally ineffective in that oil-coated ZVI surfaces are not reactive,

Approach/Activities: Emulsified ZVI (EZVI) technology provides a solution to these problems. First, it is engineered to enable maximum contact with source materials, while including ZVI suspended within water (hydrogen donor) so that direct DNAPL destruction is possible using ZVI technology. EZVI also combines food grade vegetable oil (VO) with a surfactant, elemental iron and water in a specific physical structure to enable direct DNAPL destruction utilizing a combination of abiotic and biotic processes while leveraging contaminant physical chemistry. The key innovation surrounding genuine EZVI technology is the structure of the emulsion. The structure of the EZVI technology enables; Miscibility with DNAPLs *in situ;* Continuous Sequestration (phase partitioning) of COI into outer VO membrane (decreased COI mass flux); Encapsulates ZVI so that it only reacts with COIs with hydrophobic physical chemistry; and Provides long term hydrogen source for biostimulation downgradient of source area.

Results/Lessons Learned: *In situ* DNAPL destruction utilizing the EZVI technology is frequently utilized among seasoned professionals as the positive effects of rapid mass flux abatement and source area destruction are realized. During the presentation the following topics will be discussed:

i) When is EZVI a remedial option? – Guidelines for the effective use of EZVI will be presented including; product formulation, dosing and implementation options for vadose and saturated soils.
ii) How does EZVI product composition vary and what are the consequences? – Various key parameters for the technology will be discussed, including ZVI particle size, emulsion type, and the associated remedial implications.
iii) What are the most recent advances to the EZVI technology? – Important advancements will be discussed including; Antimethanogenic properties, enhanced reactivity, enhanced emulsion stability (longevity), and decreased emulsion viscosity.

Invited Session (Ray Lees, Donna Pilla)

Remediation Technology Innovations
1q. Advances in Amendments

Poster Requested

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