

AN IN-WELL BIOREACTOR FOR THE BIODEGRADATION OF HYDROCARBONS AND CHLORINATED HYDROCARBONS

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Bacteria capable of degrading hydrocarbons are ubiquitous in the environment because hydrocarbons are natural products that have been present in the environment in high concentrations for millions of years. Still, in the aerobic remediation of hydrocarbon-impacted groundwater, it is a common occurrence to have one or two wells that lag behind or just don't quite make regulation specifications. We are developing an in-well approach to isolating treatment only in these more troublesome areas of an impacted aquifer. We are building on existing Bio-Sep bead technology which is currently being successfully used commercially as a forensic tool for characterizing subsurface microbial ecology. In these in situ bioreactors indigenous hydrocarbon bacteria are cultured in the Bio-Sep medium. Operated as an air lift bioreactor, contaminated groundwater is circulated through a bed of inoculated beads for treatment. Bio-Sep beads also release hydrocarbon degraders into the aquifer environment increasing biodegradation rates in the aquifer.

While hydrocarbon degraders are ubiquitous this is not true for chlorinated hydrocarbons. The evolutionary origin of organisms like *Dehalococcoides* which are capable of reductive dechlorination of PE and TCE to ethane is uncertain. Some chlorinated compounds occur naturally but at concentrations far lower than concentrations found in TCE and PCE plumes and from the standpoint of evolution TCE and PCE have been in the environment at these concentrations for only a short time. The result is that *Dehalococcoides* spp. are not uniformly found to occur in TCE and PCE plumes and not uniformly distributed within a given plume. We are developing a new approach to the problem of the nonuniform distribution of halorespiring organisms in a PCE or TCE plume also building on existing Bio-Sep bead technology. The ability of the Bio-Sep bead material to be rapidly colonized by the active components of a groundwater microbial community make it an ideal material to serve as an immobilization matrix for an *in situ* bioreactor to first collect and concentrate native, active *Dehalococcoides* cells from an actively dechlorinating part of a TCE or PCE plume and then transfer these indigenous dechlorinators to a less active part of the plume. Bacteria form biofilms in the interior of Bio-Sep beads but the association with the beads is dynamic with cells continually being captured and released from the beads. Therefore, an *in situ* bioreactor containing a dense culture of *Dehalococcoides* cells will release these cells when transferred to a new groundwater monitoring well. The *in situ* bioreactor can also be subjected to a continuous injection of nutrients from a surface source to maintain the growth and reproduction of the bacteria and therefore result in the continuous release of these organisms into the well environment. *Dehalococcoides* will then be transported into the aquifer matrix by groundwater flow and potentially through chemotactic movement of the cells. An initial field test of this approach will be presented.

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