

## Generation of Enriched, Anaerobic “Chase Water” to Repair Aquifer Biogeochemistry: The Best Solution is EHC® ISCR™ Technology

### Understanding of the Problem

“DCE Stall” is a problem frequently encountered when simple, “carbon-only” substrates such as hydrogen releasing compounds, [emulsified] oils, lactates or sugars are used to stimulate *in situ* reductive dehalogenation of chlorinated solvents (*i.e.*, non-EHC® ISCR applications). In response to the excessive accumulation of these problematic intermediates (*e.g.*, 1,2-DCE and Vinyl Chloride), inoculation of groundwater with *Dehalococcoides* sp., or other dehalogenators, is sometimes required.

With increasing frequency, however, it is reported to us that various microbial inoculants do not survive well in aquifers that have been previously treated with substrates other than EHC®. Hence a viable population of dehalogenators is not established and the accumulated metabolites persist and potentially migrate off site. The “failure” of the inoculum is usually caused by unsuitable environmental conditions such as:

- unacceptably low pH; unacceptably high Eh
- low availability of required nutrients;
- microbial toxicity due to surfactants/emulsifying agents present in the remedial amendments; and /or
- microbial inhibition due to induced mobilization of toxic heavy metals, such as arsenic.

These conditions are the direct result of using non-buffered, simple carbon-only remedial amendments. Thus, re-establishment of environmental conditions more conducive to the growth and proliferation of the inoculant is often needed to yield effective remediation of the impacted aquifers.

### EHC to Generate Enriched, Anaerobic Chase Water

In order to simultaneously address the potential causes of poor inoculum survival the aquifer can be enriched with anaerobic chase water that was generated using EHC®. EHC uniquely combines food-grade, controlled release carbon plus fine-grained, reduced metal (such as zero-valent iron; ZVI) to induce complete mineralization of multiple contaminants. When added to water several important reactions occur.

First, the ZVI in EHC provides a powerful mechanism to rapidly drop the Eh of water into the range most conducive to the survival of dehalogenators, such as *Dehalococcoides* sp. When in contact with water, ZVI corrodes (is oxidized) and during the process consumes dissolved oxygen, sulfate and nitrate. As a result the Eh of water placed in contact with EHC is generally reduced by between -300 and -500 mV over a period of hours. For example water that starts with an Eh of +100 mV would generally be reduced to a level of -300 to -400 mV. The process of ZVI corrosion is alkaline, therefore acids are balanced by alkalinity and the pH of the EHC generated chase water will remain near neutral.

Figure 1 shows the effect of EHC on the ORP of distilled water in a laboratory test. The test was performed in a closed bottle with headspace which was gently stirred after amendment. The ORP was

initially lowered from +350 mV to -400 mV within 24 hrs using either 0.1% and 0.25% of EHC to mass of water. The bottle was then decanted and refilled three times. The higher application rate of EHC provided consistent ORP buffering to below -350 mV in all four cycles, while the effect of 0.1% rate diminished after the 1st cycle.

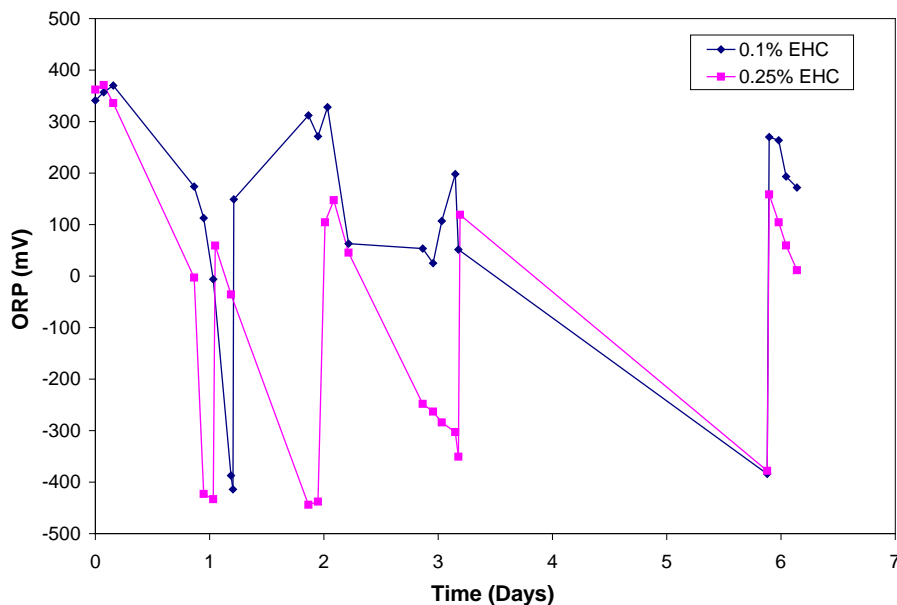


Figure 1. Effect of EHC addition on the ORP of distilled water in a laboratory test.

Second, the organic carbon in EHC is produced by milling of food grains and, as a result, provides an excellent balance of soluble carbon, insoluble carbon, major nutrients (N, P, K, S), minor (Ca, Mg, Fe), and micronutrients (Co, Mn, Mo, B). Thus, water to which EHC is added will be rapidly enriched in a broad range of major, minor and micronutrients; thereby addressing the nutritional requirements of fastidious dehalogenating bacteria. This supports the survival of the bacteria since many species are known to have complex nutritional requirements that cannot be satisfied by the nutrient-stressed groundwater present in many aquifers. A select fraction of the organic component of EHC will be rapidly consumed (fermented) yielding various volatile fatty acids (VFAs) that are source of hydrogen for resident microbes.

EHC does not contain chemical surfactants or emulsifying agents.

Finally, the problem of heavy metal toxicity can be eliminated by precipitation of metals as iron sulfides. As the iron in EHC corrodes it releases ferrous iron ( $\text{Fe}^{+2}$ ). Simultaneously, sulfate present in the water is both chemically and microbiologically reduced to sulfide. Many heavy metal species - including As, Ni, Pb, Zn, Cu and Cd - are readily precipitated from groundwater by precipitation as metal-sulfides or mixed iron-metal- sulfides. This precipitation process results in removal of much of the heavy metal toxicity and thereby enhances survival of the inoculated dehalogenators.

In summary, EHC can be used to generate anaerobic chase water to restore environmental conditions that have been misaligned due to the addition of emulsified oils and other sources of carbon-only remedial amendments. The EHC Chase Water is:

- Rapidly generated on site using conventional equipment and machinery
- Not temperature sensitive
- pH neutral; extremely low Eh
- Enriched in dissolved nutrients and VFAs known to be important and useful to select microflora

### **General Application Guidelines**

- 50 lb bag EHC added to 3,000 USG water in closed (VENTED) container
- Gentle mixing (no aeration) for 12-24 hrs; let settle for 4 hrs
- Eh drop to <-400 mV in most water sources
- Check pH and adjust it to the required range
- Decant enriched Chase Water (NOTE: depending on the configuration of the injection network a filter bag [200 micron or smaller] maybe be required to remove suspended solids).

### **Ordering Information:**

EHC costs \$2.50/lb. Contact us at:

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2871 W. Forest Rd - Suite 2, Freeport, IL USA 61032  
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[www.AdventusGroup.com](http://www.AdventusGroup.com) | [www.Adventus.eu](http://www.Adventus.eu) | [www.ETI.ca](http://www.ETI.ca)



**In Situ Chemical Reduction (ISCR™) - Do It Right and Avoid:**



- *Mobilization of metals*
- *Metabolite accumulation*
- *Extensive water chase*
- *Change in pH*