



Project

In Situ Chemical Reduction (ISCR) of 1,2 – DCA in Groundwater Confidential Industrial Site

Introduction

Adventus' ISCR technology employed, EHC®, a patented combination of hydrophilic, controlled-release solid carbon and zero valent iron (ZVI) and/or other reduced metal particles. EHC technology causes complete destruction of organic contaminants through two primary mechanisms: (i) chemical reduction and (ii) enhanced biological degradation. This unique combination stimulates ISCR of otherwise persistent organic solvents in groundwater and source zones, **without the accumulation of catabolites**. Hence, EHC is particularly effective for *in situ* treatment of subsurface environments impacted by mixtures of chlorinated solvents and/or more persistent compounds such as 1,2 dichloroethane (1,2-DCA). As outlined below, Adventus has performed extensive testing of EHC for treatment of 1,2-DCA and offers the technology for full-scale site remediation.

EHC Treatment Performance on 1,2-DCA – Bench Tests

Bench Test # 1

Adventus conducted a bench scale treatability study on groundwater from a site impacted predominantly with 1,2-DCA. The total volatile organic compound (VOC) concentration of the site groundwater was 337 mg/L and the 1,2-DCA concentration was 329 mg/L. The experimental system consisted of a column followed by two downstream soil microcosms as shown in (Figure 1) below.

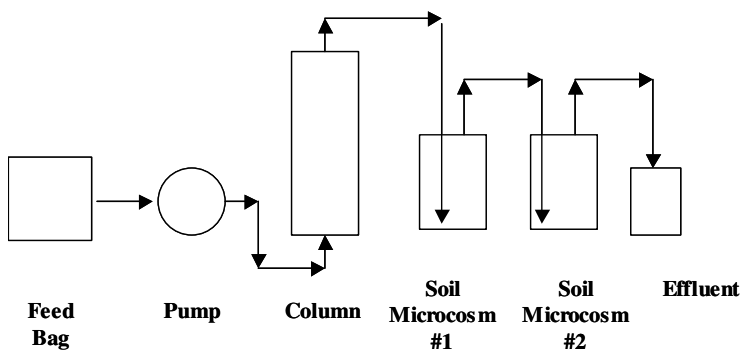


Figure 1: Schematic of experimental set up. The peristaltic pump transfers feed water from a collapsible Teflon bag into the bottom of the column. Effluent from the column flows through soil microcosm #1 and then soil microcosm #2.

The column and first downstream soil microcosm were filled with 1% EHC (by mass) mixed with site soil. The second soil microcosm was filled with only site soil. This experimental set up was designed to mimic an injection of EHC into the subsurface at the site. The second soil microcosm, containing only site soil, was added to monitor any further degradation of VOC that may occur down gradient of the reactive zone. A control system was also set up as described above; except no EHC was added (i.e. the column and soil microcosms were filled with site soil). VOC and chloride concentrations were monitored in the influent and effluents over time.

The VOC sampling on day 98 revealed a 99+% reduction in 1,2-DCA from 329 mg/L in the feed to 83 mg/L and 0.041 mg/L in the column and first soil microcosm effluents, respectively (**Figure 2**). The 1,2-DCA concentration was further reduced to 0.019 mg/L in the second soil microcosm. Chloroethane, a potential break-down product of 1,2-DCA, was not detected in the effluents. The 1,2-DCA concentration in the final effluent of the control system (no EHC present) was 221 mg/L, which corresponded to a 33% removal of 1,2-DCA. This reduction was likely the result of native dechlorinators present in the site soil and groundwater.

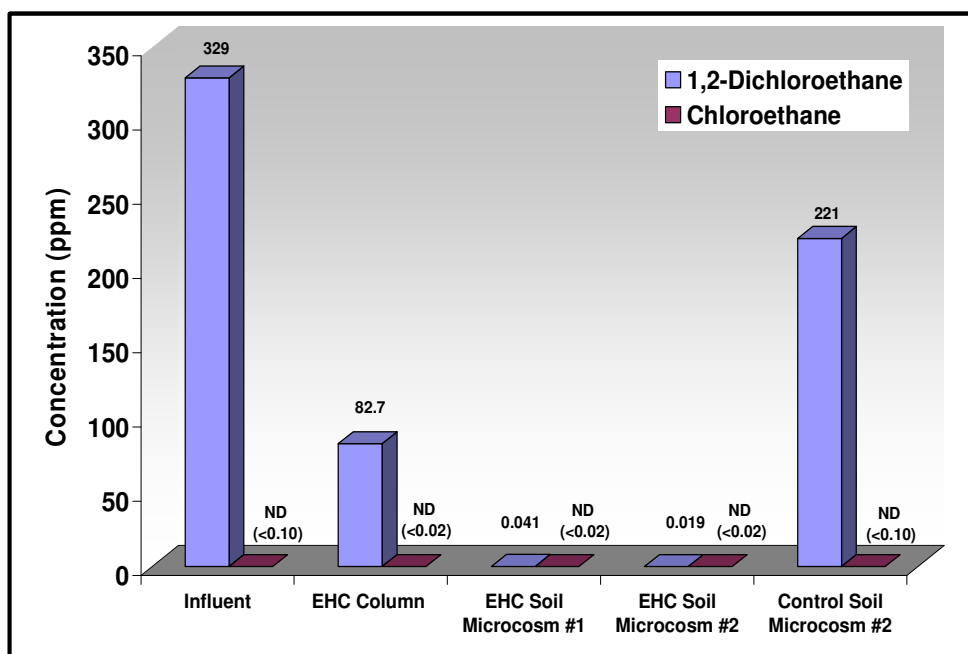


Figure 2: Influence of EHC on 1,2-DCA concentrations after 98 days of operation

Since the dechlorination of VOCs is accompanied by an increase in the chloride concentration, a chloride mass balance was obtained by comparing the measured increase in chloride concentration ($[Cl^-]_{\text{effluent}} - [Cl^-]_{\text{feed}}$) with the theoretical concentration of chloride produced (calculated from VOC concentrations). The results from the chloride mass balance confirmed complete dechlorination of the treated VOCs (**Table 1**) while the control system showed little production of chloride.

System	Concentration (mg/L)		Chloride Mass Balance
	Theoretical	Measured	
1% EHC	239	239	99.9%
Control	80	10	12.5%

Table 1: Chloride mass balance in EHC and control system after 98 days of operation.

Bench Test #2

In another bench-scale study, Adventus compared the treatment of 1,2-DCA in the presence of ZVI or EHC in amended soil columns over a period of 223 days. Results show that EHC amended soil columns reduced 1,2-DCA from an initial concentration of 24 mg/L by 95% with a 100% molar conversion to chloroethane (CA) in 35 days (**Figure 3**). In this case, the molar ratio of CA was reduced to 42 % after 64 days, and after 223 days there were no detections of 1,2-DCA and CA in the column effluent. On the other hand, the soil column amended with ZVI only showed 26%, 20% and 4% reductions in 1,2-DCA on days 35, 65 and 223, respectively. This concluded that 1,2-DCA can be effectively treated under ISCR conditions created with EHC but not with ZVI alone, and that the direct chemical reduction pathway for degradation of cVOCs by ZVI does not apply to 12DCA.

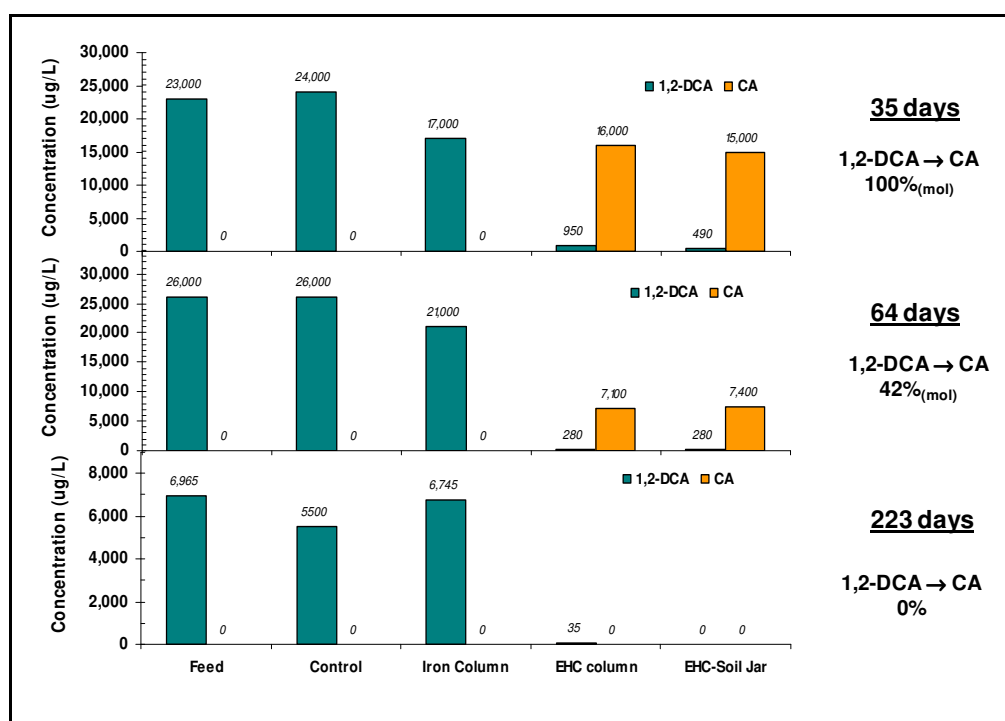


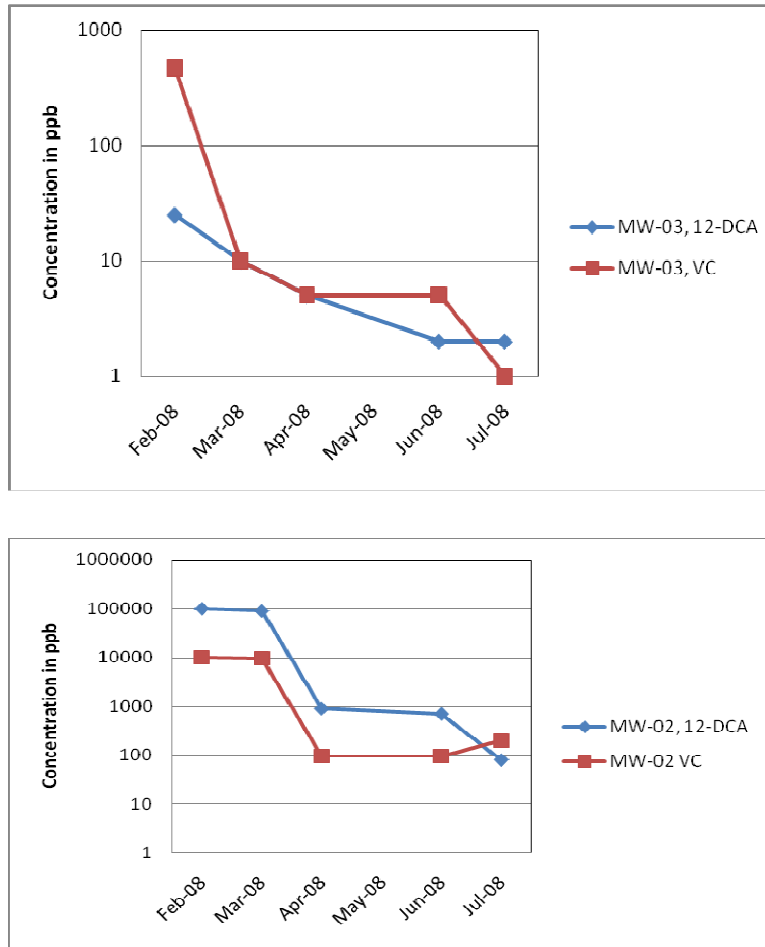
Figure 3: Influence of EHC and ZVI on Treatment of 1,2-DCA

Field Pilot Test – Industrial Site

In March 2008, Adventus conducted a pilot test at an industrial site where the primary contaminants were 1,2-DCA, vinyl chloride (VC) and *cis*- 1,2 dichloroethene (*cis*-DCE) among others. The cVOCs were migrating off-site and the objective was to reduce the levels of cVOCs to below 20 ppb VC, 50 ppb 1,2-DCA. The remedial strategy was to create a reactive barrier.

Groundwater was encountered at a depth of 12 ft bgs and the impacted saturated zone was approximately 25 ft thick. The aquifer was composed of medium-to-fine sands with occasional interbedded silt. A low permeability clay layer was encountered at 40 ft bgs. EHC was injected 6 ft upgradient of two existing monitoring wells MW-02 and MW-03 in two different areas at the site. A total of 14,000 lb of EHC was injected in each of the two areas as 30% solids slurry. Data

collected 6 months post EHC-injection showed that EHC significantly reduce the levels of both VC and 1,2-DCA in downgradient monitoring wells and was likely to achieve the treatment standards within the 9 to 12 month period (Figure 4)



Figures 4a/b: EHC Pilot Test – Data from Six Months of Post-Injection

Full-Scale Application

The data shows that the site-specific COIs can be treated to below local control standards in groundwater. Additional injections may be conducted if required during the pilot test. The full-scale application will target other source areas at the site and may include a longer PRB along the downgradient property boundary.

FOR MORE INFORMATION PLEASE CONTACT

Fayaz Lakhwala, Ph.D.
 Adventus Group
 Director of Remedial Design and Engineering Services
 1435 Morris Avenue, Union, NJ 07083
 Phone: 908.688.8543 Cell: 908.230.9567
 Fax: 908.688.8563
 e-mail: fayaz.lakhwala@adventusgroup.com