EHC® Reagent Placement Evaluation for Field Applications

EHC® *in situ* chemical Reduction (ISCR) reagent is an integrated treatment material containing controlled-release organic carbon and fine-grained zero valent iron (ZVI) for treatment of contaminated groundwater. Typically, *in situ* EHC reagent zones are created using injection placement methods, such as a direct push technique (DPT). Based on experience, the distribution of injected EHC depends on site conditions and injection equipment used. Therefore, confirmatory core evaluation is often performed to verify the radius of influence (ROI) and uniformity of EHC amended zones.

Given below are several core examination methods that could be used as part of this evaluation. Ideally, both lateral and vertical substrate distribution would be evaluated using discrete depth samples in cores collected at different distances from the injection point. The cores collected in the vicinity of the EHC injections should be compared to those outside of the perceived ROI.

ZVI PRESENCE

Visual Inspection:

Because of the presence of ZVI in EHC reagent, the amended zone should be enriched in reduced iron, both particulate ZVI and ferrous iron. In addition to distinct layers of dark colored EHC product, visual inspection of cores may show a dark discoloration in sections influenced by EHC. It should be noted that red/brownish discoloration indicative of oxidized iron is not typically observed in EHC cores, even after prolonged exposure to air, likely due to the presence of the organic substrate (Figure 1).

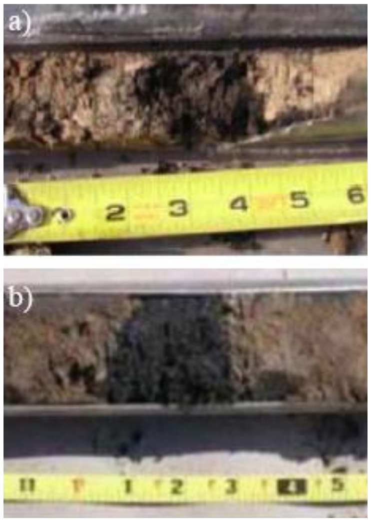

Figure 1 – EHC DPT fractures in cores at sites in a) Oregon (clay aquifer) and b) Kansas (sandy aquifer)

Magnet Inspection:

The presence of ZVI particles can also be detected using a magnet. A wet magnetic separation (as described in Attachment A) can be used as a qualitative method to determine ZVI presence in a core sample. It can also be used as a semi-quantitative method to determine the ZVI content. The procedure is designed for use with simple equipment in a field laboratory and can obtain a method detection limit of about 0.1% per soil mass. Method calibration is recommended in the field with site soils (i.e. mixing a known amount of EHC to background soil and then detecting it using the magnetic separation method).

LABORATORY ANALYSIS

If selected core samples could be sent for laboratory analyses, then TOC could be analyzed in soil. Note that a typical laboratory determination of soil iron is based on a strong acid digestion, and as such is not useful for EHC evaluation due to interference from structural native iron present in soil minerals. If the coring equipment is capable of collecting pore water samples, then these samples could be analyzed for indication parameters described in the EHC Reagent Product Application Guide – Baseline Sampling

ATTACHMENT A

Magnetic Separation Method for ZVI Content Determination in EHC Reagent Amended Soil

1) Collect about 100 g of amended core material. Take a sub-sample of about 10 g, record its wet weight (S1), dry it in an oven, and record its dry weight (S2). The objective here is to calculate soil moisture content.

2) Weigh about 50 g of wet soil sample record its weight (A) and suspend it in about 300 mL of tap water in a transparent plastic cap. Tape a magnet (ceramic block magnet) to the bottom of the cap.

3) Stir the suspension and allow it to settle. Decant most of the water containing suspended fine soil particles and floating debris.

4) Add more water and repeat the procedure until the suspension is clear. ZVI and the soil sand fraction will be retained at the bottom. The objective here is to remove most soil fines adhering to the ZVI while not washing away the ZVI particles.

5) Remove magnet from the bottom of the cup and tape it to the side of the cup. Fill it with water, stir the suspension and tip the cup towards the opposite end of the magnet location. ZVI particles will be retained at the cup wall influenced by the magnet while sand will be collected at the other end. Use a stirring stick and a squirt bottle filled with water to carefully remove and wash away the sand, while taking care not to disturb the retained ZVI particles. The objective here is to separate all iron particles from the sand. Repeat this procedure to separate any soil particles trapped with ZVI.

6) Remove magnet from the cup, using a squirt bottle wash the ZVI particles into a pre-weighed aluminum weigh boat. Position a magnet on the outside of the aluminum weigh boat to retain ZVI particles while pouring off the water in the weigh boat, dry it completely in an oven or on a propane cook stove, weigh and record the weight (B).

7) Calculate the iron fraction per dry weight soil using the following formula:

$$\textit{\% Iron} = \frac{\textit{Weight Dry Extracted Iron (B)}}{\textit{Initial Wet Sample Weight (A)}\ \dfrac{\textit{Dry Subsample Weight (S2)}}{\textit{Wet Subsample Weight (S1)}}} \times 100$$

8) Necessary Equipment:

- Scale accurate to 0.1 gram
- Magnet (e.g. a hardware store rectangular shape 1 in. x 2 in. ceramic magnet)
- Transparent plastic cups (about 400 mL)
- Drying oven or propane cook stove
- Squirt bottle
- Plastic spoon for mixing
- Personal protective equipment (gloves, eye protection)

HEALTH AND SAFETY

Prior to working with EHC consult the Safety Data Sheet (SDS) to understand proper safety, handling, storage and disposal procedures. Any vessel that contains wet EHC or EHC and water must be vented due to potential pressure build up from fermentation gasses. When working with EHC, it is recommended to use standard personal protective equipment, including: safety glasses, steel toe boots, nitrile gloves, hearing protection (when direct push equipment is used), and hard hat. Dust mask may be required when in close contact with EHC under certain conditions.