Bench-Scale Evaluation of EHC® Reagent for Treatment of Perchlorate

Perchlorate is a groundwater contaminant that is highly mobile and persistent in the environment. Perchlorate posses a risk to human health since it interferes with the uptake of iodine by the thyroid gland, which in turn disrupts the production of metabolic hormones (Brown et al., 2002).

Current research indicates that both abiotic and biotic mechanisms support removal of perchlorate from groundwater. Biological perchlorate reduction occurs when the bacterium uses perchlorate as an electron acceptor in place of other electron acceptors (i.e. oxygen or nitrate). Perchlorate reducing bacteria are ubiquitous and have even been found in pristine environments (Coates et al., 1999).

EHC® Reagent will promote both abiotic and biotic treatment mechanisms. A bench-scale treatability study showed that greater than 99% removal of perchlorate from groundwater was achieved with EHC.

Treatability Study Set-Up

A column was filled with a mixture of EHC (24% by mass) and sand. This column was designed to mimic a permeable reactive barrier trench filled with a mixture of the reactive material (EHC) and sand. The column was followed by two downstream attenuation microcosms, which were filled with soil, to monitor any further reduction of perchlorate that may occur down gradient of the reactive zone. A control system was also set up as described above, except no EHC was added to the column. The influent perchlorate concentration was approximately 100,000 ppb and the flow rate through the columns was maintained at 150 mL/day. The influent and effluents were periodically sampled for perchlorate.

Results

The perchlorate concentrations in the influent and column effluents of the EHC and control systems are presented in **Figure 1**. On day 76, the EHC column reduced the perchlorate concentration from 120,000 ppb in the influent to 9,400 ppb, corresponding to a 92% removal. The perchlorate concentration was further reduced in the first soil microcosm to non-detect (detection limit = 200 ppb). The control system showed a slight (17%) decrease in the perchlorate concentration.

The columns were not sampled for an extended period of time, however regular sampling has occurred since about day 400 of the study. All the results showed complete removal of perchlorate (detection limit = 2 ppb) while the

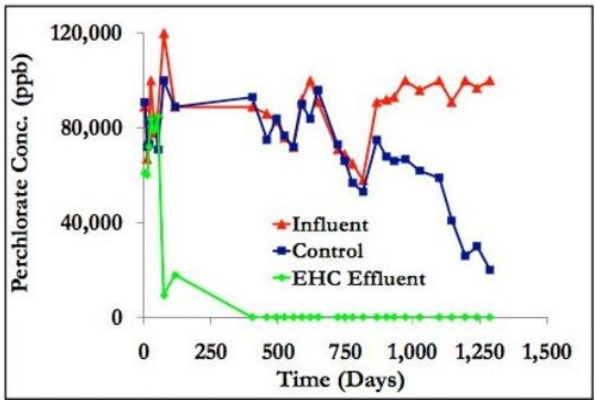

Figure 1: Influence of EHC and control on perchlorate concentrations in groundwater

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control column showed little reduction, if any, for the first 900 days of the study followed by a gradual decline, potentially due to the development of perchlorate- degrading bacteria. The most recent samples were taken on day 1,287 of the study, which corresponds to 3.5 years of treatment. This work is being conducted at 20˚C. Given that the longevity of the EHC is expected to be much greater in the subsurface due to lower temperatures, it is reasonable to believe that EHC may have longevity of at least five to seven years in the subsurface.

To illustrate that the treatment is a result of biodegradation and not an adsorptive process, chloride samples were taken along with the day-619 sampling. These data are presented in **Table 1**. The amount of chloride produced in the EHC effluent was 98% of the theoretical amount that would be created from the complete treatment of the influent perchlorate. The effluent chloride level of the control column was very close to that of the influent.

Table 1: Influence of EHC and control on chloride concentrations from degradation of perchlorate in groundwater.

	Chloride (mg/L)	Chloride Produced (mg/L)	Theoretical Chloride Produced from Perchlorate Degradation (mg/L)
Influent	23.2	-	-
EHC Effluent	58.3	35.1	35.6
Soil Control Effluent	24.5	1.3	<0

At approximately day 600 of the study, trichloroethylene (TCE) was added to the influent water to evaluate the treatment of chloroethenes simultaneously with perchlorate. The results, shown in **Figure 2**, illustrate excellent removal of total VOCs, with minimal production of cis-1,2- dichloroethylene or vinyl chloride.

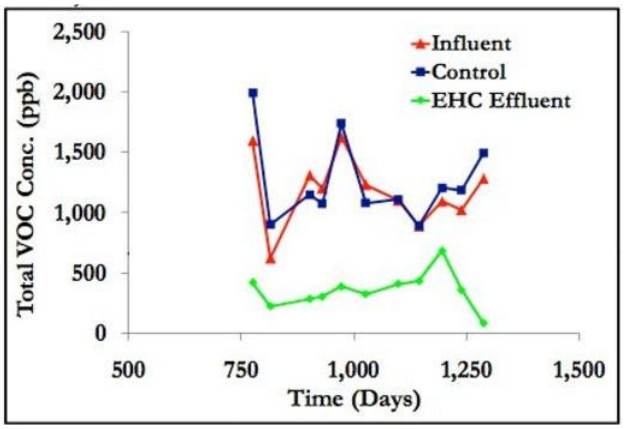

Figure 2: Influence of EHC and control on total VOC concentrations in groundwater

Conclusions

- EHC is capable of consistently treating greater than 99% of perchlorate
- EHC is capable of treating perchlorate at concentrations of at least 100 mg/L
- The treatment mechanism is likely destruction of the perchlorate given the chloride produced
- EHC has demonstrated effectiveness for 1,287 days (3.5 years) at room temperature, illustrating that it exhibits high longevity
- EHC is capably of simultaneously treating chlorinated solvents