In Situ Stabilization of Lead in Groundwater – Two Case Studies from Brazil

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Resumo

EHC-M® tem se mostrado eficaz na imobilização de chumbo (Pb) nas águas subterrâneas, em dois locais no Brasil; 1) uma antiga fábrica de reciclagem de baterias localizada no interior do Estado de São Paulo e 2) uma fábrica ativa localizada no Rio de Janeiro. Em ambos os casos, o objetivo foi a correção do pH, para imobilizar o Pb *in-situ* e limitar a migração da pluma. Para este fim, foi conduzida a injeção de EHC-M para promover a precipitação de Pb solúvel na forma de sulfetos estáveis. O EHC-M combina liberação controlada de fonte de carbono, ferro zero-valente (ZVI) e lenta liberação de enxofre. Após a aplicação do EHC-M no subsolo, uma combinação de reações químicas e biológicas irão estabelecer condições extremamente redutoras combinado com elevados níveis de ferro reduzido e sulfeto, condição em que o Pb dissolvido irá precipitar na forma de galena e também será adsorvido como óxidos de Fe estáveis.

Abstract

EHC-M® has been shown to effectively immobilize lead (Pb) from groundwater at two sites in Brazil; 1) a former battery recycling facility located in Sao Paulo state and 2) an active manufacturing facility located in Rio de Janeiro. In both cases the remedial objective was to immobilize Pb *in situ* to limit plume migration. Toward this end, injection of EHC-M was conducted to promote precipitation of soluble Pb as stable sulfides. EHC-M combines controlled-release carbon, micro-scale zero-valent iron (ZVI) and a slow-release source of sulfur. Following placement of EHC-M into the subsurface, a combination of biological and chemical reactions will serve to establish very low redox conditions and elevated levels of reduced iron and sulfide, under which conditions dissolved Pb will precipitate as galena and strongly adsorb onto Fe-oxides.

Key Words

lead, *in situ* stabilization, heavy metals

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2 – Background / Objectives

EHC-M® has been shown to effectively immobilize lead (Pb) from groundwater at two sites in Brazil; 1) a former battery recycling facility located in Sao Paulo state and 2) an active manufacturing facility located in Rio de Janeiro. In both cases the remedial objective was to immobilize Pb *in situ* to limit plume migration. Toward this end, injection of EHC-M was conducted to promote precipitation of soluble Pb as stable sulfides. EHC-M combines controlled-release carbon, micro-scale zero-valent iron (ZVI) and a slow-release source of sulfur. Following placement of EHC-M into the subsurface, a combination of biological and chemical reactions will serve to establish very low redox conditions and elevated levels of reduced iron and sulfide, under which conditions dissolved Pb will precipitate as galena and strongly adsorb onto Fe-oxides.

2 – Approach / Activities.

A pilot scale evaluation of the EHC-M technology was conducted in each case before full-scale application. The reagent was mixed with water on site and injected as an aqueous slurry into the impacted saturated zone via direct push. Prior to treatment, both sites showed acidic conditions within the plume areas with pH as low as 3 measured historically. The aqueous solubility of Pb and its precipitation products is highly pH-dependent and, in general, Pb solubility is lower at near neutral to alkaline pH. Therefore, a buffer was injected together with the EHC-M slurry to adjust the pH to around neutral. Crushed dolomite and magnesium hydroxide ($Mg[OH]_2$) was used at the Sao Paulo and Rio sites, respectively.

3 – Results / Lessons Learned.

Post injection data showed a decrease in the oxidation-reduction potential (ORP) and increase in the pH, confirming successful distribution of the EHC-M slurry and pH buffers into the targeted zones. Furthermore, dissolved phase Pb was rapidly reduced. At the Sao Paulo site, dissolved Pb was reduced from a baseline of 306 ppb to below the detection limit of 10 ppb in a pilot-scale evaluation. The full-scale implementation is currently ongoing. At the Rio facility, pilot testing showed a reduction in dissolved Pb from a maximum of 497 ppb to below the detection limit of 1 ppb in 30 days. Following full-scale application of the EHC-M technology conducted in April 2011, dissolved Pb has remained non-detect at all locations. Longer-term performance monitoring data will be presented at the seminar, including more detailed geochemical data and a review of lead immobilization mechanisms and expected precipitation products.