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Effectiveness of a Metal Stabilizer When Treating Hazardous Waste with Modified Fenton's Reagent and Sodium Persulfate

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ABSTRACT: The effectiveness of a metal stabilizer (a mixture of magnesium oxides and calcium phosphates) was evaluated when treating hazardous waste contaminated soil in conjunction with modified Fenton's reagent (MFR), sodium persulfate activated by an alkali (ASP), and sodium persulfate activated by MFR (FSP). The soil was contaminated with high concentrations of aromatic hydrocarbons, chlorinated solvents, polychlorinated biphenyls and heavy metals. The objective of the study was to utilize a combination of chemical oxidation and metal stabilization to reduce concentrations of toxicity characteristics leaching procedure (TCLP) of volatile organic compounds (VOCs), primarily benzene, tetrachloroethene (PCE), and 1,2-dichloroethane (DCA) and heavy metals, such as lead and cadmium in soils. To meet the objective, a series of soil-slurry experiments were conducted to first determine the optimum dosage of metal stabilizer needed to treat TCLP metals, followed by evaluation of two doses [i.e. 3% and 5% (w/w)] of MFR, ASP and FSP both in the presence or absence of the metal stabilizer. Treatability results showed that TCLP cadmium and lead were stabilized to non-detectable levels with use of 4% (w/w) metal stabilizer; therefore, the remaining experiments were performed at this concentration. In the absence of metal stabilizer, increases in TCLP lead and cadmium occurred with all tested doses of ASP, FSP and MFR indicating significant metal mobilization. In the presence of metal stabilizer, however, the TCLP lead concentrations decreased significantly to low levels and the degree of TCLP cadmium mobilization decreased with increasing doses of ASP, FSP or MFR showing that the metal stabilizer retains a good portion of its functionality even in the presence of chemical oxidant. When used in conjunction with metal stabilizer, ASP was ineffective and FSP showed substantially decreased treatment of TCLP benzene, PCE and DCA. On the contrary, MFR showed positive results with increased treatment effectiveness of TCLP benzene, PCE and DCA. This is likely due to stabilization of interfering transition metals present in native soils, thereby, limiting hydrogen peroxide wastage. Overall, the results indicate that the metal stabilizer complements the performance of MFR but impedes the performance of systems containing sodium persulfate as it is likely to adversely impact the treatment efficiency of both TCLP VOCs and TCLP metals.

INTRODUCTION

A former industrial facility site in Connecticut contained a complex mix of contaminants including aromatic hydrocarbons, chlorinated solvents, polychlorinated biphenyls (PCBs) and heavy metals. Although chemical oxidation has been applied at hundreds of sites throughout the United States to treat a wide range of organic contaminants, studies focusing on a combination of chemical oxidation and metal stabilization technologies on