

Binding chemistry and leaching mechanisms in solidified hazardous wastes

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Abstract

This work can be divided into four main tasks: (1) to determine the nature of the bound states, (2) to determine how these leach, (3) to determine the bulk physical and chemical changes caused by the metals' presence and their subsequent leaching, and (4) using this information through advanced concepts to develop leaching mechanisms. Model doped systems with portland cement Type 1, Type 5, and Type IP are being characterized by surface analysis using XPS, ISS, AES, and RBS and by bulk techniques using Hg porosimetry, XRD, SEM-EDS, and optical spectroscopies. Considerable progress has been made as to the chemical nature of the fixation of Pb, Cr, Ba, Zn, Cd and Hg in the cement solidification medium, their relative location with respect to the surface and their effect on physical and pore structure. Mercury has been found to be almost exclusively located at the surface of the cement particles as particulates of HgO. Chromium has been found to be mainly located below the surface of the cement as Cr^{3+} . Cadmium, zinc and lead are prominently on the surface in as yet to be determined surface compounds. Their presence there strongly affects the hydration chemistry of the cement and produces substantial amounts of surface carbonates on aging. Models for these effects have been developed. The chemical and physical changes induced by leaching are being explored as well. The material structure as to pore volume, pore area, bulk density and pore diameter are being probed before and after metal doping and before and after leaching with mercury porosimetry and physical changes are being monitored by SEM. Multi-element SEM line scans across the leach front are providing information on selective component loss and redistribution of elements on leaching. XPS is being developed to probe the degree of polymerization of silicates and has already been used to show that leaching causes silicate polymerization. The complex physical and chemical changes will be discussed in terms of binding and leaching models involving the cement structure and selective component attack by leaching solutions. The present under-

standing of the complex chemistry involved will be used to project improved systems that bind the metals better and resist leaching.

Biodegradation of biphenol by suspended and immobilized cultures of the white rot fungus *Phanerochaete chrysosporium*

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Abstract

White rot fungi are able to attack and degrade a wide variety of recalcitrant organic pollutants including polyaromatic hydrocarbons and chlorinated compounds. However, the unique degradative potential of these organisms has not yet been exploited for commercial waste treatment processes. *Phanerochaete chrysosporium*, the best studied white rot fungus, synthesizes a variety of oxidizing enzymes, such as ligninases and Mn-dependent peroxidases, that catalyze the initial rate limiting step in the degradation of recalcitrant compounds. While the production of these enzymes is essential for biodegradation, it occurs only when the mycelia are grown under very specific conditions that cannot be easily reproduced in bioreactors. We established that high levels of ligninases can be produced by both suspended and immobilized batch cultures of *P. chrysosporium* grown at a temperature of 33°C in optimized complex media. Subsequently, the degradation of biphenol by cells immobilized in Ca-alginate, κ -carageenan and nylon pads was studied in detail. Using radioactively labelled biphenol it was shown that about 20% of the initial xenobiotic is mineralized to CO₂ and another 60% is recovered as water soluble byproducts after 28 days of incubation. The extent of degradation was approximately the same for suspended cultures and cells immobilized in either the Ca-alginate or κ -carageenan. However, inconclusive results were obtained with nylon-immobilized cells due to the binding of the biphenol to nylon. It was observed that rate of mineralization is paralleled by the production of ligninases in the growth media, indicating that the induction of oxidative enzymes is very important for biodegradation. As expected, extensive degradation occurred only after the cells have entered the stationary phase. The effect of xenobiotic and co-substrate