THE WES-PHix® ASH STABILIZATION PROCESS

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ABSTRACT

This paper discusses a patented process developed by Wheelabrator Environmental Systems Inc. for chemically stabilizing ash from municipal solid waste combustion facilities. This technology, marketed commercially as the WES-PHix® Process, reduces the solubility of certain heavy metals in ash through the addition of soluble phosphate, lime and water. The addition of these reagents to ash promotes the formation of geochemically stable metal phosphate compounds which are resistant to leaching. The WES-PHix® Process produces stabilized ash which consistently passes the U.S. Environmental Protection Agency (EPA) Toxicity Characteristic Leaching Procedure and other regulatory leaching tests.

The chemical reactions caused by the application of soluble phosphate and lime to ash are discussed. The solubility of metal phosphate compounds is examined, and stabilized ash leaching test data are presented.

The advantages and performance record of the WES-PHix® Process, including cost, are also presented.

INTRODUCTION

The combustion of municipal waste in modern trash-to-energy facilities is one component of an integrated and environmentally sound approach to solid waste management. The combustion of municipal waste produces ash residue which can be safely managed in a variety of ways. In the United States, most municipal waste combustion (MWC) ash is disposed in lined sanitary landfills or ash monofills. Some ash is also beneficially used as a sanitary landfill cover material or as an aggregate in road construction.

The stabilization of ash from a specific MWC facility is often necessary to comply with regulatory leaching test requirements or to minimize metals solubility in a beneficial ash use application.

The chemical stabilization of MWC ash through the addition of soluble phosphate and lime is a highly effective method for decreasing the solubility of certain trace heavy metals. This stabilization technology, marketed commercially as the WES-PHix® Process, has been successfully used by Wheelabrator Environmental Systems since 1987. WES-PHix® is now the most widely used proprietary ash stabilization process in the world.

DISCUSSION OF WES-PHix® PROCESS CHEMISTRY

Dissolution and Precipitation Reactions

The heavy metals in untreated MWC ash which are available for leaching are present as soluble solid phases located on the surfaces of the ash particles, and as metal cations or aqueous complexes dissolved in the interstitial pore water. Research on combined MWC ash (bottom ash, fly ash and scrubber residue) indicates that for lead, less than 30% of the element is available for leaching. The majority of the trace metals in ash are present as insoluble lattice-substituted compounds, or are bound in a glassy matrix (Eighmy, 1994).

Lead, cadmium and certain other metals in ash are immobilized by the WES-PHix® Process through dissolution and precipitation reactions. Water is mixed with the ash to dissolve the soluble solid phase metals. The phosphate and lime, when added to the ash/water mixture, react with the metals in solution to form metal phosphate and metal carbonate compounds which precipitate out of solution (Eighmy et al., 1990). Some metal hydroxide compounds may also form, but they are not believed to be the solid phases which control lead and cadmium solubility in WES-PHix® treated MWC ash.

Solid Phases Controlling Metals Solubility

Substantial research has been conducted to determine the solid phases controlling lead and cadmium solubility in WES-PHix® treated MWC ash. Theoretical analyses have been performed using $p\{Pb^{2+}\}$-pH solubility diagrams, Eh-pH stability fields, and $p\{PO_4^{3-}\}$-pH predominance diagrams. The techniques of x-ray powder diffraction analysis and geochemical modeling of ash leachates have also been used to study WES-PHix® treated ash. The research conducted to date suggests that chloropyromorphite $[Pb_5(PO_4)_3Cl]$ and lead hydroxypyromorphite $[Pb_5(PO_4)_3OH]$ the predominant lead phosphate minerals formed by the WES-PHix®