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Project Summary

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Evaluation of Solidified Residue from Municipal Solid Waste Combustors

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The study summarized here evaluated the effectiveness of commercial solidification techniques to immobilize inorganic and organic constituents in five municipal refuse incinerator ash (MRIA) samples. Although the ash samples were analyzed for selected organic and inorganic constituents, the organic characterization was deleted from the analytical scheme because of the low organic composition of the ash.

The ash samples were also analyzed for elemental content, including arsenic, barium, boron, cadmium, calcium, chromium, copper, lead, mercury, nickel, selenium, sodium, and zinc. The most prevalent elements in the ash samples were calcium (2.2%-8.8%), copper (0.04%-0.17%), lead (0.07%-0.17%), sodium (0.28%-1.8%), and zinc (0.15%-6.69%).

Extracts obtained by use of the toxicity characteristic leaching procedure (TCLP) were made from the unsolidified ash samples. Analysis of the TCLP extracts showed that concentrations of metals in the ash were well below regulatory limits.

Three solidification techniques were performed on the ash samples: chemical fixation, cementation with kiln dust, and cementation with fly ash, with all of the ash samples solidified by the chemical fixation technique. A combined-ash sample and a fly-ash sample were also solidified by cementation techniques.

The TCLP and static leach test (SLT) procedures were performed on solidified ash samples, and extracts generated from the fly ash and the combined ash were analyzed for elemental content. Concentrations of all metals in the ash extracts were well below regulatory limits.

This Project Summary was developed by EPA's Risk Reduction Engineering Laboratory, Cincinnati, OH to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction and Objectives

This study was performed to evaluate the effectiveness of commercial solidification techniques to immobilize TCLP-extractable hazardous constituents of ash from five municipal refuse incinerators. Combined ash samples (a mixture of bottom ash and fly ash) were collected from four facilities and fly ash as well as combined ash samples were collected from a facility in Dayton, Ohio, for a total of six ash samples from five facilities.

All ash samples were solidified by chemical fixation. Two of these ash samples (a combined ash and a fly ash) were also solidified by cementation with kiln dust and with fly ash.

Concentrations of inorganic constituents in the ash samples and their extracts were compared before and after the solidification procedures. TCLP extracts of the ash samples were not analyzed for organic constituents because concentrations of organic compounds were equal to or below the quantifiable method detection limits.

Methods

To determine the pH and electrical conductivity (EC) of the ash samples, a slurry of equal volumes of sample and deionized water was prepared and the pH of the decanted liquid was measured. A slurry of one part fly ash to five parts water was used to generate enough volume for pH and EC analysis of the Dayton fly ash sample.

The distribution of particle sizes in the ash samples was quantitatively determined: particle sizes larger than 75 µm, by sieving, and particle sizes smaller than 75 µm, by sedimentation with a hydrometer.

Before analysis, the ash and leachate samples were subjected to acid digestion procedures. Inductively coupled argon emission spectroscopy (ICP) was used to analyze for boron, barium, cadmium, calcium, chromium, copper, nickel, silver, sodium, and zinc in the ash and leachate samples. Furnace atomic adsorption spectrophotometry was used to analyze samples for arsenic, lead, and selenium by the procedures outlined in EPA Methods 7060, 7421, and 7740, respectively. Cold vapor atomic adsorption spectroscopy was used to determine mercury in the ash and leachate samples.

The solidified ash samples were prepared according to specifications in ASTM Method C-192-81 entitled, "Standard Method of Making and Curing Concrete Test Specimens in the Laboratory." The unconfined compressive strength (UCS) of the solidified samples was measured as a way of estimating the maximum shear strength developed by solidified ash samples. The permeability coefficients for cured solidified ash samples were measured with the use of flexible-wall membrane triaxial cell.

The ash and solidified ash samples were extracted according to the TCLP, a procedure which is designed to assess the presence of organic and inorganic contaminants in liquid, solid, and multiphase wastes.

Solidified ash samples were also extracted by the SLT, a test that measures the maximum credible concentrations of elements in quasi-static groundwater that has been in contact with a stabilized waste. Sequential SLT's were also performed on each solidified ash sample. Each extract was filtered through a 0.60- to 0.80-Hm glass-fiber filter to remove solids.

Results

Because of the very low levels of organics found in the MRIA samples, organic characterization of the ash leachates, the solidified ashes, and the leachates of the solidified ashes was deleted from the experimental scheme. The most prevalent inorganic species found in the samples were calcium (2.2% to 8.8%), copper (0.04% to 0.17%), lead (0.07% to 0.17%), sodium (0.28% to 1.8%), and zinc (0.15% to 0.69%).

Metal concentrations in TCLP extracts of ash and solidified ash were below the regulatory levels defined in the TCLP. The low levels of trace elements found in the TCLP extracts indicated that the metals in the MRIA samples were not soluble in the extraction fluid. Because the TCLP extracts of the Marion combined ash and the Dayton fly ash contained the largest concentrations of metals, the leachates of these two solidified samples were submitted for inorganic analyses.

Permeability coefficients of solidified cured waste materials ranged from 1.0 x 10^{-5} to 1.4 x 10^{-6} cm/sec. UCS results ranged from 18 psi in the Marion combined ash solidified by chemical stabilization to 97 psi in the Dayton combined ash solidified by cementation with kiln dust. For materials to be disposed of in a landfill, minimum strengths of 50 psi or greater are desired.

Conclusions and Recommendations

Because organic compounds were either not detected or were found in low parts-per-billion levels in the ash samples, these compounds were not determined in the TCLP extracts. The most prevalent elements found in the ash samples were calcium, copper, lead, sodium, and zinc.

Permeability coefficients for solidified ash samples showed that the solidified ash samples would have low to moderate permeability as disposed waste. UCS for the solidified ash samples ranged from 18 to 97 psi, which indicated a high degree of variability in compressive strength.

Results of the analysis of TCLP extracts showed that extractable metal concentrations in all the ash samples were well below regulatory limits both before and after the ash samples were solidified. Similarly, concentrations of metals in extracts from the SLT procedure were extremely low for all of the solidified ash samples.

Additional ash samples, known to be relatively high in metals and possibly organics, should be solidified and analyzed. Because of the extreme heterogeneity in metals concentrations in ash from MSW facilities, time-averaged samples should be obtained that would give a more accurate representation of ash characteristics.

The full report was submitted in fulfillment of Contract No.68-01-6999 by Radian Corporation under the sponsorship of the U.S. Environmental Protection Agency.

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The complete report, entitled "Evaluation of Solidified Residue from Municipal Solid Waste Combustors," (Order No. PB 89-190 284/AS; Cost: $15.95, subject to change) will be available only from:
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