United States
Environmental Protection
Agency

Solid Waste and
Emergency Response
(OS-305)

EPA/530-SW-90-037
Spring 1990

EPA

MUNICIPAL WASTE COMBUSTION ASH INFORMATION UPDATE

This Information Update provides a status report on projects involving the use of municipal waste combustion (MWC) ash and other MWC residues. This first edition focuses on research, development, and demonstration projects currently under way in the United States. Subsequent editions will report on research activities, as well as commercial-scale projects, taking place in other countries and in the United States.

The Environmental Protection Agency (EPA) would appreciate comments from readers on the usefulness of the information in this research update, as well as suggestions on additional types of information that would be of interest. Address comments to: Municipal Solid Waste Program, MWC Ash Update, OS-301, U.S. Environmental Protection Agency, 401 M Street, SW, Washington, D.C., 20460.

EPA Projects

Evaluation of Solidification/Stabilization and Other Technologies for Managing MWC Ash; Office of Research and Development, Waste Minimization, Destruction and Disposal Research Division

This project is the first phase of the EPA Office of Research and Development's program to provide credible data that municipalities can use to plan and implement strategies for managing ash. The objective of this project is to investigate the effectiveness of solidification/stabilization and other technologies in eliminating or reducing the release of toxic constituents from MWC ash and its leachate. The program is designed to evaluate treatment technologies, rather than to determine how ash characteristics are affected by MWC designs, operating conditions, and waste input. Therefore, all investigations will be conducted using ash from the same facility.

In April 1989, EPA's Office of Research and Development issued a Request for Participation in the program. EPA agreed to pay for collection and processing of the ash before providing it to treatment vendors, and for physically and chemically testing untreated and treated ash residues. Vendors were expected to pay for the transportation of their process technology, costs for personnel conducting on-site activities, and for the demonstration of the treatment technique.

Vendors were selected, and the program was initiated in the fall of 1989. Preliminary data from three process investigations are expected to be available in the fall of 1990. A Technical Advisory Panel, consisting of members from the private sector, environmental advocacy groups, incineration vendors, academia, state regulatory agencies, federal and foreign regulatory agencies, and trade associations, assisted EPA in developing the program, evaluating proposals, and selecting vendors. The panel will continue to help EPA evaluate the performance of treatment technologies as the program proceeds.

For further information, contact Carlton C. Wiles, Chief, Stabilization Section, MSWRMB, WMDDRD, U.S. Environmental Protection Agency, 26 W. M.L. King Drive, Cincinnati, OH 45219; (513) 569-7795.

Projects Outside EPA

Ash Utilization for Artificial Reef Construction in Long Island Sound; Marine Sciences Research Center, State University of New York at Stony Brook

In May 1985, the Marine Sciences Research Center initiated a research program to examine the feasibility of using stabilized incineration residues (SIR) to build artificial reefs in the ocean. These studies showed that incineration residues could be combined with cement to form a solid block possessing the physical properties necessary for ocean disposal.

Following these studies, in December 1986, the Besser Company research facilities at the Alpena Community College in Alpena, Michigan, began making blocks with SIR using conventional block-making machines. The block mix consisted of 63.8 percent combined fly and bottom ash, 21.2 percent crushed ash, and 15 percent Portland Type II cement. Water was added to adjust the moisture content of the

mix to 10.2 percent. The well-mixed materials were then fed into the block-making machine to mold 8-by-8-by-16 inch blocks with a hollow core.

In April 1987, SIR blocks and standard cement blocks were submerged at a depth of approximately 26 feet in Conscience Bay in Long Island Sound, N.Y. In the bay, tidal currents can exceed 6 mph and sediments are composed mainly of poorly sorted gravel and coarse sand. The blocks were arranged in two separate reefs about five feet apart—one composed of SIR blocks, and the other with concrete blocks. Each reef was designed to maximize the surface area exposed to sea water and to provide numerous crevices to facilitate biological colonization.

After their placement in Conscience Bay, the blocks were periodically retrieved for unconfined compressive strength testing. When blocks were last retrieved after 380 days of exposure to seawater, the strength of SIR blocks remained constant at 1,103 pounds per square inch (psi), while the strength of the concrete blocks decreased from 1,087 psi to 779 psi. Metals of environmental concern, including lead and cadmium, showed no signs of leaching.

Diver and photographic surveys were conducted from April 1987 to May 1988 to document the organisms colonizing the two reef structures. Both structures were colonized rapidly, with hydroids attached to all sides within six weeks of placement. As the summer progressed, bryozoan colonies succeeded the hydroids as the dominant species growing on the reef surfaces. In addition, the structures attracted several fish species.

Continued monitoring of the reef site is planned and will provide data on the long-term effects of SIR on the marine environment.

Additional Research at SUNY/ Stony Brook

Two new research projects are underway at the State University in Stony Brook. One is examining the possibility of using ash-containing concrete blocks in the construction of retention walls, or shore protection devices. Researchers are studying ways to upgrade the reef block mix because retention walls require much greater structural integrity. A boathouse with ash-containing blocks is also being constructed, with both the inner and the outer walls containing ash. In addition, studies are under way to test the possibility of using ash in construction materials.

For further information, contact Dr. Frank Roethel, Marine Sciences Research Center, Waste Management Institute, State University of New York, Stony Brook, NY, 11794; (516) 632-8732, or consult the *Waste Management Research Report*, "Stabilized Incinerator Ash Tested in Construction of Artificial Reef," by Dr. F.J. Roethel and V.T. Breslin.

Ash Utilization for Artificial Reef Construction in the Gulf of Mexico; HDR Engineering, Inc. and Florida Institute of Technology

In May 1989, Pinellas County, Florida, sponsored a project to evaluate the potential for using stabilized MWC ash in the construction of an open ocean reef in the Gulf of Mexico. HDR Engineering, Inc. is serving as a contractor to the county, along with Florida Institute of Technology as a subcontractor.

The process of stabilization involves mixing granular solid waste with chemical additives and curing the mixture at a constant temperature for a specific period of time. The proposed research program consists of:

- permitting and site selection;
- characterizing the ash;
- developing the mix design;
- conducting engineering and chemical evaluations of the stabilized ash used for building the artificial reef;
- designing and fabricating the artificial reef;
- placing the reef in the ocean by the end of 1990 to initiate the field demonstration program; and
- evaluating the economic feasibility of using stabilized MWC ash to build artificial reefs.

Three MWC ash types will be provided by Pinellas County for characterization and use in constructing the reefs:

- 100% bottom ash (grate ash);
- 100% fly ash; and
- fly ash combined with scrubber sludge.

To evaluate the effectiveness of stabilization in reducing leachate from MWC ash exposed to seawater, a series of leaching experiments will be conducted on the loose ash under varying conditions of ash/sea water ratios, pH, and proportions of fly ash and bottom ash that correlate with selected mix designs. The mix for the artificial reefs will be designed so that it can be cast into shapes, and will contain about 15 percent cement.

The proposed reef system will be comprised of duplicate reefs for each accepted mix. In addition, two reefs will be constructed of known material (concrete). For relatively uncomplicated shapes, artificial reef units will be loaded onto a pocket barge and the units will be dropped continuously until a reef of

appropriate profile and size is created. Scuba divers will check on the progress of the reef profile.

Monitoring will be conducted to decide if the MWC ash is an environmentally acceptable material for artificial reef construction. The monitoring program will consist of studies to evaluate the specific engineering aspects of the reef system; chemical and mineralogical studies to determine rate of release of metals, rate of uptake of magnesium, formation of new minerals, variation of trace elements and organic composition of the blocks; biological studies to investigate the colonization and diversity of organisms on the blocks and around the reef site; and bioaccumulation studies focusing on the fouling communities collected from the reef site.

For further information contact Sheree Stewart, HDR Engineering, Inc., Suite 225, 5100 W. Kennedy Boulevard, Tampa, FL 33609-1806; (813) 287-1960.

Ash Utilization in Bituminous Concrete; New York Department of Environmental Conservation

The purpose of this project is to determine the suitability of MWC residue as an aggregate in bituminous concrete. The study is a joint effort of the Long Island Regional Planning Board, the New York State Energy Research and Development Authority, the Port Authority of New York and New Jersey, and the New Jersey Department of Transportation. The New York State Department of Environmental Conservation is involved in an advisory capacity.

The research is intended to evaluate the engineering properties of incinerator residues (bottom ash and combined ash) and the environmental concerns associated with using ash as a substitute aggregate material. This will be accomplished by a series of laboratory tests on ash, followed by construction of a test pavement section which will be monitored for approximately three years.

In the initial phases of the study, bottom and combined ash will be sampled and tested for uniformity and suitability as an aggregate, and for heavy metals, organics, and toxicity.

The study will examine potential problems arising from stockpiling ash for the long periods (3-6 months) that would occur if ash was used as an aggregate. Potential problems to be monitored include the generation of stockpile dust, runoff, and physical changes in the material. In addition, samples of the stockpile material will be tested in the laboratory where personnel and facilities will be monitored for fugitive dust exposure.

The study will evaluate the production, and placement on a roadway, of bituminous concrete that includes the incinerator ash as a portion of the aggregate. This will be accompanied by monitoring for air quality, wastewater problems, and worker safety parameters.

The final portion of the study will be devoted to monitoring the performance of the roadway sections under traffic conditions to assess the engineering properties of the bituminous mixture, and testing any leachate and runoff for heavy metals, organics, and toxicity. The findings of the research will be documented in a final report.

For further information contact Norman Nosenchuck, Division of Solid Waste, New York State Department of Environmental Conservation, 50 Wolf Road, Albany, NY, 12233; (518) 457-6603

Vitrification of Residue from Municipal Waste Combustion Facilities; American Society of Mechanical Engineers, U.S. Bureau of Mines

This study will examine whether residue from the burning of municipal waste can be fused into a glassy material (vitrified) usable in construction.

Vitrification immobilizes toxic materials in the residue. By testing samples of residue from seven to ten municipal waste combustion facilities, the researchers hope:

- to confirm that the glass-like product is environmentally benign, denser than the original residue, and takes less energy to produce than is recovered from burning municipal waste;
- to determine the optimal conditions and operating constraints for running an electric arc furnace to vitrify combustion residue, either continuously or during off-peak power periods;
- to identify beneficial uses for vitrified residue, potential markets and potential limitations on the product's use; and
- to identify the amount and nature of any residual material, emission or effluent.

For further information contact David Lewin, ASME Public Information, Suite 216, 1825 K Street, NW, Washington, D.C. 20006; (202) 785-3756.

Utilization of Ash Products from Combustion of Shredded Solid Waste; Energy Answers Corporation and SUNY College of Environmental Science and Forestry

The purpose of this research is to characterize aggregate from combustion of refuse-derived fuel (RDF) and

to assess the feasibility of, and environmental impacts from, using bottom ash from an RDF unit as an aggregate substitute. This project is a joint venture of Energy Answers Corporation (EAC), the SUNY College of Environmental Science and Forestry, Smith and Mahoney, P.C., and Rensselaer Polytechnic Institute.

Specific project tasks include: (1) the production, sampling, and testing of the ash aggregate over the course of a year to assess the variability of physical and chemical characteristics; (2) simulation of aggregate stockpiling and storage to determine potential environmental impacts; (3) the production of concrete products made from ash aggregate for performance and environmental testing; and (4) an assessment of the suitability of ash aggregate in proposed uses based on environmental, handling, health, and safety criteria.

Bottom ash was obtained from an RDF facility in Albany and sampled on a daily basis throughout the year. Processing of the ash involved removal of metals and material greater than one half inch (the remaining material is referred to as "ash aggregate" or "boiler aggregate"). The Toxicity Characteristic Leaching Procedure and the Extraction Procedure toxicity tests were regularly performed on the ash aggregate to determine its regulatory classification. The following physical characteristics of the ash aggregate were monitored:

- grain size distribution;
- moisture content;
- density and specific gravity;
- cation exchange capacity;
- percentage of constituent materials;
- compactability; and
- percentage of metals.

Tests were also performed twice a month to determine the variation in the physical and structural characteristics of the ash as a function of seasonal variation in the solid waste input stream.

Initial results support the use of ash aggregate as an aggregate substitute for many applications. Data from the open-pile storage simulation suggest that ash aggregate stockpiled outside and exposed to acid rain (pH 4) produces a leachate with negligible levels of heavy metals. Ash-containing concrete products subjected to acid rain also produce a leachate with negligible levels of heavy metals and maintain compressive strengths comparable to those of conventional concrete products.

Recently the New York Department of Environmental Conservation approved the ash aggregate for use as a road base asphalt aggregate.

For further information, contact Jocelyn Mullen, Energy Answers Corporation, 79 N. Pearl Street, Albany, NY 12207; (518) 434-1227, or refer to EAC's Paper #88-24.14 "Utilization of Ash Products from Combustion of Shredded Solid Waste," by Patrick Mahoney and Jocelyn Mullen.

Trace Metal Recovery from Municipal Solid Waste Incinerator Ash; Rutgers, The State University of New Jersey, Department of Chemical and Biochemical Engineering

One approach for the treatment of incinerator residuals is component separation and recovery, which relies on removal and recycling of potentially hazardous constituents. This approach returns bulk and trace metals to the marketplace and allows reuse of the inert constituents as an aggregate.

Since 1984 the New Jersey Hazardous Substance Management Research Center has funded a research, development, and evaluation effort for separation and recovery of trace hazardous constituents from incinerator residuals. The project's specific objectives are:

- to chemically and physically characterize untreated and treated residuals and process streams;
- to define process requirements for separation and recovery of regulated metals (e.g. lead, cadmium) and soluble salts (e.g., chlorides, sodium, and calcium);
- to identify potential markets and market requirements for use of treated residuals and process streams; and
- to evaluate process economics for various recovery scenarios.

This effort has identified the physical and chemical characteristics of bottom and fly ashes from several MWC facilities in the United State and Canada and has defined the chemistry of a viable separation and recovery process for heavy metals. The process employs aqueous extraction at mildly acidic conditions in the presence of chlorides to achieve high separation efficiencies, followed by selective electroplating of heavy metals. Efforts to date have focused on lead and cadmium recovery. Typical removal efficiencies from fly ashes have been 70-80 percent for lead and greater than 95 percent for cadmium. A laboratory process facility operating at a rate of one kg/hr of ash has been under development since 1988. An outgrowth of this laboratory facility will be design criteria and economic evaluation for full-scale demonstration of the process (10-20 tons/day).

Extraction studies using ash from several resource recovery facilities provided insight to the leaching characteristics of the ashes and the effects of the composition of the extract solution. Various salt

solutions were investigated for their capability to extract heavy metals. The effect of the cations in the salt solutions was observed at neutral and acidic equilibrium conditions. An ash/extract equilibrium pH of 3.0 was found to be the most efficient level of acidity to remove higher amounts of lead. The presence of chloride salts in solution also significantly increased the ability of the extract to recover lead from the ash residues.

The extractable levels of cadmium for all of the residual ashes stabilized rapidly, and the removal mechanism did not exhibit a pH dependency. Trace levels of cadmium and chromium were readily extracted from all the ashes investigated.

For further information, contact David Kosson, Rutgers, The State University of New Jersey, Department of Chemical and Biochemical Engineering, P.O. Box 909, Piscataway, NJ 08855; (201) 932-4346, or consult *Trace Metal Recovery from Municipal Solid Waste Incinerator Ash*, by Dr. David Kosson, I.A. Legiec and C. Hayes.

Use of Incinerator Ash in Pavements; New Jersey Department of Transportation

Through the Interagency Engineering Committee, the New Jersey Department of Transportation is investigating the possible uses of incinerator ash in roadway pavements. The Interagency Committee is composed of engineering managers from the New Jersey Department of Transportation, the Port Authority of New York and New Jersey, the New Jersey Turnpike Authority, the New Jersey Highway Authority, the New Jersey Department of Treasury, and the Delaware River Port Authority, who joined forces to address common engineering problems. The Committee has elected to combine their efforts with a research project already under way in the State of New York.

This project involves the full-scale production of asphalt paving materials partially composed of incinerator ash, and use of the asphalt in the construction of pavements. The Committee has proposed using an asphalt plant in New Jersey to produce the paving material and to place the materials on one of New Jersey's highways. The field trial will include paving materials produced from both bottom ash and combined ash; however, paving investigation work will emphasize the use of bottom ash. The N.J. Department of Transportation hopes to install test pavements in the summer of 1990.

For further information, contact Kenneth Afferton, N.J. Department of Transportation, 1035 Parkway Avenue, Trenton, NJ, 08625; (609) 530-2529.