PROJECT facts

U.S. DEPARTMENT OF ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

ENVIRONMENTAL WATER AND RESOURCES

06/2000

FLUIDIZED BED COMBUSTION ASH LANDFILL DESIGN

PRIMARY PROJECT PARTNER

Radian International
Austin, TX

MAIN SITE

Tri-States Generation and Transmission Association
Nucla, CO
Ohio Edison
Lorain, OH
Freeman United Coal Mining Company
Canton, IL

TOTAL ESTIMATED COST

$5,230,000

COST SHARING

DOE	$4,810,000
Non-DOE	$ 420,000

Description

Atmospheric fluidized bed combustion (AFBC) systems produce a highly alkaline by-product unlike conventional coal fly ash or wet limestone flue gas desulfurization (FGD) systems. AFBC ash can quickly set into a concrete-like mass. Its high lime content can heat the ash to boiling when wetted, and can pose a health and safety. Trace metals fixed in the ash are potentially mobile in leachate, which typically has a pH near the regulatory limit for corrosivity of 12.5. Because of these unique characteristics of AFBC ash and a lack of comprehensive study, the US EPA decided in 1992 that AFBC should be studied further before issuing a final ruling on its exemption from RCRA regulation in 1998.

A comprehensive study of AFBC ash in the disposal environment was conducted at a site in central Illinois. Three landfill test cells were constructed to determine long-term by-product performance and monitor for environmental effects. One cell contained straight AFBC ash; the other two cell contained a mix of AFBC ash with a Class F fly ash. One of these was compacted in place, and the final cell was placed as a flowable grout. All of the test cells were unlined and uncapped to represent a worst-case design and to generate leaching data in a reasonable time frame.

Project results show that properly mixed and placed AFBC/fly ash mixtures create a durable, impermeable low-strength concrete. In contrast, unmixed AFBC ash quickly degrades with exposure to moisture, allowing substantial amounts of water to percolate. None of the test cells produced hazardous leachate, but high concentrations of common soluble salts were present in the leachate from the unmixed AFBC ash, raising the possibility of groundwater contamination. AFBC/fly ash mixtures were impermeable enough to act as their own cap and liner, preventing any leachate from forming.

One of the keys to creating durable materials from reactive by-products such as AFBC ash is to properly blend them so that all reactive components are consumed, leaving a fully hydrated and relatively inert cemented mass. Most AFBC ash is too rich in lime and calcium sulfates. Left on its own, some of these components react with alumina in the ash to form the mineral ettringite, providing initial cementation. Leftover lime and calcium sulfate are easily dissolved by infiltrating rain, however, and as they are removed the ash returns to a soil-like consistency. Fly ash addition reduces the excess amounts of these components and allows the mineral calcium silicate hydrate to form, improving long-term strength permeability.

NETL

Fluidized Bed Combustion Ash Landfill Design

By-product mixtures with AFBC ash outperform lime- and fly-ash-stabilized FGD sludge mixtures used commercially for landfill caps and as liners for landfills and impoundments. AFBC mixtures placed as a grout may also be useful as a controlled low-strength material in construction applications.

Goal

To ensure the most cost-efficient delivery of electrical power, the U.S. Department of Energy (DOE) is conducting research and development to improve coal combustion by-product (CCB) management. The research program emphasizes characterization and reuse of CCBs to help stimulate markets for new materials such as those produced under the DOE's Clean Coal Technology program. Over the next 5 to 10 years, the program's goals are to develop processes leading to a 100% increase in the current rate of FGD by-product use, a 10% increase in the national rate of overall CCB use, and a 25% increase in the number of CCB applications considered "allowable" under state regulations.

Benefits

- Construction experience from the test cells provides guidance for design and operation of full scale disposal facilities
- Data from the test cells support permitting and other regulatory decision making, and can help calibrate physical and chemical models of by-product performance.
- Durable, impermeable by-product mixtures demonstrate the potential for beneficial use of AFBC by-products and environmentally sound disposal methods.

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Illinois Clean Coal Institute
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Electric Power Research Institute
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(cofunding)

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Freeman United Coal Mining Company
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Midwest Grain Products Company
Pekin, IL
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Central Illinois Lighting Company
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