Coal Combustion Product Use - Program 78

Program Overview

Program Description

Disposal of coal combustion products (CCPs) is an expense, a potential long-term liability, and, in many locations, difficult due to limited site availability or environmental opposition. Other challenges include increasingly stringent regulations on ash disposal; lack of knowledge about the engineering value of using CCPs in materials or as additives, such as partial replacement for portland cement in concrete; and questions about ash generated when cofiring biomass with coal or produced by integrated gasification combined cycle (IGCC) power systems. At the same time, the doubling of installed capacity of scrubbers for SO_2 control will double production of flue gas desulfurization (FGD) gypsum, rapidly saturating the major current user of this product — wallboard manufacturing. Finally, the anticipated expansion in the use of spray dryer SO_2 controls and fluidized-bed boilers will produce volumes of solid products that currently have no large-scale acceptable use.

The Electric Power Research Institute's (EPRI's) Coal Combustion Product Use program (Program 78) builds on years of investigation into sustaining the use and value of CCPs, despite property changes due to the application of gaseous air pollutant controls. It also seeks new uses for current CCPs and markets for the new CCPs from biomass cofiring and IGCCs, with the larger goal of achieving a use rate of 50% within a decade.

Research Value

The CCP Use Program demonstrates that these products can be used beneficially and in greater quantities even in the face of property changes due to upstream air pollution controls or different fuels or generation technologies. The program's R&D enables members to:

- Avoid disposal costs for CCPs, which range from $5 to $60/ton and require extensive staff and management time needed to find and permit a landfill
- Retain or earn new revenue by selling products to ready-mix concrete plants, wallboard manufacturers, agricultural soil amendment distributors, roadway and structural fill builders, and others, typically for $10–$20/ton, although prices can be as high as $60/ton. This includes:
  - Products sold today, such as fly ash and FGD gypsum
  - Products not currently sold in quantity, such as spray dryer or fluidized-bed combustion (FBC) solid products, and ash containing activated carbon, elevated sodium levels, or biomass products of combustion
- Anticipate and resolve issues that may be barriers to the use of CCPs from biomass cofiring and IGCCs.

Approach

The program collaborates with organizations such as the American Coal Ash Association (ACAA) to educate state government agencies and engineers on the environmental and engineering benefits of using CCPs, and with the EPA and the U.S. Department of Agriculture (USDA) to address significant barriers to CCP use at a national level. As issues arise with materials that use CCPs, this program researches the root cause of the problems and develops solutions, including:

- Research to maintain and increase high-volume uses of coal ash looks at ways to counter the impact of sodium-based injected sorbents (for SO_x control) or biomass cofiring on ash use; resolves concerns about fly ash use in concrete (e.g., slow set time); seeks to mitigate alkali-silica reactions; determines the ability and cost (relative to other options) of beneficiating carbon-enriched ash to allow its use in concrete; investigates commercially-offered solutions to elevated levels of ammonia on fly ash (as selective catalytic reduction [SCR] catalysts age); and seeks and investigates large-volume uses for non-spec ash.

- R&D involving technologies and information to increase the use of SO_2 control-derived CCPs continues the national network field tests of FGD gypsum as a soil amendment to demonstrate its agronomic value and environmental acceptability (via risk analyses), and demonstrates promising high-volume uses of spray dryer or FBC solid product.
- Outreach to promote use of CCPs works jointly with other sponsors of EPA's Coal Combustion Products Partnership (C^2P^2) and the ACAA to explain the engineering and environmental value of CCP use to potential users and regulators. At the request of members, EPRI briefs state departments of transportation (DOTs) and environmental authorities on the benefits of CCP use.

Accomplishments

The CCP Use program is recognized in the electricity industry as an authoritative source for up-to-date, unbiased information on the benefits and environmental acceptability of using CCPs in commerce. Recent examples of value provided include:

- Demonstrated that no significant mercury is released during concrete curing, or by leaching of demolished and crushed concrete, when fly ash containing mercury is used in the manufacture of the concrete
- Quantified the amount of mercury released by one type of wallboard manufacturing process when FGD gypsum containing mercury is used as the feedstock
- Demonstrated that concrete cracking due to reactions between cement and aggregate could be mitigated by replacing some of the cement with Class F ash; provided evidence that, for many aggregates, cracking could be mitigated by replacing large volumes of cement with Class C ash or ternary blends
- Organized a collaborative including utilities, government agencies, industry, and academia to advance the use of FGD gypsum and other FGD solids in agricultural applications
- Identified potential uses for spray dryer and FBC solid products based on engineering properties and European experience

Current Year Activities

The program R&D for 2010 will focus on continuing and expanding the field studies of FGD gypsum use as a soil amendment for a range of soils and crops, demonstrating one or two of the most promising uses of spray dryer product, continuing to assess the impacts of sodium compound injection for SOx control on ash use, and beginning to assess the use of ash from boilers cofiring biomass and IGCC plants. Specific efforts will include:

- Completion of five to six demonstrations of FGD gypsum use to improve crop growth in various soils with no environmental impact
- Field tests of one or two potentially large beneficial uses of spray dryer or FBC solid products
- Determination of impacts of sodium injection into the flue gas for SO_3 and possible SO_2 reduction on fly ash use and disposal (with Program 49)
- Resolution of one or two issues with concrete manufactured using fly ash, such as high-volume cement replacement, slow set time/low early strength, carbon-enriched fly ash, and ASR mitigation
- Identification of factors potentially limiting use of fly ash from biomass cofiring or power generation via IGCC and plans to overcome these limits

Estimated 2010 Program Funding

$0.7M

Program Manager

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Summary of Projects

Project Number	Project Title	Description
P78.001	Maintaining and Increasing High-Volume Uses of Coal Ash	By demonstrating the engineering benefits and environmental acceptability of fly ash containing other constituents due to air pollution controls, this research will help CCP managers promote the use of their solid products and avoid disposal.
P78.002	Technologies and Information to Increase Use of SO2 Control Products	Demonstrating the agronomic benefits and environmental acceptability of using FGD gypsum as a soil amendment, and developing new uses for spray dryer absorber and FBC products, will create new markets for the greatly increased production of SO_2 control materials as more plants install these devices.
P78.003	Outreach to Promote Use of CCPs	EPRI's outreach efforts on behalf of greater CCP use can help power companies firing solid fuels convince regulators and potential users of the value of their product and convert disposal costs into revenues from product sales.

P78.001 Maintaining and Increasing High-Volume Uses of Coal Ash (046746)

Key Research Question

Several air pollution controls can affect fly ash use by altering the composition of the ash due to biomass cofiring with coal; increasing carbon beyond levels acceptable in concrete (NOx and mercury controls); causing ammonia to be adsorbed onto the ash, creating an odor problem (NOx controls); and adding alkali (especially sodium) to the fly ash (SO_3 or SO_2 reduction). These effects counter the goals of national, local, and environmental nongovernmental organizations (NGOs) to increase CCP use, while also adding operating costs for power companies. In some parts of the United States, it is nearly impossible to permit and operate a new disposal facility.

Approach

This project will continue work on (a) determining the engineering acceptability of using ash in concrete or other applications if it contains elevated sodium levels due to sorbent injection for SO_3 or SO_2 control, and (b) determining the engineering properties of concrete produced with ash generated by boilers cofiring biomass.

Given the ongoing interest in potential impacts of mercury captured by fly ash on its environmental acceptability when used in commercial products (e.g., cement), the project will follow the dialogue and propose R&D if/when warranted. EPRI has already demonstrated the lack of mercury emissions during concrete manufacture and after its use.

In addition, the project may pursue one of the following options, as power company and CCP marketer needs evolve with changing CCP quality and markets:

- Evaluate the environmental performance of products, such as trace metal leaching from concrete manufactured using fly ash.
- Identify current uses of non-spec fly ash, determine barriers to wider use, and, in the case of technical barriers, conduct the necessary tests to make those uses acceptable to more potential users.
- Develop tools to determine the optimal mix of fly ash and cement for concrete manufacture based on the chemical properties of the fly ash, cement, and aggregate
- Seek methods to enable the use of ash with elevated levels of ammonia (e.g., greater than 50 ppmw), such as fixation of the ammonia, or separation of high from low ammoniated ash by management of the electrostatic precipitator (ESP) hopper evacuation system.

- Determine if commercial ash beneficiation technologies for carbon are sufficiently effective on injected activated carbon to enable the treated ash to be used in concrete. Obtain and review any existing test data or conduct such tests (e.g., on the suppliers' pilot facilities). For high-carbon ash intended to be used as feed for cement kilns, test the ability of mild beneficiation to remove most of the mercury while retaining the carbon fuel value.

Impact

By demonstrating the engineering benefits and environmental acceptability of using fly ash in numerous applications, despite changes to the fly ash brought about by air pollution controls, this project helps power plants:

- Avoid disposal costs and liabilities, which can be $10-60/ton ash
- Retain or earn new revenues from sale of CCPs, which can vary from a net 0 to more than $60/ton ash

How to Apply Results

Power company CCP managers and their CCP marketers can use the test data and supporting analyses to plan continued use of their fly ash and identify new uses consistent with local market and transportation conditions. They can use the same information to inform existing and potential users of the value and acceptability of these uses.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
Use Options for Fly Ash Containing Elevated Sodium Content or Biomass Co-firing Products: Guidelines for using or safely landfilling (a) sodium- or calcium-containing ash, or (b) CCPs derived from biomass cofiring with coal. Guidelines will be based on pilot simulations for sodium-based additives and literature studies and field tests by others for the biomass cofiring products.	12/31/10	Technical Report

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Use Options for Fly Ash Altered by Air Pollution Controls: Update of 2010 report, based on further test and survey results.	12/31/11	Technical Update
Ash Use in Concrete: Optimizing Engineering Properties: Progress report on obtaining data for manufacturing concrete with different fly ashes, cement, and aggregates to obtain desired concrete properties, including acceptable set times/early strength and management of alkali-silica reactions. Possible updates on additional topics (e.g., carbonation of the concrete) if directed and funded to study these areas by the funders.	12/31/11	Technical Update
Ash Use in Concrete: Optimizing Engineering Properties: Guidelines for manufacturing concrete with different fly ashes, cement, and aggregates to obtain desired concrete properties, including acceptable set times/early strength or management of alkali-silica reactions. Additional topics (e.g., carbonation of the concrete) to be identified by funders based on issues experienced when selling fly ash.	12/31/12	Technical Report

Product Title & Description	Planned Completion Date	Product Type
Use Options for Fly Ash Altered by Air Pollution Controls: Update of 2011 report, based on further test and survey results.	12/31/12	Technical Update
Use Options for Fly Ash Altered by Air Pollution Controls: Final report (projected) on this topic.	12/31/13	Technical Report

P78.002 Technologies and Information to Increase Use of SO2 Control Products (052539)

Key Research Question

Although more than 80% of FGD gypsum currently produced is used, the present market — wallboard manufacturing — is projected to become saturated within the next two to four years as a result of the doubling of FGD capacity. A need also exists to find uses for the solid products from spray dryers (whether pure alkali or alkali-ash mixes) or fluidized-bed combustion (FBC), because numerous power companies are considering the installation of these systems during the next decade.

Approach

In 2010, the project will continue to focus on agricultural uses of FGD gypsum. A national network, established in 2006, coordinates field tests of FGD gypsum application to the range of underperforming soils and crops grown in the United States. Region-by-region, the network seeks to connect gypsum sources with nearby agricultural users who could use gypsum amendments beneficially, provides these teams of sources and users with test plans and analytical protocols, and conducts the laboratory analyses for teams that do not have that capability. The network also assembles, archives, interprets, and synthesizes the results, and organizes periodic workshops to disseminate the results and provide a forum for sharing issues and insights.

Starting in 2008 and continuing through 2010, the project will increase its efforts in assessing the risks of this gypsum use. For gypsum produced by scrubbers in which the capture of mercury and other hazardous air pollutants (HAPS) is maximized and attempts are made to separate the gypsum fines (for disposal) from the usable coarser material, the project will characterize the gypsum and assess its performance and environmental behavior in field applications. It will also study the alleged release of mercury and hydrogen sulfide from wallboard manufactured using FGD gypsum, assess the health risk of any such releases, and seek countermeasures or product specifications, if found necessary.

For spray dryer and FBC products, EPRI will complete its assessment of the engineering properties of these materials and initiate one or two field tests of the use of each product (spray dryer calcium-sulfur material for units installed downstream of an existing ESP or calcium-sulfur-ash mixture for units without an upstream ESP or from FBCs). The applications will be selected based on the engineering properties and existing experiences abroad with using some of these materials.

Impact

By demonstrating the engineering benefits and environmental acceptability of using FGD gypsum in agriculture and spray dryer or FBC products in civil engineering applications, this project helps power plants:

- Avoid disposal costs and liabilities, which can cost $10-20/ton gypsum
- Retain or earn new revenues from sale of CCPs, which can reach $20/ton gypsum

How to Apply Results

Power company CCP managers and their CCP marketers can use test data and supporting analyses from the FGD Gypsum Network to encourage use of their gypsum by farmers (and their advisors in the local agriculture extensions) within an economical haul range of their FGD-equipped power plants and to gain acceptance by state regulators. These same staff can use the assessments and demonstrations of the uses of CCPs from spray dryers and FBC units to deploy a targeted marketing plan for these materials.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
Agronomic Use of Gypsum Materials: Annual update with test results from field applications of FGD gypsum to a range of crops and soils, along with expert assessment of their implications for the value of the resulting crop (quantity and quality), resource use (water, fertilizer, field labor), environmental acceptability, and economics. Will include risk assessments for one to two of these sites.	12/31/10	Technical Report
Use of Gypsum with Minimized HAPS Constituents: Chemical and physical characterization of gypsum produced by one or more FGDs whose absorbers are operated to maximize mercury and other HAPS capture, and whose gypsum size separation systems are designed and operated to separate the HAPS-enriched fines from the coarser material.	12/31/10	Technical Update
Beneficial Uses of Spray Dryer and FBC Solid Products -- Promising Applications: Selection of applications and sites for field tests of the use of spray dryer and FBC solid products.	12/31/10	Technical Update

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Agronomic use of Gypsum Materials: Final report (projected) with test results from field applications of FGD gypsum to a range of crops and soils, along with expert assessment of their implications for the value of the resulting crop (quantity and quality), resource use (water, fertilizer, field labor), environmental acceptability, and economics. Will include risk assessments for one to two additional sites (beyond the 2010 report). Also will include results of tests on the gypsum product that attempt to separate HAPS-enriched fines from the coarser material.	12/31/11	Technical Report
Beneficial Uses of Spray Dryer and FBC Solid Products -- Interim Field Test Results: Interim field test results (engineering and environmental performance) of applications using spray dryer and/or FBC solid products.	12/31/12	Technical Update
Beneficial Uses of Spray Dryer and FBC Solid Products -- Final Field Test Results: Final field test results of applications using spray dryer and/or FBC solid products.	12/31/14	Technical Report

P78.003 Outreach to Promote Use of CCPs (055576)

Key Research Question

Many potential CCP users are not users because they, or their regulators (state environmental or transportation agencies), do not understand the technical value and environmental acceptability of CCP applications. Outreach efforts — user-focused briefing papers, conference presentations, and sometimes personal visits — can show potential users and their regulators how they and the environment can benefit by using CCPs in appropriate applications.

Approach

Prepare technical briefs as needed to provide the scientific basis for overcoming regulatory, policy, or public perception barriers to greater CCP use. Present papers at meetings of potential users, and participate in the EPA's Coal Combustion Products Partnership (C^2P^2) program. Support member requests for assistance with technical information for state or local agencies. Create a public website that contains these issue briefs in conjunction with the EPRI Environment Sector's Program 49 on CCP Environmental Issues. Maintain a Tech Watch function for new issues limiting current or potentially expanded use of CCPs.

Impact

EPRI's outreach efforts on behalf of greater CCP use could enable power companies firing solid fuels to:

- Earn a net $10–$60/ton for CCP (revenue + avoided disposal), depending on location and use, if the outreach effort enables a power company to divert its CCPs from disposal to beneficial use.
- Promote re-use as opposed to disposal.

How to Apply Results

Environmental compliance and CCP management staff can use the technical briefs to show their community, potential CCP users, and local regulatory authorities that CCP use is environmentally, technically, and financially sound.

2010 Products

Product Title & Description	Planned Completion Date	Product Type
Benefits and Acceptability of Using CCPs: Outreach: Annual set of technical briefs and presentations informing the public of the value and acceptability of using CCPs, focused on issues of most interest during the year.	12/31/10	Technical Resource

Future Year Products

Product Title & Description	Planned Completion Date	Product Type
Benefits and Acceptability of Using CCPs: Outreach: Annual set of technical briefs and presentations informing the public of the value and acceptability of using CCPs, focused on issues of most interest during the year.	12/31/11	Technical Resource
Benefits and Acceptability of Using CCPs: Outreach: Annual set of technical briefs and presentations informing the public of the value and acceptability of using CCPs, focused on issues of most interest during the year.	12/31/12	Technical Resource

Product Title & Description	Planned Completion Date	Product Type
Benefits and Acceptability of Using CCPs: Outreach: Annual set of technical briefs and presentations informing the public of the value and acceptability of using CCPs, focused on issues of most interest during the year.	12/31/13	Technical Resource