ISSUE I • 2006

ASH at work

Application, Science and Sustainability of Coal Ash

CCPS: A VALUABLE U.S. ECONOMIC RESOURCE

A WIN/WIN SOLUTION FOR FGD-GYPSUM

A HYBRID APPROACH TO CCP MANAGEMENT

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Tel: (720) 870-7897
Fax: (720) 870-7889
www.acaa-usa.org

Published by:
Lester Publications, LLC
2131 NW 40th Terrace – Suite A
Gainesville, FL 32605
Main Line: (877) 387-2700

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Printed in Canada.
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For reprint information, contact Amber Billman at (877) 387-2700.

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Cover features: Synthetic Materials (SynMat) processes and loads FGD gypsum on barges at TVA's Cumberland Fossil Plant. The material is destined for use in wallboard, cement, and agricultural products throughout the Inland River System.

THE POWER OF LEARNING AND SHARING

Part of the great value of ACAA is the willingness of its members to share their experiences and knowledge. In 1991 I attended my first ACAA meeting. At that time I met Professor Oscar Manz from the University of North Dakota, one of the great pioneers of CCP research and education and an honorary ACAA member. I often referred to his papers that explained CCP fundamentals and provided innovative ideas that I applied to We Energies CCP utilization program. Oscar always showed great enthusiasm and eagerness to help students and the industry's "rookies." It was a privilege to receive one of his personal, handwritten notes of congratulations, or to be on the mailing list for his entertaining memoir of his early work experience. Oscar is long retired from University of North Dakota, but his legacy of ideas, values, and attitudes continue to be applied every day at universities, utilities, and within the circles of ash marketers.

At the ACAA symposium in St. Petersburg, Florida in 2003, longtime ACAA member and officer, Jim Burnell, formerly with Allegheny Power, received ACAA's honorary membership. I was deeply moved by Jim's sincere acceptance speech. It was clear to many in the audience that Jim had a passion for CCP utilization. Jim willingly shared his experiences with me and others. I did not have experience working in a power plant and knew very little about coal. Eager to learn, I often asked Jim questions about boiler designs, mills, coal mining, and coal chemistry. He patiently answered my questions and referred me to other sources for information. What at the time seemed like simple, casual conversations, later saved me a lot of time and hassle, and saved my company a substantial amount of money as I applied these lessons to my work at We Energies. Jim's career reinforced that CCP utilization is not a power plant's afterthought. His example and mentorship continues to resonate—people can have a proud career in CCP utilization and that that they can have a significant positive impact on the industry, the environment, and society.

The utility industry has changed since my first ACAA meeting in 1991. Mega mergers, competition, complex environmental regulations, bankruptcies, fuel price volatility, new accounting rules, and stricter financial reporting impacted our once relatively calm and steady industry. Employees are expected to do more with fewer resources and less personnel. Sometimes we are not prepared for these paradigm shifts. I believe associations like ACAA help the industry to progress by providing the agenda and venue for the stakeholders to gather,

Thomas Jansen, P.E.
Supervising Engineer – CCP Group
We Energies ACAA Chairman

identify the experts, address the issues, develop strategies, and connect the mutual interests. ACAA brings the rookies, veterans, students, and experts together. It facilitates the exchange of ideas, and cultivates new leaders, promoters, and advocates for CCP utilization and resource conservation.

This past September, I was struck by the networking at ACAA's fall meeting in Atlanta. Many ACAA meetings are held in large hotels and the attendees spread out through the hotel. In Atlanta we met in relatively tighter confines, and many of the members and guests congregated in the atrium area of the hotel. This allowed me to listen to numerous conversations (well maybe I inadvertently eavesdropped on a few) and informally participated in many others. In addition to the usual friendly banter, I heard discussions on improving ash quality, storage options for high volumes of ash, potential standards for blending fly ash, the intricacies of a state's regulations for CCP use that could serve as a model elsewhere, and new, *real* market opportunities for high volumes of fly ash. And these discussions were outside of the conference room where we had formal presentations on FGD gypsum and a Beneficial Use Forum. Fortunately, I met dozens of new contacts that have expertise in a wide range of fields. I already tapped some of these new contacts for information and gratefully applied it to my public comments on new, challenging state rules on CCP utilization. ACAA networks are a quick and powerful resource that I hope all members and stakeholders will use when they struggle with an issue or problem.

A downsized company, a "steady sized" company, and an upsized company, can all benefit from ACAA membership. It provides continuity and institutional knowledge during times of changing personnel. It offers support when you can't do it all. It offers formal training as well as a reservoir of experience within its membership when you don't know it all. Attend ACAA meetings and workshops—learn and share. ❑

A GREAT YEAR AHEAD!

By Dave Goss

We have just entered a new year and I hope each of you will find this to be a rewarding one. As I look back on 2005, I think we should be proud of a number of achievements. The Association remains viable and our credibility continues to increase. ACAA was instrumental in the planning of the Green Highways Forum that was held in College Park, Maryland. A number of our members spent many hours working with the EPA, the FHWA, and others to acquaint members of those staffs of the value of using CCPs in sustainable highway activities. Likewise, more of our volunteers helped staff members in EPA regional offices become more aware of the use of CCPs as a material than can be used beneficially in many ways. The Office of Solid Waste has tasked the regions to develop programs within their respective areas to promote the use of industrial materials, including coal ash. We anticipate providing more of this type of support in 2006.

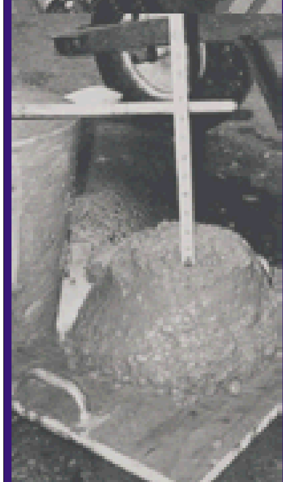
Dave Goss,
ACAA Executive Director

Tom Jansen was heavily involved in the planning and conduct of the fourth Beneficial Use Summit held in Philadelphia in late November. As before, Tom Jansen was instrumental in setting up the agenda, recruiting speakers, and soliciting financial support. It would be impossible for me to list all the individual members who during 2005 contributed to our mission. Many people responded to urgent or routine requests for information, ranging from highly technical to highly unusual. I thank those of you who made presentations, worked on committees and in ACAA leadership roles, offered suggestions, and talked with those outside the industry to provide them assistance. I also thank those of you who staffed the ACAA exhibit booth at GreenBuild, CoalGen 2005, or World of Coal Ash. Certainly the World of Coal Ash must be considered a significant achievement as the feedback from attendees has encouraged us to hold the next WOCA in 2007 in Cincinnati.

In addition to our tireless volunteer members, I want to thank our staff. Without Mike MacDonald, ACAA would not function smoothly. In addition to his creative and artistic artwork for the electronic newsletters, meeting announcements, and *Ash at Work*, Mike maintains our databases, arranges logistical support, and proofreads (and corrects) most of the drafts we prepare in the office. Starting in June, Annely Noble joined the staff and has likewise added much to our daily operations. Her cheerful smile, thorough attention to detail, and enthusiasm has helped Mike and me manage the harried times we sometimes encounter.

In closing, my thanks goes to each of you who have in the past, and I am sure will continue to do so in the future, supported, promoted, assisted, and worked hard to enable ACAA to flourish. I thank you for those tasks you did, unknown to me and others, that have kept us moving forward as an organization. ❏

Calendar of Events



ACAA 2006 Winter Meeting
OMNI Austin Hotel Downtown
January 29 - February 1, 2006

ACAA 2006 Summer Meeting
Wyndham Milwaukee Center Hotel
June 4 - 6, 2006

ACAA 2006 Fall Meeting
Kansas City Hyatt Regency Crown Center
September 25 - 27, 2006

The World of Coal Ash
Marriott Cincinnati at RiverCenter
Northern Kentucky Convention Center
May 7 - 11, 2007

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ACAA

CCPS: A VALUABLE U.S. ECONOMIC RESOURCE

By Janet Gellici, Executive Director, American Coal Council
www.americancoalcouncil.org

The use of Coal Combustion Products (CCPs) provides a direct economic benefit to the U.S. of more than $2.2 billion annually and a total economic value of nearly $4.5 billion each year. These findings are from a recent study published by the American Coal Council (ACC) and authored by Andy Stewart (Power Products Engineering). "The Value of CCPs: An Economic Assessment of CCP Utilization for the U.S. Economy," details the economic value of CCPs, including:

- Avoided Cost of Disposal
- Direct Income to Utilities
- Offsets to Raw Material Production
- Revenues to Marketing Companies
- Transportation Income
- Support Industries
- Research
- Federal & State Tax Revenues

With coal consumption projected to increase by over 35 percent in the next 20 years—from 1.1 million short tons in 2003 to 1.5 mst in 2025 (Energy Information Administration, EIA)—the production and use of CCPs will also increase, providing even greater economic opportunity for the U.S. economy. Capitalizing on that opportunity will involve finding ways to enhance the utilization of CCPs in greater quantities and in new, innovative applications.

ANNUAL CCP PRODUCTION (VALUES IN SHORT TONS)

CCP	2001	2002	2003
Fly Ash	76,013,930	68,869,740	77,239,710
Bottom Ash	21,846,100	22,107,060	26,658,240
FGD Sludge	16,686,700	17,045,140	14,311,500
Gypsum	9,326,100	9,550,700	8,599,400
Other	1,164,900	957,000	1,986,780
Total	125,037,730	118,529,640	128,795,630

Source: Federal Energy Regulatory Commission (FERC), EIA Form 767

INDUSTRY GROWTH

Electric utilities are, by far, the largest users of coal; close to a billion tons of coal is utilized to generate electricity in the U.S. today. Recent EIA projections indicate coal consumption for electricity generation will increase by an average of 1.6 percent annually through 2025. CCPs, created when coal is burned in the generation of electricity, are the third largest mineral resource produced in the U.S.

In 2003, more than 128 million tons of CCPs were produced in the U.S. This was predominantly fly ash, which accounted for nearly 60 percent of CCP production. Of the 128 mt of CCPs produced in 2003, 34 mt were utilized in value-added applications, such as cement and concrete products, highway pavement, soil stabilization and construction bedding, manufactured products, and agriculture, among others. The production of CCPs has consistently outpaced utilization for the past 35 years, representing a significant untapped market potential.

FUTURE ECONOMIC OPPORTUNITY

The 94 mt of CCPs that weren't utilized in 2003, were disposed of or landfilled—

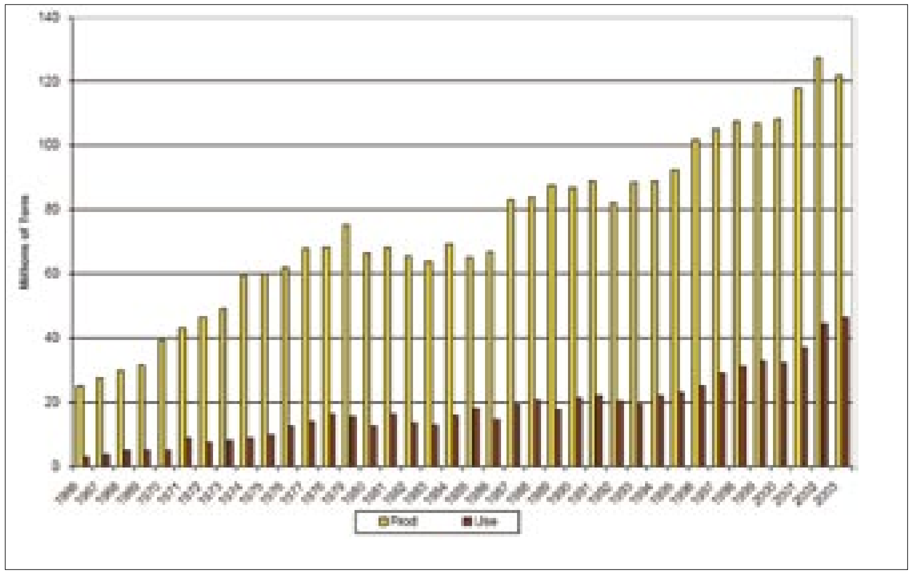
a costly and inefficient use of land. According to the ACC study, in 2003 industry spent more than $560 million to dispose of CCPs. The cost savings of beneficial reuse, in other words the avoided cost of disposal, totaled nearly $200 million in 2003. In addition to providing significant cost savings over landfilling, beneficial reuse programs produce better, more durable products and help contain the cost of electricity. This, in turn, leads to greater economic growth and prosperity, which enhances our nation's ability to steward the environment.

The ACC's Economic Assessment confirms the economic value of increased CCP utilization. The direct revenues that accrue to utilities, marketing companies, and the transportation industry from the sale and handling of CCPs are noteworthy. In 2003, utility CCP sales exceeded $140 million; marketing firm revenues annually exceed $485 million; and transportation companies realize annual revenues in excess of $230 million. Tax revenues are estimated at more than $100 million at the federal level and over $70 million at the state level.

Enhanced utilization of CCPs offers significant technical, economic, and environmental benefits for our nation. ❑

For details and ordering information on the ACC's Economic Assessment of CCPs study, contact the ACC at (602) 485-4737, info@americancoalcouncil.org or visit www.americancoalcouncil.org/whats_new.cfm.

CCP Production and Beneficial Use (1966-2003)



Source: American Coal Ash Association Annual Coal Combustion Product Production and Use Survey

A WIN/WIN SOLUTION FOR FGD-GYPSUM:

RESEARCHERS DISCOVER BENEFICIAL APPLICATIONS FOR BY-PRODUCT IN AGRICULTURE

By Cliff Ramsier and Darrell Norton

In an ironic twist, an attractive new market for the coal ash industry has developed as a result of agricultural research conducted by the USDA and related universities. With winds of change sweeping every industry, including agriculture, research conducted since 1995 at The Ohio State University and the USDA-ARS National Soil Erosion Research Lab at Purdue University have uncovered some viable new reasons for using FGD-Gypsum as a regular part of production agriculture. While some farmers already use gypsum to increase soil nutrients, prevent surface sealing, and detoxify soils, widespread use of gypsum would provide the coal ash industry with a huge market for an under-used by-product with challenging disposal issues.

Current production of FGD-gypsum is consumed by an expanding construction industry for both wall board and cement. This doesn't include the sulfite materials that, for the most part, are landfilled. In the next seven to ten years, an additional 15 to 17 million tons of these FGD materials will be generated with little hope of use in the construction industry. Other uses will be necessary to reduce pressures on current and future landfills.

Agriculture to the rescue! Recent research work has centered on FGD-gypsum or calcium sulfite and to a much lesser extent on fly ash. Researchers have found three agronomically valuable functions of these materials. First, and most obvious, is the fertilizer value of these materials. Both calcium and sulfur are essential minerals required for plant growth and development. While these two minerals are rarely yield limiting to the grower, there is a growing benefit to these two materials in low organic matter soils and when the crop requirements are high. Scrubbing SO_2 emissions in recent years has reduced the atmospheric deposition of sulfur in normal rainfall.

Gypsum has long been known as a good soil conditioner, especially in regions of

the country with saline and sodic soils. Today, the effects of current farming practices have caused those same benefits to be noticed in more common soils. From the time the Corn Belt was settled in the early 1800s, farming has meant tilling the soil. While this practice was good for crop production, it was detrimental to soil structure and organic matter. As soil organic matter has diminished, so has soil structure. Many of the soil aggregates that were once stable are now vulnerable to the ravages of everyday rainfall. The chemistry of rainwater is such that it takes the electrolytes from the surface clays, which cause the clays to disperse. These dispersed clays form a crust on the surface which seals out both water and air when the clay dries. Healthy productive soils need both air and water in very large volumes. Gypsum applications to the soil surface provide the rainfall with an alternative source of electrolyte which prevents soil crusting, thus keeping the soil open and permeable to rainwater and air.

Finally, gypsum is more effective than liming materials at remediation of sub-soil acidity by detoxifying the excess exchangeable aluminum, which causes low pH. Excess aluminum prevents root development in that region of the soil. This most often occurs in the subsoils, since most liming materials are applied to the surface or shallowly incorporated. Since lime is only slightly soluble, it does not get to the subsoil in sufficient quantities to solve the problem economically. While gypsum is not a liming material

In the next seven to ten years, an additional 15 to 17 million tons of these FGD materials will be generated with little hope of use in the construction industry. Other uses will be necessary to reduce pressures on current and future landfills.

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- Glenn Outland, Plant Engineer, Roanoke Valley Energy Facility, 2004

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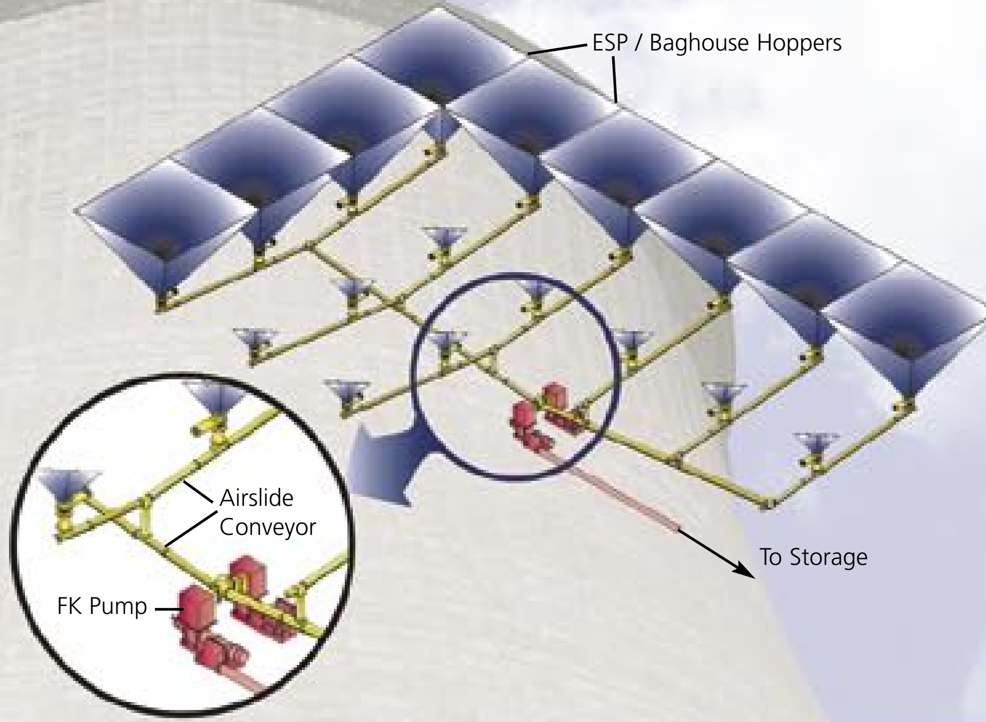

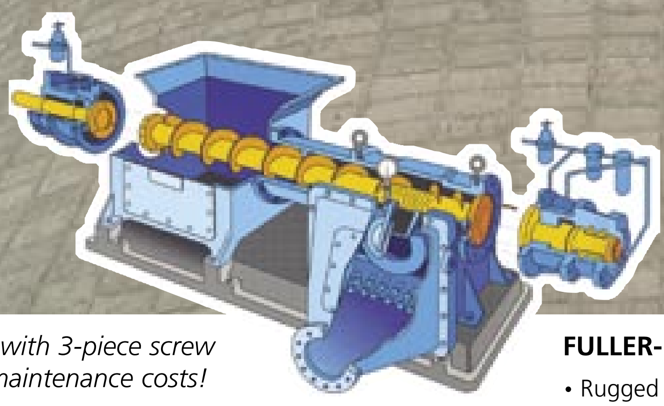

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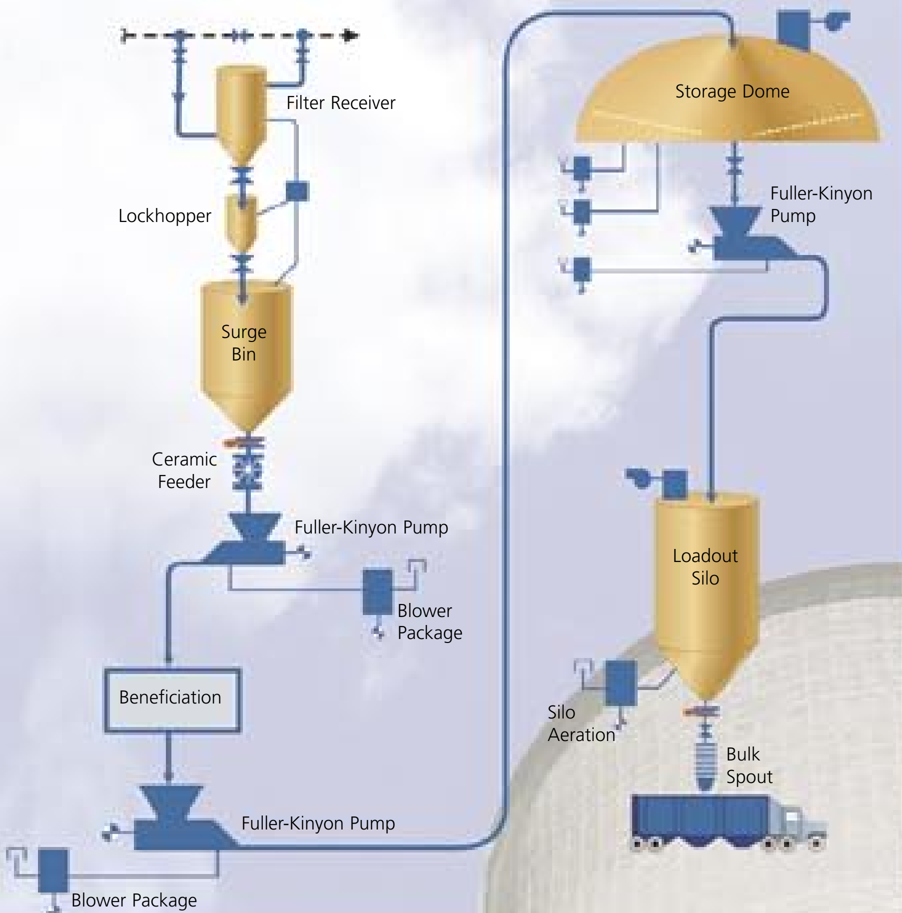
ASH MARKETING APPLICATIONS



FLY ASH INTERCEPT

- Capture ash dry from existing plant ash handling systems

LONG TERM DOME STORAGE AND AERATED RECLAIM

- No moving parts in dome
- Domes with over 30,000 ton capacity

SILO RECLAIM AND TRUCK LOADOUT

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- Standard sched. 40 pipe

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- Feed rates up to 50 TPH

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- Butch Houseknecht, Operations Manager, Separation Technologies, Inc. (STI) Baltimore, Maryland

FLSMIDTH

(liming materials are classified by their ability to neutralize acids) it does detoxify the aluminum by forming a non-toxic species of aluminum. This occurrence allows the crop roots to penetrate deeper into the soil to intercept greater volumes of water and nutrients. Farmers know that better roots equal better crops.

Greenhouse gasses are an ongoing concern of environmentalists everywhere. Two primary greenhouse gasses are carbon dioxide and nitrous oxide. Science and industry are looking for ways to sequester carbon to reduce the amount in the atmosphere. One proven way to sequester carbon is to fix it as organic matter in soil. Also, rooting is related to carbon sequestration because 90 percent of the carbon in roots is converted to soil organic matter, whereas 90 percent of surface residue is oxidized and the carbon returned to the atmosphere. Therefore, more carbon is sequestered by increasing root growth.

Another tie between FGD-gypsum and soil organic matter is the surface properties of soils. If soil surfaces crust, crop yields are reduced. Today's farmers must keep the soil surface from crusting to maintain profitable yields. The good news for the utility industry is that the farmer now has two options. The first is some type of tillage which has the detrimental effect of releasing more carbon dioxide into the atmosphere and reducing soil organic matter. Improved soil water management characteristics also reduce nitrous oxide emissions from agricultural soils. The better option is to apply FGD-gypsum to the soil surface which has the added benefits of those listed above. The utility's world is improved since the highest quality and lowest cost material is generated by an emission control scrubber as FGD-gypsum. The best part of all this is the volume. There are more than 175 million crop acres in the U.S. alone. Each acre would require ½ ton per year to prevent surface sealing. This means that the potential for FGD-gypsum use is more than 80 million tons per year. Now that is real volume!

The story keeps getting better but the next step depends on the regulations and the value of carbon and/or nitrogen credits. As is mentioned above, reducing or eliminating tillage in crop production tends to sequester carbon. In fact, as much as ½ ton of carbon is sequestered each year that tillage is avoided. That means that agriculture may become a very important source for low costs carbon credits. Of course, these credits will need to be aggregated and processed to offset the amount of carbon produced by energy production. While not high value today, the income will help to mitigate the costs involved in compliance if credits become an issue. Carbon credits on a small scale will not generate enough value to offset the transaction cost of making application for credits, so farmers are not likely to acquire them as individuals until the value per

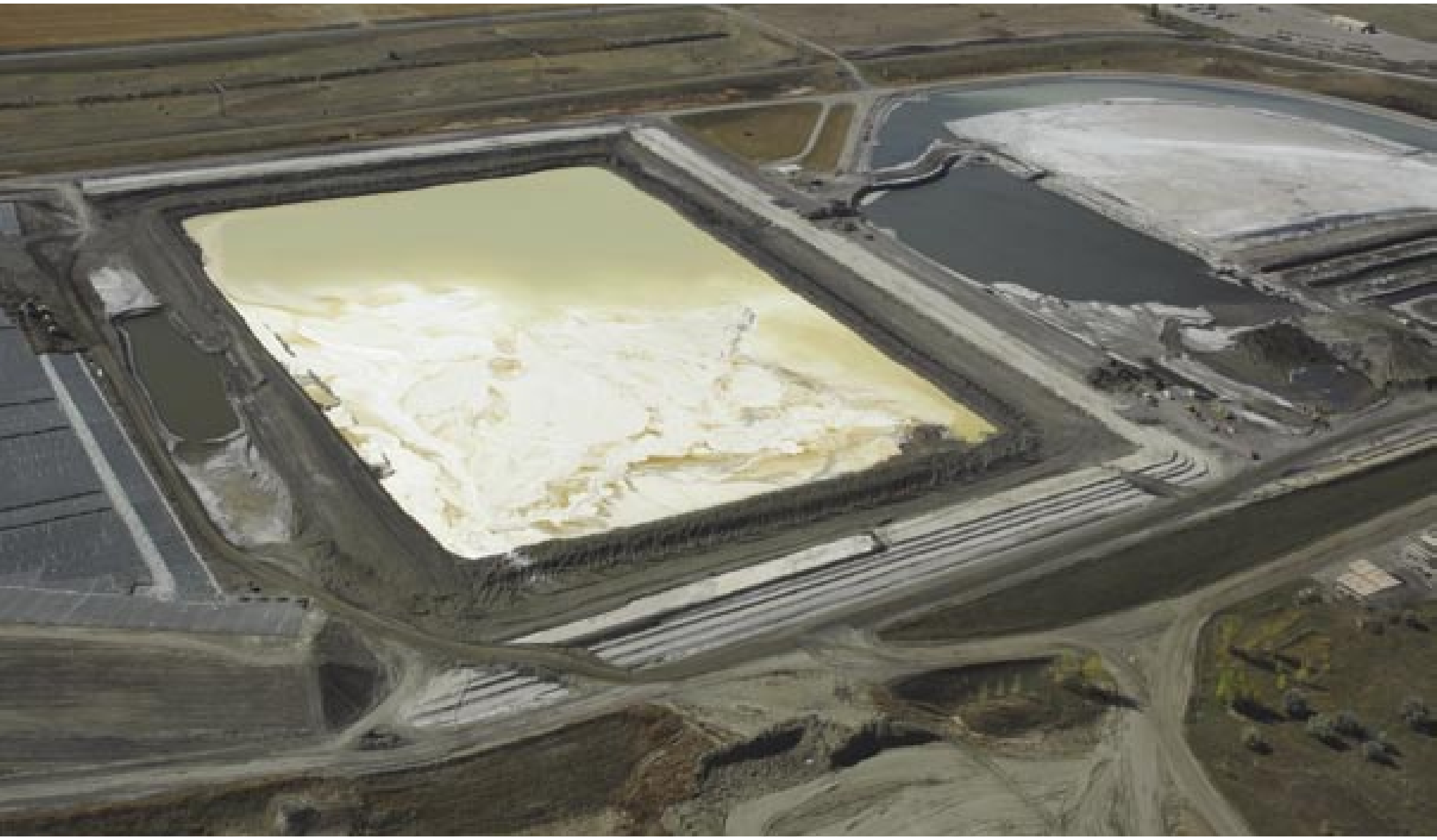
There are more than 175 million crop acres in the U.S. alone. Each acre would require ½ ton per year to prevent surface sealing. This means that the potential for FGD-gypsum use is more than 80 million tons per year. Now that is real volume!

ton of credit is very high. However, a utility could aggregate credits on a very large scale and significantly impact the cost to produce energy. It goes without saying that any positive relationship between power generators and farmers has the potential for great public relations.

If the authors could be so bold to suggest a solution for the disposition of FGD-gypsum and sulfites, we believe that a trade is mutually beneficial to both industries. FGD-gypsum generators need to dispose of their materials and some day may benefit from carbon credits, while farmers could benefit from these materials. If CCP producers were to trade the transportation of FGD materials to agricultural areas and provide the verification and aggregation of carbon credits from farmers' lands, the growers would likely accept these materials in trade for the carbon and possible NOx credits they would generate. Since many generators are already in the transportation business, arranging backhauls with trucks, rail or barges would be a relatively simple, low-cost, in-house activity. There are a few good sources for making the aggregation and verification processes as simple as a phone call.

As is often the case, change is not comfortable. A bright future is in store for those who seek creative ways to improve a difficult situation. The authors believe that the utility industry can provide new and rewarding leadership by implementing change in beneficial ways. ❏

Cliff Ramsier is Technical Director, Ag Spectrum Co. (cliffert@accnorwalk.com) and Darrell Norton is Senior Soil Scientist, USDA-ARS National Soil Erosion Research Lab (norton@purdue.edu).



REUSE AND DISPOSAL WORKING TOGETHER:

A HYBRID APPROACH TO CCP MANAGEMENT

By Ron Jorgenson and Jason Obermeyer, Golder Associates Inc., Lakewood, Colorado

According to ACAA's September 2005 estimate, the coal-fired power industry generated approximately 122 million tons of coal combustion products (CCPs) in the United States in 2004, of which about 49 million tons were beneficially reused. The resultant CCP utilization rate of 40 percent indicates that the beneficial reuse of CCPs represents an important component in the operation of many coal-fired power plants. Moreover, ACAA and others are devoting considerable effort to increasing the beneficial reuse of CCPs, with new applications and growing reuse volumes being achieved each year.

On the other hand, ACAA's estimate suggests that approximately 73 million tons of CCPs were disposed in 2004. Future environmental regulations will likely impact both the marketability and the generated volume of CCPs. At the risk of sounding gloomy, these facts indicate that large-volume disposal of CCPs will remain an operational reality at most coal-fired power plants for the foreseeable future.

A concept that may be worthy of consideration involves the beneficial reuse of CCPs to make disposal practices more economical when disposal becomes necessary. The integration of beneficial reuse into more sophisticated disposal designs can help the industry move toward a more efficient and cost-effective overall CCP management strategy.

This hybrid approach is part of an innovative CCP disposal facility design at Great River Energy's Coal Creek Station generation facility, near Underwood, North Dakota. The

The integration of beneficial reuse into more sophisticated disposal designs can help the industry move toward a more efficient and cost-effective overall CCP management strategy.

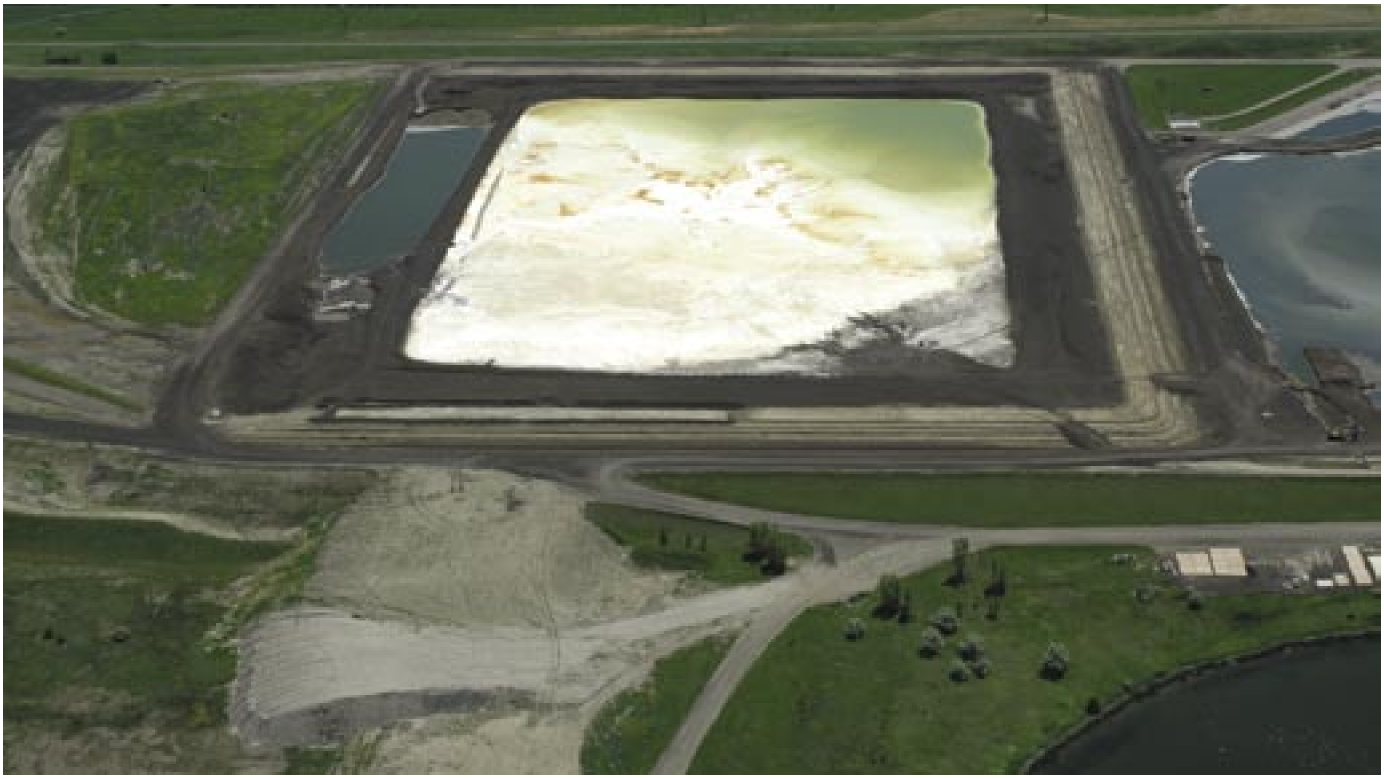
primary design goals are to transport and place unused CCPs at the lowest possible cost and provide for long-term stability in an environmentally appropriate design. Perhaps the most intriguing aspect of the innovative design, however, is the way CCPs are used to make the disposal practice more efficient. This is being accomplished in two ways:

- The engineering properties of CCPs are being used to facilitate vertical stacking of disposed materials over an existing lined footprint to avoid or postpone construction of a new disposal facility, and to minimize the disposal footprint.

- Numerous components of the disposal facility are being constructed using CCPs in lieu of exhausting the site's limited soil resources or importing soil materials.

The beneficial use of CCPs in the design contributes to several significant advantages over traditional disposal methods in terms of CCP disposal costs and predicted environmental performance. Existing disposal facilities are used more efficiently due to the vertical stacking of CCPs, which adds airspace and eliminates or postpones costs associated with siting, permitting, constructing, operating, monitoring, and closing a new disposal facility. Environmental risk may be reduced by minimizing disposal area footprints.

Coal combustion products are also being beneficially reused as construction materials for the vertical expansion. Design



Existing disposal facilities are used more efficiently due to the vertical stacking of CCPs, which adds airspace and eliminates or postpones costs associated with siting, permitting, constructing, operating, monitoring, and closing a new disposal facility.

At full capacity, CCP placement heights will exceed 80 feet, and the added capacity will total more than 7 million cubic yards.

components that would normally consist of hauled or imported soil materials are instead being constructed using CCPs having appropriate characteristics to meet the design requirements. For instance, structural materials such as fly ash and bottom ash are being placed around the perimeter to allow for the stable placement of weaker materials such as flue gas desulphurization (FGD) sludge well above pond embankments. Also, bottom ash is being used to construct a drainage layer that will reduce the average hydraulic head acting on the composite liner system and improve the environmental performance of the disposal facility.

Other innovative design features include systems that allow hydraulic conveyance of fly ash, bottom ash, and FGD sludge at relatively high solids contents to reduce the amount of water managed at the disposal site. This also includes bottom ash seepage berms and passive pipe systems that control the phreatic surface and allow recirculation of CCP transport waters back to the plant.

Unused CCPs are currently being placed higher than the previous pond embankment crests. At full capacity, CCP placement heights will exceed 80 feet, and the added capacity will total more than 7 million cubic yards. By taking advantage of the engineering properties of CCPs to allow vertical stacking on an existing lined footprint, GRE has been able to significantly reduce direct and indirect costs associated with CCP disposal at their Coal Creek Station generation facility. Similar opportunities exist for the coal-fired generation industry to move toward more sophisticated disposal designs that reduce costs by incorporating new CCP reuse applications. ❑

Ron Jorgenson is a senior consultant and Jason Obermeyer is a geotechnical engineer with Golder Associates Inc. in Lakewood, Colorado. Mr. Jorgenson can be reached by phone at (303) 980-0540 or by email at rjorgenson@golder.com. Mr. Obermeyer can be reached at the same phone number or by email at jobermeyer@golder.com.

ACAA RESPONDS TO URGENT REQUEST

In late October, the ACAA staff received a phone call from El Dorado County California Environmental Management Department (EMD). It was discovered that a small amount of fly ash had been inadvertently introduced into the district's water treatment plant, instead of soda ash. ACAA provided district officials the names of several members who have expertise in health issues related to CCPs. As a result, the district was able to determine, following testing, that there had been no degradation of health safety to the public. In response to our assistance, Dave Johnston of the El Dorado County EMD sent ACAA a note, stating, "Thanks very much to you and your staff, Dave. Your assistance was critical for the prompt resolution of this incident…" Without the talented and responsive membership we have, ACAA could not continue to provide this type of support. ❑

ERRATA

In the Summer/Fall 2005 issue of Ash at Work, "Table 1. ADA-ES leaching test results for ACI ash by-products" on page 14 contained a formatting error. We have reprinted that table for your information here. Inadvertently, the headings "TCLP" and "SGLP" should have been placed above the fifth and sixth columns. The heading "Mercury in Leachate (μg/L)" should extend over both of these same columns. There is now a divider between the fourth and fifth columns which helps differentiate the data. We thank those sharp eyed readers who brought this formatting error to our attention.

Table 1. ADA-ES leaching test results for ACI ash by-products.

Plant	Sample Location	ACI Rate (lb/Mmacf)	Mercury in Solid (μg/g)	Mercury in Leachate (μg/L)	
				TCLP	SGLP
Gaston	COHPAC B-Side	1.5	10-50	0.01	BDL[a]
Gaston	COHPAC B-Side	1.5	10-50	N/A[b]	BDL
Gaston	COHPAC B-Side	1.5	10-50	BDL	BDL
Pleasant Prairie	ESP Hopper Composite	10	0.5-5	BDL	BDL
Pleasant Prairie	ESP Hopper Composite	10	0.5-5	BDL	BDL
Pleasant Prairie	ESP Hopper Composite	10	0.5-5	BDL	N/A
Brayton Point	Downstream ESP	0	0.2-0.53	BDL	0.01
Brayton Point	Upstream ESP	0	0.2-0.32	0.02	0.05
Brayton Point	Downstream ESP	10	0.4-1.4	0.07	0.03
Brayton Point	Upstream ESP	10	N/A	0.03	0.01
Brayton Point	Downstream ESP	20	0.4-1.4	BDL	0.01
Brayton Point	Upstream ESP	20	N/A	0.02	0.02
Salem Harbor	ESP Row A	0	0.1-0.7	0.034	BDL
Salem Harbor	ESP Row A	10	0.1-0.7	BDL	BDL
Salem Harbor	ESP Row A	10	0.1-0.7	BDL	BDL

[a]BDL = below detection limit of 0.01 μg/L
[b]N/A = not available.

TURN PROBLEMS INTO PRODUCTS

This patented process* was invented by power plant people for power plants, and is the only proven technology that reduces fuel costs and produces no ash waste stream. Carbon Burn-Out™ is uniquely suited to the utility industry's specialized needs, including new environmental regulations.

With two sites in operation, and two more under construction, we can customize a solution that will integrate seamlessly into your existing operations. **With our help, you'll have a long-term solution to managing your fly ash problems.**

** U.S. Pat No. 5,160,539*

THE GREEN HIGHWAY FORUM

EPA Administrator Stephen L. Johnson addresses the Green Highway Forum in College Park, MD.

In late 2004, as part of ACAA's strategic planning process, a plan was approved by its Board of Directors implementing a "green highways" concept. The concept emphasized use of coal combustion products (CCPs) in highways in a variety of ways including being used alone, in combination with other forms of CCPs, and combined with non-ash materials. The incentives behind the developed concept were the derived advantages from beneficial technical, economic, and environmental impacts. Although the primary use of fly ash is in concrete, other forms of CCPs could be considered for more non-traditional highway applications. For example, these might include soil stabilization, binders for in-place pavement recycling, use in flowable fills, aggregates, source materials for structural fills and embankments, components in manufactured soils, and for granular base courses beneath pavements.

At this same time, unknown to ACAA, EPA Region 3 in Philadelphia was working with the Wetlands & Watersheds Work Group, a non-profit organization involved in wetlands policy and management along with the Federal Highway Administration (FHWA) on their own "Green Highways" initiative. These groups were planning a conference, the "Green Highway Forum," promoting the need for a more environmentally sensitive process of designing and planning transportation systems. Dave Goss contacted Dominique Lueckenhoff, Associate Director of the Office of Watersheds, in the Water Protection Division of EPA Region 3 to learn more about the planned event. Over the course of time, and in concert with EPA's John Sager, Jason Harrington of the FHWA and many others, the "Green Highways" initiative was expanded in concept to a wider-ranging program. A June 2005 planning "Charrette" was held in Philadelphia and was attended by leaders from the public and private sectors. In part, through ACAA's efforts, the Green Highway concept was expanded to include an emphasis on the use of "recycled materials," that is, products and byproducts of industrial processes, such as coal ash, foundry sands, wood and paper mill residues, scrap tires, and recycled concrete.

The Green Highway Forum was held in College Park, Maryland at the University of Maryland, Nov. 8-10, 2005. Attendees from the Mid-Atlantic Region, as well as many outside the area, participated in the planning and conduct of the forum. Industry groups included not only ACAA, but the American Concrete Pavement Association, Foundry Recycling Starts Today, Rubber Manufacturers Association, Slag Cement Association and the Wetlands & Watersheds Work Group. Its goal was to foster partnerships for improving natural, built, and social environmental conditions in a watershed, while sustaining the transportation infrastructure (safety, structural and service levels).

The Executive session was facilitated by Marianne Horinko (formerly of the EPA) and now with the Global Environment & Technology Foundation (GETF). During this session, a three-pronged approach was explored in which "Partnership Development," "Recognition" and "Opportunities" became focal points. In all three elements, public and private sector partnerships were identified as key factors of helping develop the "Green Highways" concept. The "Green Highways" initiative is not a certification program, it is an opportunity to recognize state and local transportation agencies, industry, and their partners who are making contributions, defining objectives, and moving toward ideas and strategies that will ultimately underpin actions of progress for the

Mid-Atlantic region. A draft "roadmap" served as a guide to Executive Level participants bringing the diverse viewpoints of many agencies and interest groups together. Ten guiding principals were considered:

1. Achieve goals through voluntary participation and public/private partnerships
2. Utilize market-based approaches and economic incentives
3. Provide communication and support network to avoid duplication and help streamline business practices and processes among those organizations supporting and enabling the "Green Highways" philosophy
4. Promote conservation and integrated, watershed management
5. Promote innovative stormwater protection
6. Promote use of recycled materials
7. Recognize existing environmental stewardship practices among transportation agencies by promoting them within the resource/regulatory universe of stakeholders
8. Remove barriers to achieving innovative and positive results
9. Leverage transportation and environmental resources (public and private) to multiply benefits and maximize results
10. Support and stimulate applied research and training to remove barriers identified by partners and stakeholders

At a lunch presentation on November 8, EPA Administrator Stephen L. Johnson spoke to the Forum and applauded it for its work of envisioning the future of transportation and environmental protection. Administrator Johnson spoke to the need of connecting transportation and land use in ways to promote stewardship, safety, and sustainability. He offered the Forum the challenge to help replicate the action of the Mid-Atlantic region by working toward a national summit to be held in 2007. Other speakers included Neil Pedersen of the Maryland State Highway Administration; Carol Murray, Commissioner of Transportation for New Hampshire; Don Welsh, Regional Administrator, EPA Region 3; and a number of other key state highway and industry representatives.

Participants of the Executive Session of the green Highway Forum engaged in brainstorming and visioning on Tuesday, Nov. 8.

During a closing message, the Chief Executive Officer of the GETF, Mr. F. Henry "Hal" Habicht II, left the important message that this was not the end of an event, but rather the beginning of a movement. As he and others stated, the "Green Highways" concept is not new, as many organizations have taken environmental sensitivity into account when working with transportation projects. It is, however, a new effort to recognize the "greenness" of many projects already completed and those to be initiated. As Cindy Burbank, Associate Administrator of the "Federal 'Green' Highway Administration" (her terminology) remarked, it is similar to the scenic byways program wherein state and federal agencies recognize certain roadways for their unique contributions to America's transportation system.

The energy of the conference was remarkable. During the three day event, many presentations were made by public and private sector participants. In the words of Mary Ivey, Director of the Environmental Analysis Bureau of the Department of Transportation for New York State, the goal of this initiative should be to leave any roadway or transportation system, "better than before." It is intended to be an effort to encourage partnerships when working with the myriad of issues associated with transportation systems, such as watersheds, permits, context sensitive solutions, materials, specifications, economics, planning, education, and numerous other points of common or divergent interest.

ACAA will remain intimately involved in this process and will encourage its members to support the financial and resource commitments needed to foster the success of the "Green Highway" program. ❑

THE CURRENT STATE OF THE SCIENCE RELATED TO **THE RE-RELEASE OF MERCURY FROM COAL COMBUSTION PRODUCTS**

By Debra F. Pflughoeft-Hassett, David J. Hassett, Loreal V. Heebink, and Tera D. Buckley
University of North Dakota Energy & Environmental Research Center (EERC)

The issue of mercury does not end with the reduction of mercury emissions. Mercury emission controls will result in reapportioning the mercury that was previously released to the atmosphere into coal combustion products (CCPs). The stability of mercury associated with CCPs is an issue that has only recently been under investigation but has become a prominent question as the industry strives to determine if current management options for CCPs will need to be modified.

ANTICIPATED IMPACTS OF PROPOSED MERCURY CONTROL TECHNOLOGIES ON CCPS

The highest potential for mercury controls to impact CCPs is through the use of sorbent injection technologies that will incorporate the sorbent into the fly ash stream. At this time, the most likely sorbent candidate is activated carbon. The mercury concentration of fly ash tends to increase with the carbon content of the ash. The second most likely impact to CCPs is in flue gas desulfurization (FGD) materials generated from wet calcium-based FGD systems. The use of wet FGD systems for mercury control has the potential to facilitate multipollutant control and may provide some impetus for utilities to consider wet FGD systems over other SO_2 controls to meet new emission standards.

STABILITY OF MERCURY ON CCPS

Mercury and other air toxic elements can be present in fly ash, FGD material and, to a lesser extent, bottom ash and boiler slag. Mercury concentrations ranging from <0.01 to 2.41 ppm in fly ash and from 0.001 to 0.342 ppm in bottom ash have been reported. Recently, the EERC reported that of 21 samples from mercury control demonstrations, only six had mercury concentrations greater than those noted for samples from systems without mercury control with concentrations ranging from 4.7 to 120 ppm.

The total concentration of mercury on CCPs or sorbents cannot be used as an indicator of stability. Stability must be evaluated by subjecting the sample to a variety of laboratory tests that expose the material to conditions that simulate utilization and disposal scenarios. These tests include 1) direct leachability; 2) vapor-phase release at ambient and elevated temperatures; and 3) microbiologically induced leachability and vapor-phase release.

Leaching – The amount of mercury leached from currently produced CCPs is extremely low and does not appear to represent an environmental or re-release hazard. Concentrations of mercury in leachates from fly ashes and FGD material using either the toxicity characteristic leaching procedure (TCLP) or the synthetic groundwater leaching procedure (SGLP) are generally below detection limits (0.005 to 0.05 µg/L).

Vapor-Phase Release – The release of mercury vapor from CCPs resulting from the use of mercury control technologies has been evaluated on a limited basis. Research indicates that mercury bound to the ash or activated carbon is fairly stable.

Microbiological Release – EERC researchers have reported on the microbiologically induced release of mercury vapor from CCPs. The EERC concluded that organomercury species were detected at very low levels both in the vapor and leachate generated from the microbiologically mediated release experiments.

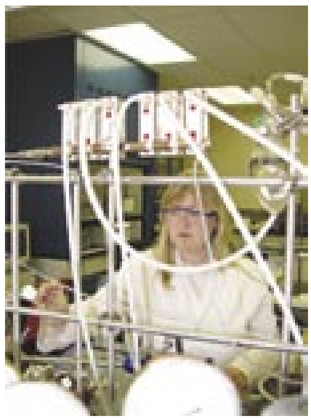
CONCLUSION

The current state of the science indicates that mercury associated with CCPs is stable and highly unlikely to be released under most management conditions, including utilization and disposal. The exception to this is exposure to high temperatures such as those that may be achieved in cement and wallboard production. Therefore, existing CCP management options are expected to be environmentally sound options for CCPs from systems with mercury control technologies installed. ❑

ACKNOWLEDGEMENTS

Much of the information presented in this article was generated from a project under way at the EERC sponsored by the U.S. Department of Energy, the EERC Center for Air Toxic Metals®, Cinergy, the Electric Power Research Institute, Great River Energy, the North Dakota Lignite Research Council, and the Utility Solid Waste Activities Group. The final report for this effort will be released by the end of 2006. Other data presented in this article were summarized from:

EERC Research Scientist Erick Zacher removes leached fly ash.



Loreal Heebink, EERC Research Chemist, calibrates before analyzing mercury collected on analytical gold traps.

Hassett, D.J.; Pflughoeft-Hassett, D.F.; Heebink, L.V. *The Review of the Current State of the Science Related to the Rerelease of Mercury from Coal Combustion Products*, Final Report for the Utility Solid Waste Activities Group; EERC Publication 2004-EERC-11-01; Energy & Environmental Research Center: Grand Forks, ND, Nov 2004.

Hassett, D.J.; Pflughoeft-Hassett, D.F.; Heebink, L.V. *Mercury Information Clearinghouse Quarter 4 Report – Re-Release of Mercury from Coal Combustion Byproducts*; Report for the Canadian Electricity Association; Energy & Environmental Research Center: Grand Forks, ND, Oct 2004.

Disclaimer: References in this article to any specific commercial product or service are to facilitate understanding and do not imply endorsement by the U.S. Department of Energy.

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Coal Ash Disposal Systems

Typical Discharge of Fly and Bottom Ash Slurry

High Concentrated Slurry Disposal Systems (HCSD) have been in use for a variety of materials for a number of years. However, fairly recently this technology has been introduced to North America for the disposal of ash tailings in the power industry.

This system allows for an economical method of disposal, which is also environmentally friendly. Traditional methods for the disposal, of both Fly Ash and Bottom Ash, such as: trucking, conveying or wet slurrying at low concentrations, have numerous operational and cost disadvantages associated with them. Previously, alternative methods that resolved the operational drawbacks had not been available.

PSI has a long history of tailings disposal experience on a variety of systems, which have often required specialized designs, such as: gravity flow, energy dissipation (drop boxes, drop tanks, orifices, cascades, etc.), open channel flow, hydraulic/paste underground back fill, and thickened/paste surface tailings disposal. PSI offers a high level of experience to provide innovative approaches to the specialized ash disposal systems required by our clients.

HCSD Advantages

Ecological Advantages:

- Significant reduction in water usage
- Pipeline transportation is safe, reliable, silent and dust free
- Water run off is limited, thus reducing water reclaim systems
- Thickened ash is not subject to run out
- Seepage into groundwater is virtually eliminated
- Ground can be easily covered for restoration of natural environment

Operational Advantages:

- Minimal or non mechanical spreading at disposal site
- Minimizes the number of people required for system operation
- High availability of pipeline transportation system
- Low maintenance pumps greatly reduces annual operating costs

Economical Advantages:

- Significantly higher pump efficiency vs. centrifugal systems
- Transportation of smaller volumes reduces overall costs
- Central ramp or side hill discharges can avoid raising perimeter dams
- Self draining and sloping at low angles (2-6%) offers long term stability
- Extends effective life of disposal sites

High Concentrated Ash Disposal System at Pacific Power Photos Courtesy of GeHo Pumps

Key Services

- Key Services
- Feasibility Studies
- Basic and Detailed Engineering
- Laboratory Testing of Ash Samples
- Solids/Liquid Separation Evaluation
- Disposal Site planning and Layout
- Disposal Site planning and Layout
- Construction Management
- Operations Training
- System Operation
- Loop Testing Programs
- Due Diligence Studies
- Project Scope Flexibility to Suit client needs:
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  - Turn Key Project
  - Start-up and Commission Assistance
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2004 ACAA SURVEY REFLECTS CONTINUED ANNUAL GROWTH IN ASH UTILIZATION*

PRODUCTION LEVELS OUT, BUT USE CONTINUES MOVE UPWARD

ACAA's 38th Annual Coal Combustion Products (CCP) Production and Use Survey results were released in September for data year 2004. Beneficial CCP utilization tonnage went up by a noteworthy 5.6 percent from 2003 figures, while production showed very little change at only 0.6 percent. The estimated total coal ash used versus CCPs produced in 2004 was 40.1 percent (see Survey Report), an increase from 2003's 38.1 percent.

Ash utilization, since first tracked has grown from approximately 12 percent in 1966 to the currently reported 40 percent. This historic trend can be attributed to a number of changing market and environmental factors over the years. Primary among these include:

- An increase in general environmental awareness by both the public and industry;
- An emphasis on recycling and conservation of natural resources;
- A continuing growth in the number of new applications to which CCPs can be applied;
- A growing use of synthetic gypsum for wallboard created by wider implementation of flue gas desulphurization emission control systems;
- An increase in the use of fly ash as a substitute for portland cement in concrete; and
- A continued high demand for concrete construction and a shortage of portland cement.

U.S. EPA/INDUSTRY GOAL OF 50% UTILIZATION STILL ON TRACK

The U. S. Environmental Protection Agency, in concert with ash industry stakeholders, looks to 50 percent CCP utilization by the year 2010. Based on increases over the last 10 years, utilization has gone up annually an average of 1.97 percent. This is a very positive indicator that 50 percent utilization is a goal that can be realistically obtained and possibly surpassed.

Production and utilization charts (See Charts 2 and 3) for 2004 survey findings identify types and quantities of CCP produced and the percentage of overall CCPs beneficially used. The following are notable highlights.

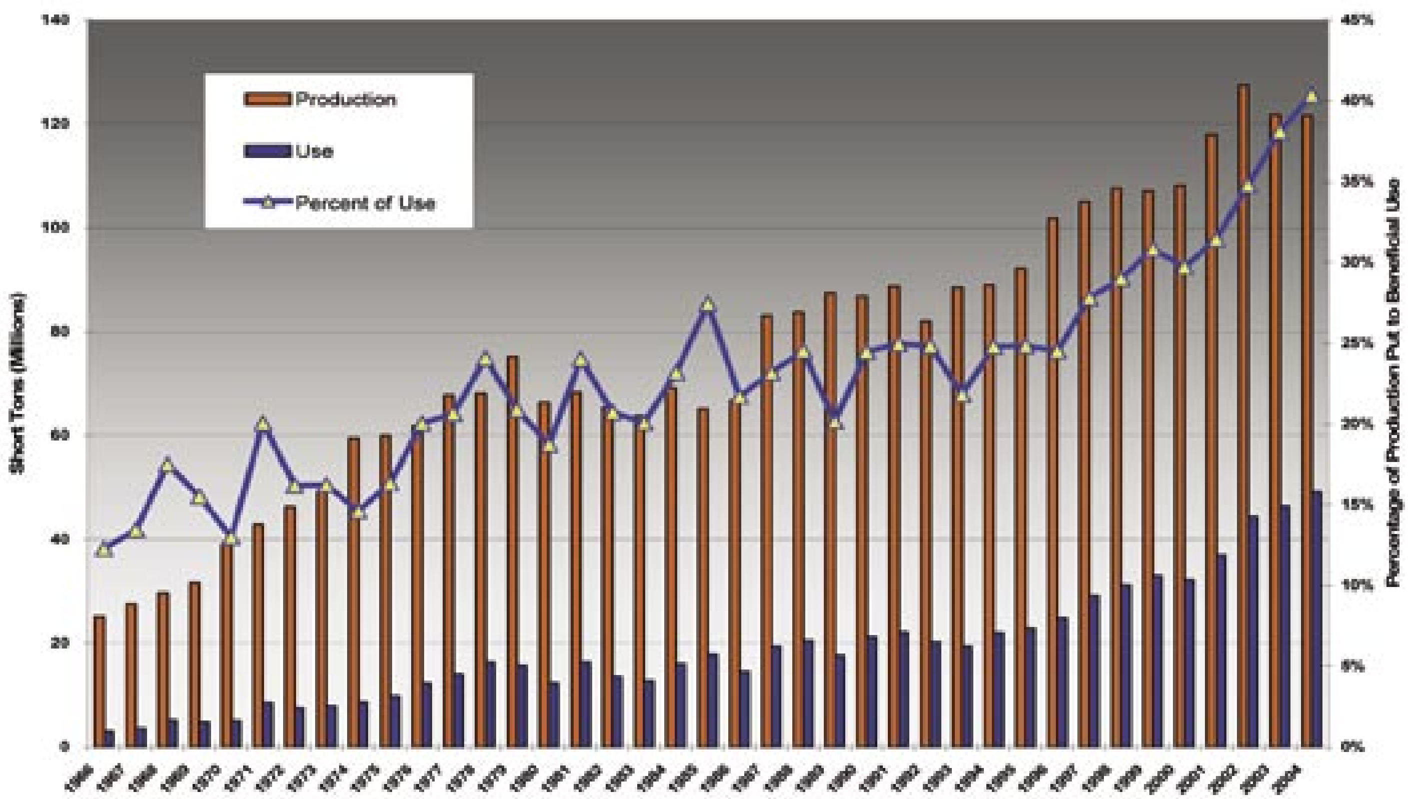


Chart 1. CCP Production & Use Comparison (1966 – 2004)

American Coal Ash Association
15200 E. Girard Ave., Ste. 3050
Aurora, CO 80014-3955

Phone: 720-870-7897
Fax: 720-870-7889
Internet: www.ACAA-USA.org
Email: info@acaa-usa.org

2004 Coal Combustion Product (CCP) Production and Use Survey

CCP Categories (Short Tons)	Fly Ash	Bottom Ash	FGD Gypsum	FGD Material Wet Scrubbers	Boiler Slag*	FGD Material Dry Scrubbers*	FGD Other*	FBC Ash*
CCP Production Category Totals**	70,800,000	17,200,000	11,950,000	17,500,000	2,202,296	1,829,830	115,596	867,397
CCP Production Total								**122,465,119**
CCP Used Category Totals***	28,068,970	8,152,469	9,044,955	1,195,877	1,973,385	177,480	3,291	473,391
All CCP Used Total								**49,089,818**
CCP Use By Application******	**Fly Ash**	**Bottom Ash**	**FGD Gypsum**	**FGD Material Wet Scrubbers**	**Boiler Slag**	**FGD Material Dry Scrubbers**	**FGD Other**	**FBC Ash**
1. Concrete/Concrete Products /Grout	14,121,868	789,071	291,439	0	0	37,343	0	0
2. Cement/ Raw Feed for Clinker	2,345,754	615,192	449,063	39,378	33,505	0	0	0
3. Flowable Fill	179,735	0	0	0	0	11,274	0	0
4. Structural Fills/Embankments	4,685,091	3,064,773	0	266,651	7,268	0	0	61,985
5. Road Base/Sub-base/Pavement	488,214	1,092,006	0	0	7,070	0	0	0
6. Soil Modification/Stabilization	500,630	21,117	0	0	0	0	0	190,426
7. Mineral Filler in Asphalt	90,033	0	0	0	39,942	0	0	0
8. Snow and Ice Control	5,563	830,329	0	0	87,711	0	0	0
9. Blasting Grit/Roofing Granules	0	70,312	0	0	1,747,238	0	0	0
10. Mining Applications	1,113,361	39,682	0	282,033	0	122,589	0	134,648
11. Wallboard	0	0	8,148,078	0	0	0	0	0
12. Waste Stabilization/Solidification	2,441,513	257,375	0	338	4,615	0	0	70,722
13. Agriculture	52,314	19,272	131,058	10,593	0	2,775	0	0
14. Aggregate	7,995	409,362	0	0	38,000	3,499	0	0
15. Miscellaneous/Other	2,036,899	943,978	25,317	596,884	8,036	0	3,291	15,610
CCP Category Use Totals	**28,068,970**	**8,152,469**	**9,044,955**	**1,195,877**	**1,973,385**	**177,480**	**3,291**	**473,391**
Application Use To Production Rate	39.65%	47.40%	75.69%	6.83%	89.61%	9.70%	2.85%	54.58%
Overall CCP Utilization Rate								**40.08%**
Cenospheres Sold (Pounds):	**11,391,150**							

* As submitted based on 60 percent coal burn.

** CCP Production totals for Fly Ash, Bottom Ash, FGD Gypsum, and Wet FGD are extrapolated estimates rounded off to nearest 50,000 tons.

*** CCP Used totals for Fly Ash, Bottom Ash, FGD Gypsum, and Wet FGD are per extrapolation calculations (not rounded off).

**** CCP Uses by application for Fly Ash, Bottom Ash, FGD Gypsum, and Wet FGD are calculated per proportioning the CCP Used Category Totals by the same percentage as each of the individual application types' raw data contributions to the as-submitted raw data submittal total (not rounded off).

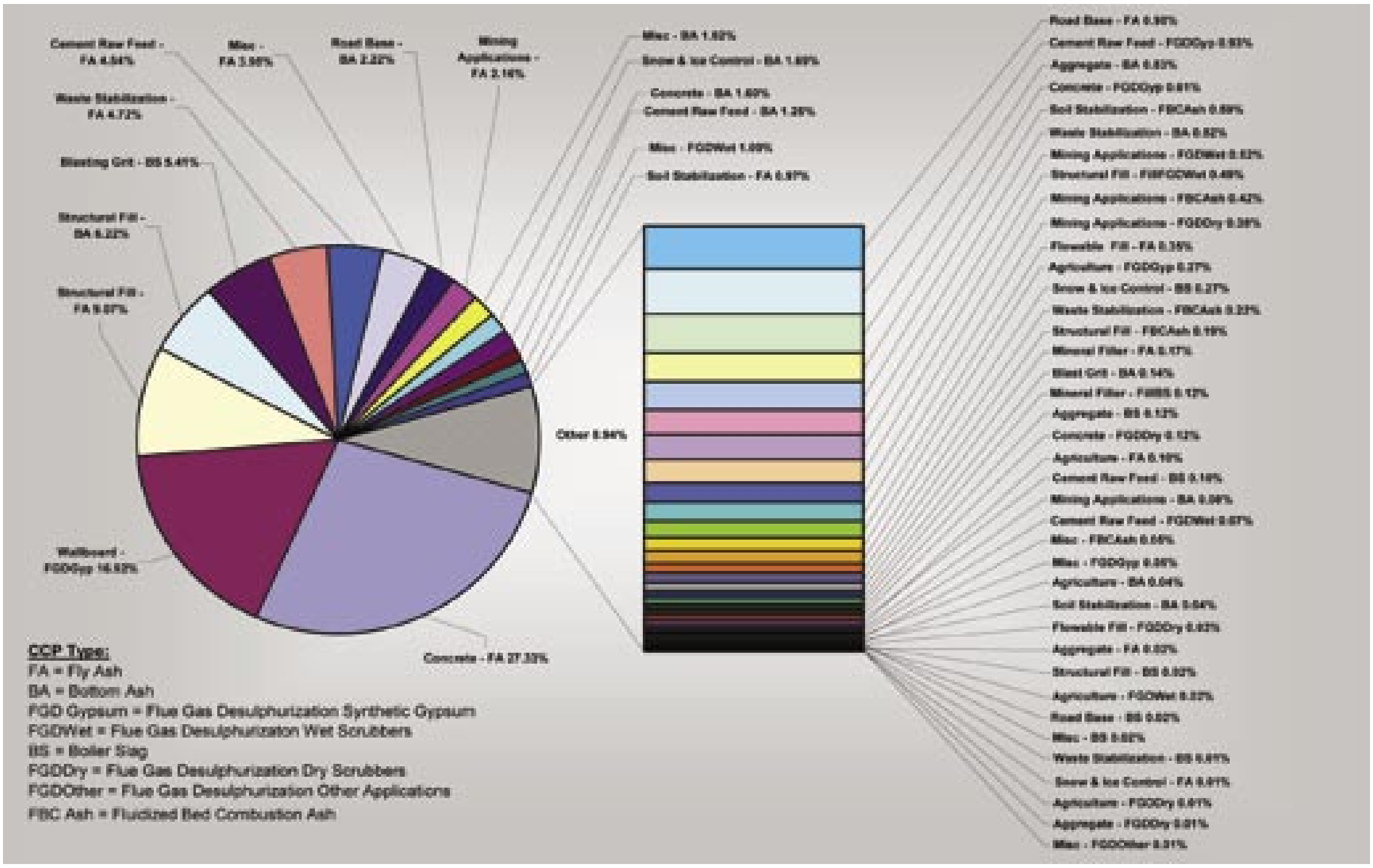


Chart 2. 2004 Percent Used By Type of Total Beneficially Applied CCPs

DEMAND FOR FLY ASH USE IN CONCRETE JUMPS BY 12%

The categorization of CCPs by type and tonnage produced versus the total of all CCPs produced was again topped by fly ash at approximately 57 percent, a small increase over 2003. Fly ash utilization versus production increased 1 percent. As has been the case in prior years, the predominant use of fly ash is as a substitute for portland cement in concrete products. 2004 survey data revealed an exceptional increase of fly ash use in concrete of 12 percent. This is consistent with the continued high demand for concrete construction and a shortage of portland cement. Fly ash contributes to enhanced concrete strength and durability and is typically less expensive than the portland cement it replaces. Data reflected a modest decrease in use of fly ash for cement raw feed for clinker, structural fill, and soil and waste stabilization.

FGD SYNTHETIC GYPSUM WALLBOARD PRODUCTION INCREASES BY 4.6%

Typical of all CCP categories for 2004, production of synthetic gypsum from flue gas desulphurization (FGD) systems increased only slightly from 2003. FGD gypsum, though, continued with the second highest utilization rate of any CCP Category, 75 percent, an increase of 6 percent from 2003. According to survey results, the primary use of FGD gypsum continues to be in the manufacturing of wallboard whose use went up by 4.6 percent in 2004.

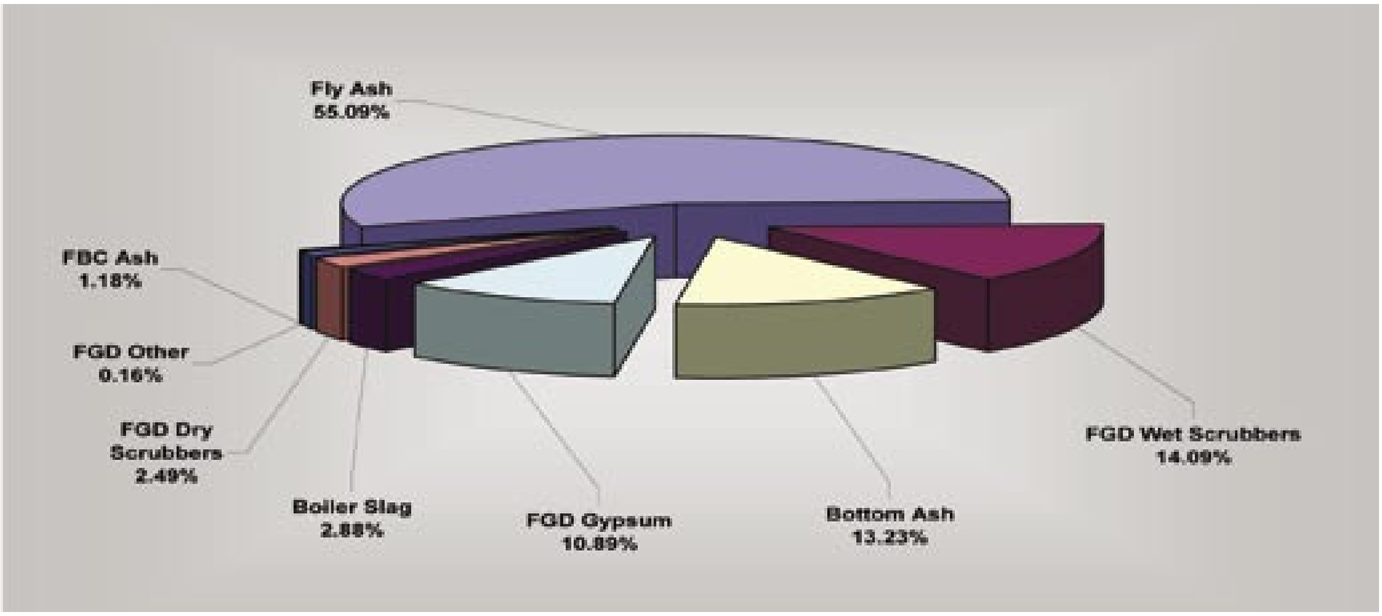


Chart 3. Percentage 2004 CCP Production by Type

BOILER SLAG REMAINS MARKET OF HIGHEST DEMAND

Although a considerably smaller market than fly ash, FGD and bottom ash, the percentage of utilization to production, 90 percent, makes boiler slag the market of highest demand. Boiler slag is predominantly used in blasting grit, roofing granules, and snow and ice control. Reported use of boiler slag dropped from 95 percent in 2003 to 90 percent in 2004. This reduction may be due in part to old power plant units that produced boiler slag being removed from service.

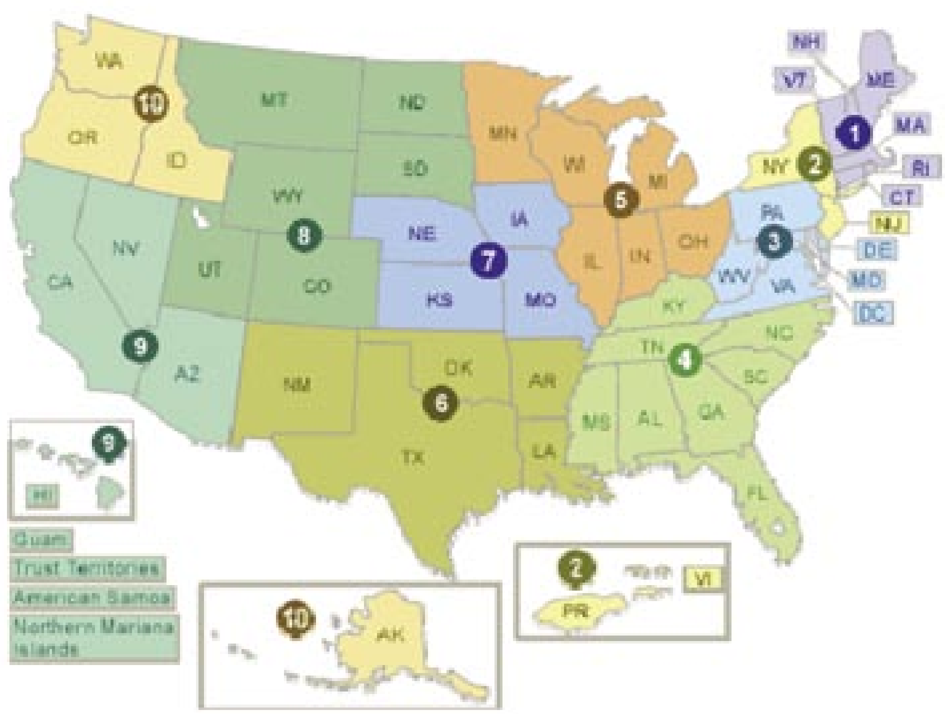
BOTTOM ASH USE SHOWS LITTLE CHANGE

Bottom ash production in 2004 dropped 5 percent from reported 2003 figures. Utilization remained virtually the same. Significant contributors to bottom ash use were in structural fills, embankments and pavement road base applications.

CENOSPHERES SOLD: A NEW CCP CATEGORY IN 2004**

With the 2004 Survey, ACAA has begun tracking "cenospheres sold." Typically marketed by the pound versus tons for all other CCP materials, the inclusion of this category is intended to monitor market demand for this high-value mineral filler. Cenospheres are used in flexible PVC pipes, rubber, polypropylene, polyester, and machine tooled metals. Cenospheres are acquired by surface skimming utility plant ponds used to store sluiced fly ash. As end use is not documented by the selling utility, cenospheres will be reported separately. Utilities reported in 2004 they sold 11,391,150 pounds of cenospheres.

Beneficial CCP utilization tonnage went up by a noteworthy 5.6 percent from 2003 figures, while production showed very little change at only 0.6 percent.



Map 1. US EPA Regions

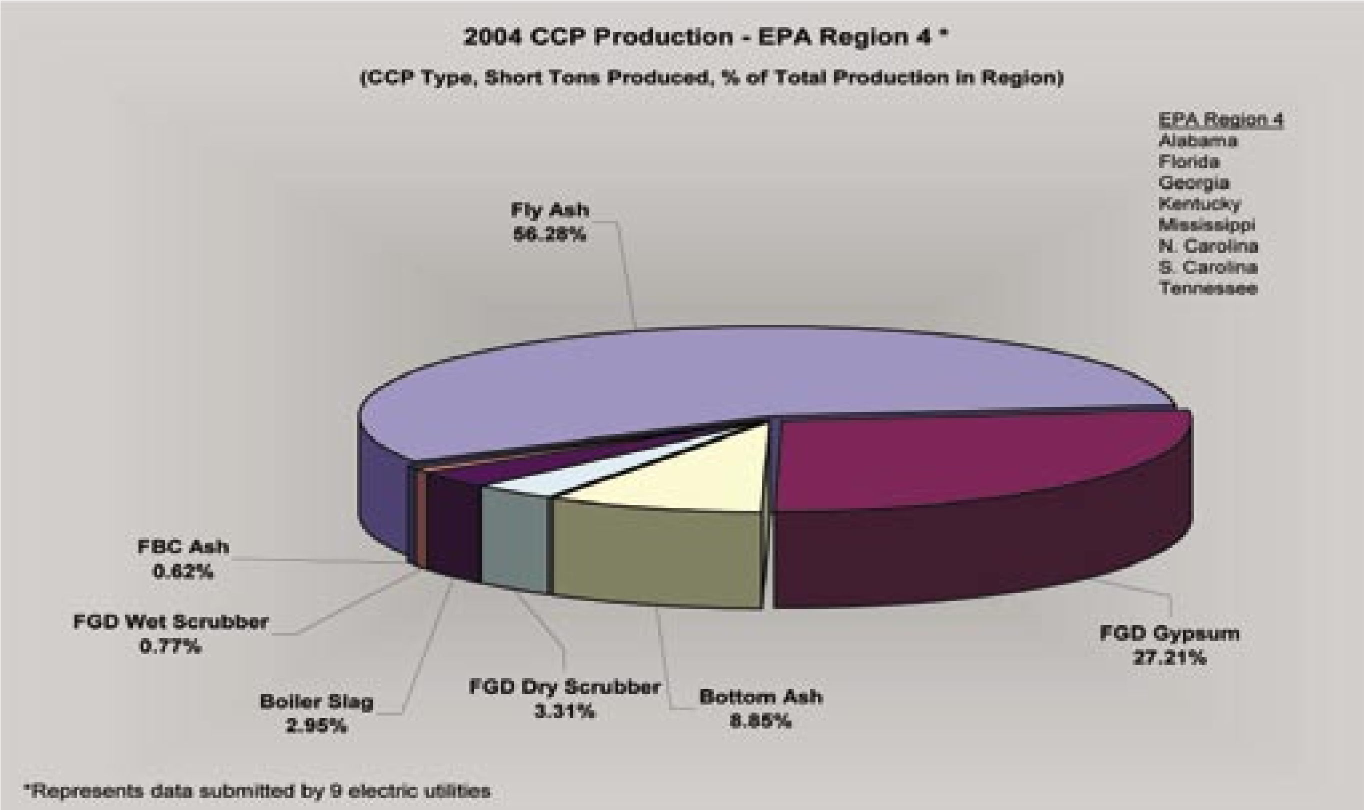


Chart 4. 2004 CCP Production – EPA Region 4

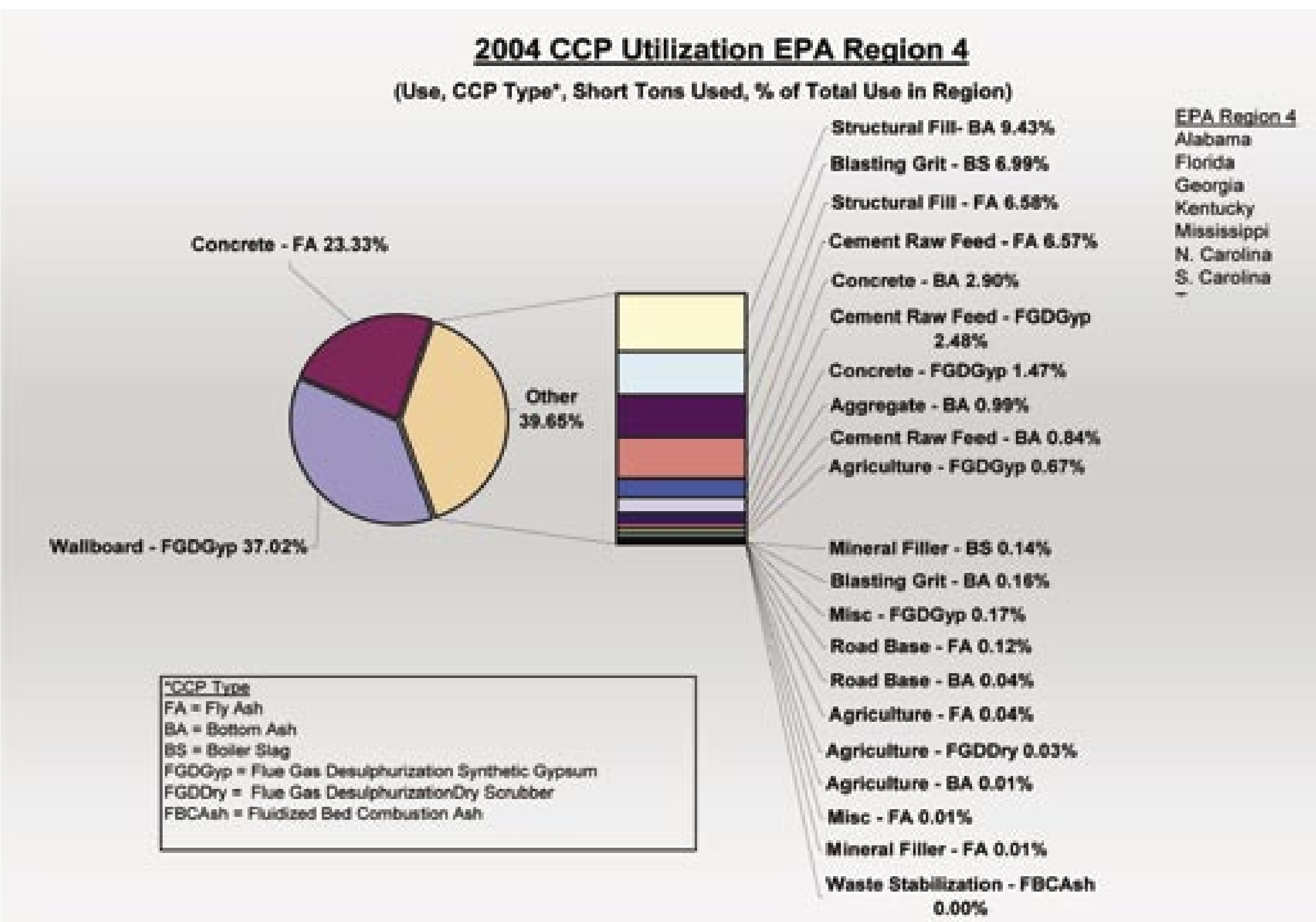


Chart 5. 2004 CCP Utilization – EPA Region 4

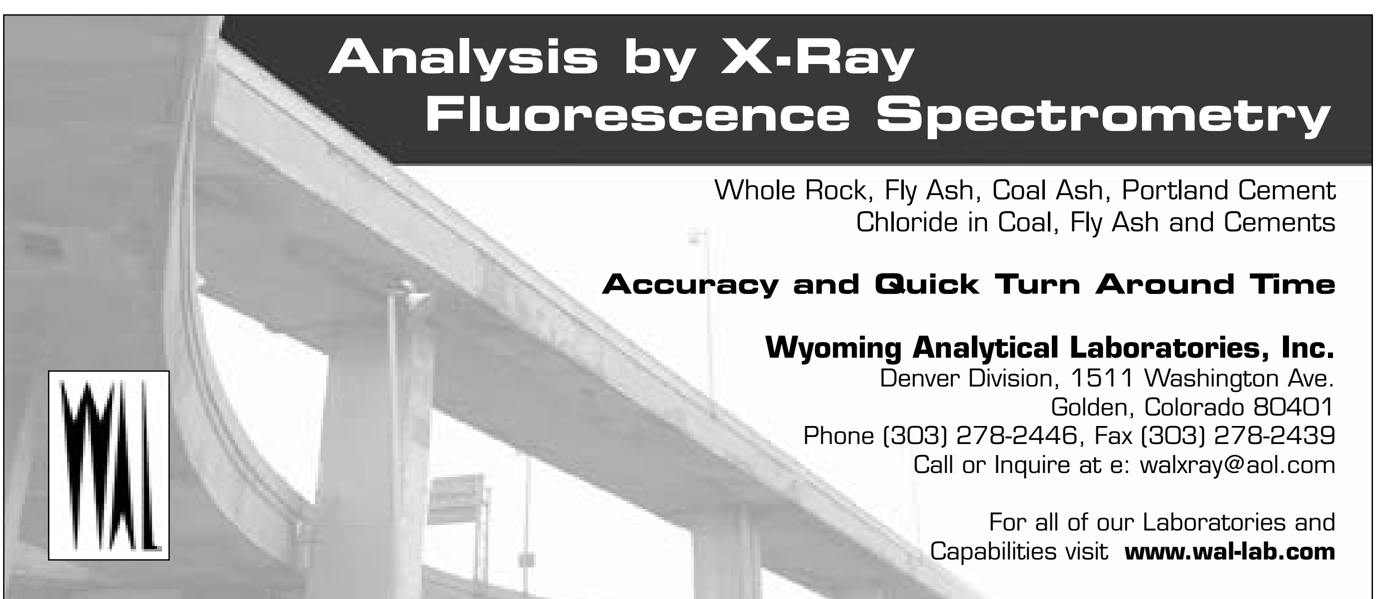
VIEWING ASH PRODUCTION AND USE FROM A REGIONAL PERSPECTIVE

Micro-Charting Survey Results by EPA Region

CCP data broken down by regional areas of the U.S. reflects the impact of the type and source of coal burned, market demand for CCP applications, state and local environmental regulation, and emission control systems employed. ACAA, beginning with 2004 survey data, began to graphically chart CCP production and utilization by U.S. Environmental Protection Agency geographical regions (Map 1). Regionalized charts are available to ACAA members on the ACAA Web site designated under CCP Surveys. Charts for prior survey years are anticipated in the near future. ❑

**Reported results are industry-wide extrapolations based on data from 60 U.S. electric utilities representative of nearly 500 coal-fired utility power plants. CCP "production" figures can vary from year to year based on the amount of coal burned, the resultant ash content and the number of flue gas emission systems in use. ACAA's survey is based on voluntary responses which can also affect production and use data.*

***"Cenospheres sold" are given as reported by submitting utilities, without extrapolation.*



THE INDUSTRIAL RESOURCES COUNCIL – A NEW MARKETING OPPORTUNITY

By David Goss, Executive Director, ACAA

For many years, the ash industry has worked hard to promote coal ash materials as products. Coal combustion "products" have replaced coal combustion "by-products" (CCBs) and coal ash "wastes" as legitimate materials for consumption in the marketplace. Within the ash and utility industries, the logic of this terminology is well understood. However, to the public and many state and federal agencies, CCPs remain the "byproduct" of the combustion of coal to generate electricity. To some of these same persons CCPs are materials that can be recycled, instead of disposed. One takes aluminum cans or newspapers to a recycling center to convert them into other useful products. It is simple for people to associate recycling with the positive aspects of taking something out of the waste stream and placing it back into the marketplace. Many states have recycling coordinators or departments within state and municipal governments whose jobs rely on recycling materials that would otherwise be disposed.

It has been said that the coal ash industry is a great recycling success story. More than 40 million tons of CCPs are used every year instead of disposed. But this story is not well-known outside the utility industry. Many state and federal agencies are unaware of the many uses for fly ash, bottom ash, FGD gypsum, boiler slag, and similar products. Our industry is not alone in wanting to promote the broader use of materials that are produced as byproducts of other processes. In fact, many of the issues that serve as barriers to increased CCP use can be found in the foundry sands industry, wood and paper products industry, the iron and steel slag industry, with scrap tires, and with recycled concrete and asphalt.

It was because of the similarities of the issues that ACAA began discussions with several industry associations, including FIRST (Foundry Industry Recycling Starts Today), NCASI (the National Council for Air and Stream Improvement which represents the wood and paper products industry), RMA (Rubber Manufacturers Association), and NSA (National Slag Association). All of these organizations are industry groups that see the beneficial use of their materials as sound environmental, economic, and technical alternatives to the use of other materials. It was natural, that the common interests gave rise to the idea of forming a partnership to address similar opportunities and barriers. Following a brainstorming session hosted by EPA Region 5 in Chicago in July 2005, the directors of these associations agreed to form the "Industrial Resources Council." The IRC is envisioned as a clearing house for information pertaining to the beneficial use of coal ash, foundry sands, wood and paper industry byproducts, slag for the iron and steel industry, and scrap tires. Working with the EPA and the Federal Highway Administration (FHWA), the IRC has been received positively as a consolidated voice for multiple industries attempting to achieve similar goals.

Both the EPA and FHWA recognize many of the materials produced by these industries to be legitimate and useful products that can help conserve natural resources, reduce the need for disposal space, and provide technical and economic advantages over other materials. Literature, training, and outreach activities supported by both agencies reinforce the synergy between these industries. The EPA has, under the Resource Conservation Challenge, developed an action plan with National Priority Areas. These NPAs include the beneficial use of secondary materials, of which CCPs, foundry sand, and construction and demolition debris represent major components. The success of the Coal Combustion Products Partnership (C^2P^2) has demonstrated how public/private partnerships can broaden understanding and work to identify actual or perceived barriers to beneficial use. Other industries would like their own C^2P^2 programs, but the EPA is limited in its resources to do that. Therefore, the formation of the Industrial Resources Council helps leverage federal support in the same way it does industry support. For many years, the FHWA has provided technical and environmental information supporting the use of industrial materials through the Recycled Materials Resource Center. ACAA and the other industries have supported RMRC activities with information, publications, and in-kind efforts.

Industry involvement in the Green Highways Initiative, C^2P^2, Beneficial Use Summits, and EPA national and regional efforts make it clear there are many opportunities for the IRC to help further promote beneficial use. The IRC can serve as initial source of information pertaining to industrial recycling and help coordinate the expertise of private industry to respond to governmental needs. The council is negotiating with the National Recycling Coalition (www.nrc-recycle.org/default.htm) to place this industrial focus under the larger umbrella of NRC's activities related to post-consumer waste. NRC members include 20 state agencies as well as many other private sector and local government entities. ACAA's work with the IRC should help create opportunities for new markets and uses of coal ash across the U.S. ❑

FIELD DEMONSTRATION OF COAL COMBUSTION BY-PRODUCTS BASED ROAD SUB-BASE IN ILLINOIS

By Chugh Y.P.[1], Mohanty S.[1] and Bryant M.[2]

Most of the coal combustion by-products (CCBs) generated by Illinois coal burning power plants are managed in on-site impoundments. In some cases, these materials may require removal and disposal in solid state landfills or other management units at substantial costs. This traditional CCB management approach represents a negative cash flow for the power plant and places an additional cost on the use of Illinois coal. Development of new on-site management units according to current or proposed regulatory requirements is becoming more and more expensive. Therefore, development and demonstration of large-volume beneficial use applications for ponded fly ash are considered very important as a cost reduction strategy for the generation industry and value enhancement for the coal mining industry. One such application described below is the road sub-base for the Industry Access Truck Route in Meredosia, Illinois, which used approximately 77,000 cubic yards of compacted high loss-on-ignition (LOI), Class-F ponded fly ash. The Truck Route (Figure 1) is a 24-feet wide road built on a 0 to 7 feet thick compacted fly ash sub-base. Illinois Department of Transportation estimated that the use of fly ash in this project saved more than $100,000 to the State of Illinois. Furthermore, natural resources in the form of relatively fertile soil were preserved by substituting fly ash for the available borrow in the area; quality agricultural topsoil is limited in the area.

Figure 1. Industry Access Truck Route, Meredosia, Illinois

Pre-construction geotechnical characterization of the foundation soil, and the ponded fly ash were performed through standard ASTM and AASHTO laboratory and in-situ procedures. Laboratory analyses indicated that the fly ash to be a uniformly graded soil with mean particle size of 0.08 mm. The plastic limit and liquid limit of the fly ash were 26.6 and 34 percent, respectively. The fly ash was classified as A-4 (i.e. silty soil) soil based on the AASHTO soil classification system. Standard Proctor test and modified compaction tests indicated the optimum moisture content to be 20.4 and 19 percent, respectively. California Bearing Ratio values for the ash were higher than the minimum value required of a typical sub-base material (i.e. 3 percent). In-situ Immediate Bearing Value (IBV) tests on the fly ash yielded average IBV value of 31 percent, higher than the State's requirement of 6-8 percent. Overall, the results indicated the fly ash to be suitable for use as a sub-base. ASTM shake leachate studies were performed on the fly ash to assess the water pollution potential. Six monitoring wells were installed in the vicinity of the project area to monitor post-construction impacts on ground water. Multiple groundwater quality samples were collected prior to the construction of the road and the analyses data were used as the baseline data for all future water quality analyses. Based on the projected traffic loading, geotechnical, and geo-environmental studies (Chugh et al, 2003; Mohanty, 2003) the pavement cross-sections were developed.

Graded and compacted subgrade native soil, 6-in thick aggregate base course (Type B), 6-in thick bituminous concrete binder course (Superpave, IL-19.0, N50), 2-in thick bituminous concrete surface course (Superpave, Mix "C", N50), 6-in thick aggregate shoulders (Type B) were the structural layers used in the road construction. The fly ash layer thickness varied from 0-7 feet. Finally, 2 feet of native soil cover was used over the fly ash side slopes. Moisture content of compacted fly ash was kept below 105% of the dry optimum moisture content (18-21 percent) and compaction density was 95 pcf during construction. Two lysimeters were installed in the sub-base for leachate collection. The construction work began in June 2002, was completed by September 2002, and the road was opened to traffic in October 2002.

Four Falling Weight Deflectometer (FWD) studies have been performed on the road, over three years since project completion, as part of post-construction structural performance assessment. The most recent FWD survey yielded an average back-calculated subgrade modulus value of 16,400 psi for the entire road, which is very satisfactory for fine-grained soils such as this fly ash. The most recent FWD survey results indicate fairly uniform effective structural number values over the entire project, ranging from 3 to 5.2 in, with mean value of 3.9 in. Both the back-calculated subgrade moduli and effective structural numbers for the project have increased over past two years, pointing towards stabilization in its structural performance. No performance related issues have been reported over the last three years.

Over the last three years, water quality analyses from the monitoring wells have conformed to the Illinois EPA Class I and Class II water quality standards. Furthermore, the recorded trace element levels have been decreasing during this period. Water quality data from lysimeters also show decreasing trend for the same trace elements. At this stage, there is no evidence that the ash utilization has negatively affected the groundwater. Therefore, large volume CCB applications can be successful with proper concept, design, construction and appropriate post construction monitoring. ❑

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REFERENCES:

[1] Chugh Y.P. and Mohanty S., 2004, "Construction and Assessment of High Carbon Coal Combustion Products Based Rod Sub-base", International Conference on Clean Coal Technologies in Mining Industry, Concepción, Chile

[2] Mohanty S., 2003, "Engineering and Demonstration of a Fly Ash Based Road Sub-base", MS thesis, Department of Mining and Mineral Resources Engineering, Southern Illinois University, Carbondale, IL, USA, pp 76

ACAA FLY ASH BASICS
QUICK REFERENCE CARD

Coal Fly Ash

Fly ash is a fine, powdery material created when coal is burned to generate electricity. Before escaping into the environment via the utility stacks, the ash is collected and may be stored for beneficial use or disposed of, if necessary. The use of fly ash provides environmental benefits, such as the conservation of natural resources, the reduction of green house gas emissions and eliminating the need for ash disposal in landfills. It is also a valuable mineral resource that is used in construction and manufacturing. Fly ash is used in the production of portland cement, concrete, mortars and stuccos, manufactured aggregates along with various agricultural applications. As mineral filler, fly ash can be used for paints, shingles, carpet backing, plastics, metal castings and other purposes. This quick reference card is intended to provide the reader basic source, identification and composition information specifically related to fly ash.

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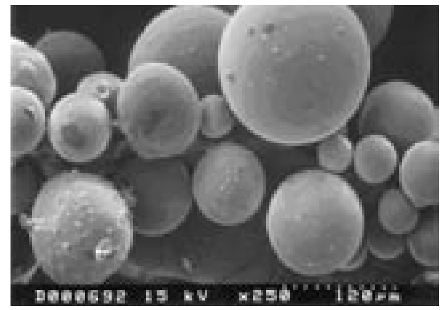
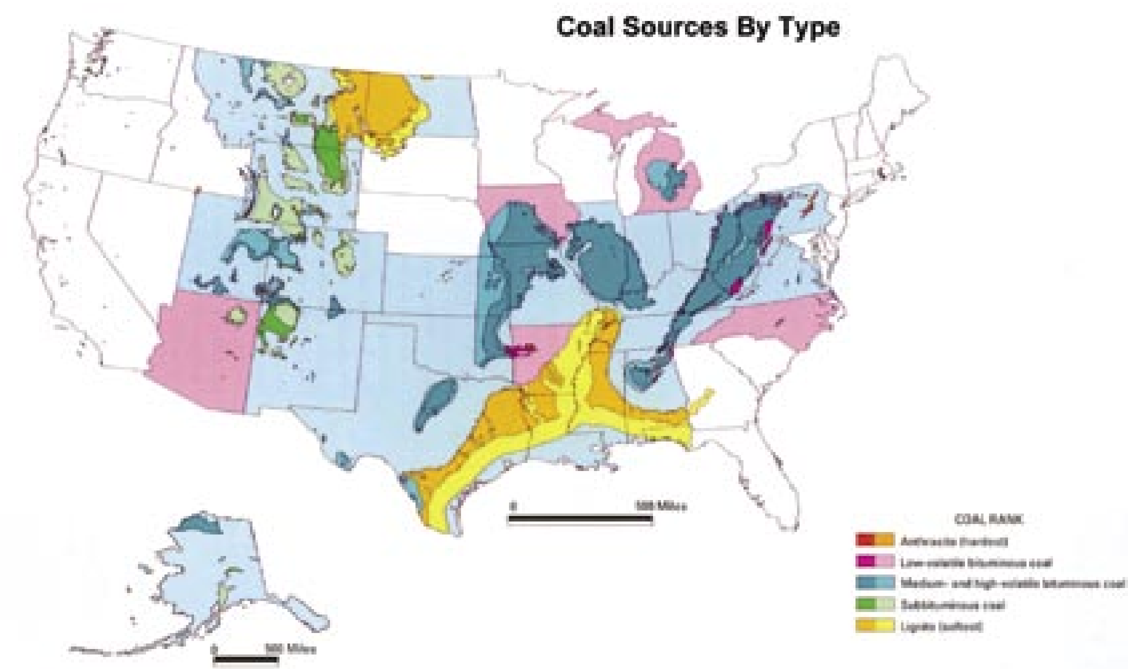
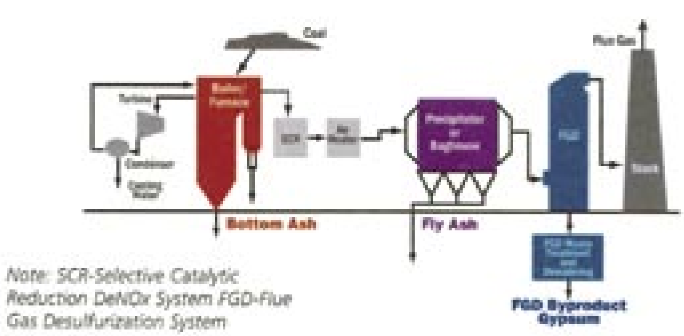


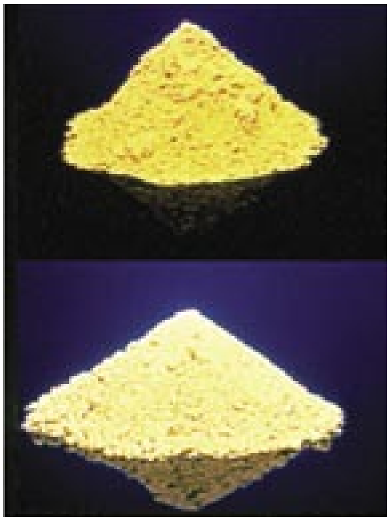
Fly Ash at 3000X
(Typical size 10 to 100 microns)



Typical Steam Generating System



Factors Impacting Coal Ash Generation Characteristics
Coal Composition (Type of Coal)
Grinding Mill Efficiency (Consistency of coal source and fineness)
Combustion Environment (Temperature and oxygen supply)
Boiler Configuration
Rate of Particle Cooling



Chemical Elements in Coal Ash (Bulk chemistry by mass)

Major (25 - 1%)	Intermediate (1% - 10 ppm)	Minor (50 - 5 ppm)	Trace (10ppm - BDL)	Typically Minor (100 - 1ppm)
Silicon	Barium	Silver	Mercury	Cesium
Aluminum	Strontium	Arsenic	Chloride	Rubidium
Iron	Manganese	Cadmium	Fluoride	Germanium
Calcium	Boron	Chromium	Selenium	Tin
Magnesium	Molybdenum	Copper	Beryllium	Colbalt
Sodium	Vanadium	Nickel	Antimony	Gold
Potassium	Sulfur	Lead	Uranium	Platinium
Titanium	Phosphorus	Zinc	Thorium	
Carbon				

Common Applications for Fly Ash

- Concrete
- Structural fills
- Cement/Raw feed for cement klinker
- Road Base/Sub-base/Pavement
- Snow and ice control
- Aggregate
- Flowable fill
- Mineral filler in asphalt
- Waste stabilization
- Mining applications
- Soil modification/Stabilization

Normal Ranges of Chemical Composition for Fly Ash By Coal Type

Compounds	Bituminous Coal	Sub-Bituminous Coal	Lignite Coal
SiO_2	20-60%	40-60%	15-45%
Al_2O_3	5-35%	20-30%	10-25%
Fe_2O_3	10-40%	4-10%	4-15%
CaO	1-12%	5-30%	15-40%
MgO	0-5%	1-6%	3-10%
SO_3	0-4%	0-2%	0-10%
Na_2O	0-4%	0-2%	0-6%
K_2O	0-3%	0-4%	0-4%
Unburned Carbon (LOI)	0-15%	0-3%	0-5%

Sample Oxide Analysis By Type of Fly Ash

Compounds	Class F	Class C
SiO_2	55%	40%
Al_2O_3	26%	17%
Fe_2O_3	7%	6%
CaO (Lime)	9%	24%
MgO	2%	5%
SO_3	1%	3%

Comparative Factors Between Class F and Class C Fly Ashes

Subject	Class F	Class C
Coal Sources	Anthracite & Bituminous	Lignite & Sub-Bituminous
Sum of Oxides (SiO_2 + Al_2O_3 + Fe_2O_3)	At least 70%	At Least 50%
CaO content	Generally <8%	Generally >10 to 35%
Self-Cementing?	No	Yes
Particle Size	Coarser	Finer
% Loss on Ignition(Carbon)	Higher (1-20%)	Lower (<1%)
Cenosphere Content	Greater	Lesser

On-Line Coal Ash Information Resources:

American Coal Ash Association (ACAA)
www.ACAA-USA.org

Univ. of Kentucky, Center for Applied Energy Research (CAER)
www.flyash.info

Univ. of N. Dakota, Energy and Environmental Research Center (EERC)
www.undeerc.org/carrc

University of Wisconsin-Milwaukee - CBU
www.uwm.edu/dept/CBU

United States Geological Survey
www.usgs.gov

Association of Canadian Industries Recycling Coal Ash (CIRCA)
www.circainfo.ca

American Coal Council
www.americancoalcouncil.org

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