

ISSUE 1 • 2010

ASH at work

Applications, Science and Sustainability of Coal Ash

EPA'S COAL ASH RULE PROPOSALS

GOOD SCIENCE VS. POLITICAL SCIENCE

WINTER OLYMPICS GO FOR GREEN

FLY ASH CONCRETE SUSTAINABILITY

SYNTHETIC GYPSUM

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Applications, Science and Sustainability of Coal Ash

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On the Cover

A proposal from the Environmental Protection Agency has caught the attention of everyone who works with coal ash. The U.S. EPA headquarters in Washington, D.C. is pictured on the cover. ACAA Executive Director Thomas H. Adams and ACAA Chair Mark Bryant comment on this important development in their messages on pages 3 and 4.

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NOT A RULE, JUST A PROPOSAL

By Thomas H. Adams, Executive Director ACAA

Before getting to the EPA proposal, let me take a moment to say it certainly was nice to see such a strong attendance at our recent meeting in Nashville. Obviously, the focus of the interest of most attendees concerned the EPA rule on coal combustion product disposal. But there was a lot of other activity that made the meeting an important event. Thank you for your interest and participation.

We now have the proposal for the regulation of coal combustion products (CCP). Included is a proposal for regulating disposal under Subtitle C of the Resource Conservation and Recovery Act of 1976 (RCRA) and two proposals for regulation under Subtitle D. Even though the EPA is calling CCP a “Special Waste” under their Subtitle C proposal, the fact remains that Subtitle C is intended for hazardous wastes no matter how the agency tries to characterize it otherwise. Subtitle D covers non-hazardous wastes, such as municipal solid waste, and is the solution to truly protecting beneficial use of CCP. Many questions have revolved around the agency’s decision to release a proposal that seeks considerable input rather than a detailed framework for a final rule.

The agency speaks clearly that encapsulated beneficial uses need to continue to grow for a variety of societal benefits. However, unencapsulated uses, such as geotechnical fills and agricultural use of FGD gypsum are suspect in EPA’s eyes. It is odd that one of the projects cited as a damage case is the Battlefield Golf Course in Chesapeake, Va. Recently, the EPA’s Region 3 office issued a report showing no effects on the groundwater from the use of CCP at that location. It seems that

“Over the coming months it will be critical for ACAA members, their customers and colleagues to participate in the public comment period.”

if we find no damage we just need to study the project more closely. Could it be that there is no damage because the project was engineered and built properly?

The EPA dismisses the concept of a stigma resulting from a Subtitle C rule affecting the encapsulated beneficial uses. According to the proposal, markets will differentiate between EPA-approved beneficial uses and CCP destined for disposal as a hazardous waste. Liability concerns are not justified. Trust us, they say.

Justification for proposing hazardous waste rules comes from concern resulting from CCP spills and groundwater contamination constituting a list of “damage cases.” Since CCPs do not fail the characteristic test criteria under Subtitle C, the only means to declare them to be hazardous is to call them a “special waste.” In this case the agency asserts that when concentrated in large quantities these materials present significantly elevated levels of elements known to be dangerous to human health and the environment. Therefore disposal sites that contain large quantities of CCPs must be deemed to be hazardous. Never mind the 1993 and 2000 determinations to the contrary.

Also, as power plants add more process control equipment, the CCP generated have higher levels of dangerous elements. No data exist to prove this assertion, mind

you, but it must be happening, right?

Another piece of odd logic is the theory that onerous disposal rules and dramatically increased disposal expense will drive more recycling. I have a very hard time understanding how beneficial use will increase as a result of demonizing CCP when sent to disposal.

Over the coming months it will be critical for ACAA members, their customers, and colleagues to participate in the public comment period. Letters are vital to making clear to the agency how important it is to make a Subtitle D rule. Hearings may also be held. Each and every stakeholder’s voice needs to be heard. Letters submitted prior to publication of the rule have been important. It is time to write again and comment on the aspects of the proposal that are helpful to beneficial use and those aspects that endanger continued recycling. Our meetings in Baltimore will be dedicated to discussing the proposal and potential responses.

There is a long way to go before the regulation of CCP disposal will be decided. We will need your continued attention and response. The battle is dynamic, changing almost daily. More surprises and even a lawsuit or two are on the horizon. The one thing I can promise you is that the ACAA will continue to work diligently until the battle is won. ♦



GOOD SCIENCE VS. POLITICAL SCIENCE AND LOOKING IN THE REARVIEW MIRROR

Mark Bryant, Chairman ACAA, Ameren Energy Fuels & Services

The U.S. EPA has finally released the long debated and nervously awaited draft regulatory approaches for the management and disposal of Coal Combustion Residues (CCB), and now we can ask: “Are we having an effect?”

I am sure by now that everyone reading this issue of *Ash at Work* has read the proposed language – 560 pages of page ripping suspense. Just kidding! But it is important that all stakeholders know what it says and understand the details.

We recently shared, while in Nashville, our best guess at the multipronged menu EPA was considering and frankly, we weren’t far off. It seems we have a politically correct proposal that includes both a Subtitle C (Special Waste) option and a Subtitle D non-hazardous option, one each for the “parties” to focus on. Now supporters for both sides of the debate have a victory, goal and a purpose to keep their bases motivated. While our industry, the utilities and most stakeholders have embraced the RCRA Subtitle D options, the EPA and anti-coal environmental activist groups strongly prefer a Subtitle C option that raises the cost and complexity of ash handling and management even higher.

Why are the same regulations and methods that are adequate for all the municipal solid waste in the U.S. insufficient for CCBs that aren’t recycled or reused? The science tells us that the material can’t qualify as a hazardous waste by any standard equally applied to other wastes. Heck, the technical difference between a RCRA C landfill and a RCRA D landfill is pretty small, but the disproportion in costs comes from the increased permitting, handling, transportation and record keeping.

While it would have been great if EPA would lead with a strong non-hazardous option, by EPA not leading with a strong hazardous option, I believe we have had a positive impact and that we are representing ourselves and our industry very well. Also, while EPA states that they have not been persuaded to agree about the potential damage that a hazardous stigma will inflict on our beneficial use and recycling markets, they have offered a concession of sorts, with the “Special Waste” category. Should EPA be expected to have significant expertise in these markets? Is EPA willing to gamble on a very suc-

prohibitive and ultimately more attractive. The quicker they raise the price, the quicker we as a nation move to substantial efforts in “green” energy.

I strongly support clean and green energy, but I really dislike artificial incentives. We need to keep this discussion honest and based on the facts and science. Artificial market forces will only raise the cost of energy for all and that is unnecessary.

We all felt that a signal of the result of our efforts would lay in the fact that EPA would not favor one option over another;

“Have I done all I could to try to convince my representatives or regulators how good science and not political science should carry the day in this debate?”

cessful green story when the very people involved in that business are advocating caution? For all the technical reasons, the Subtitle D approach is the right answer.

Remember that this is but one battle in the war on coal. The higher goal of those in favor of a hazardous option is to impose more costs on coal fueled generation. The renewable options for electricity generation are more expensive by a stretch. Environmental activists claim that coal has received a free pass for decades and the price of coal fueled energy is artificially low. Their plan, it seems, is that continued imposition of regulations and carbon capture and sequestration will raise the price of coal based power so that eventually the cost will approach the price of renewable energy, making it less cost

we got that. But another strong signal was delivered in that EPA has released not only the draft rule that was a result of the Office of Management and Budget review, but also the “original” language that was initially delivered to OMB many months before and for extra measure in a “redline” version showing all the changes. This seems very curious. I am familiar with the rulemaking process but far from an expert; this move seems politically motivated and somewhat unusual. Environmental activists have claimed that the OMB process has been heavily influenced by industry representatives and their influence or “lobbying” when in fact quite the opposite is true. Records show there have been more and more frequent meetings between the environmental groups and EPA and OMB than



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with industry groups. Again, we need to keep it honest, we can't just say anything that serves our purposes.

So how do we proceed from here? After an outstanding attendance at Nashville and a well received call for volunteers and support, we are entering the "Long Pull" phase of this journey. Strategies will be hatched, teams and task groups formed. Comments will be prepared on the rule-making and submitted for the record. A new batch of letters will be needed, again. But as we continue our drive forward, here is my challenge to each and every member of this industry; When you get into your car every evening, look into that familiar face in the rearview mirror and ask: "Have I done all I could to try to convince my representatives or regulators how good science and not political science should carry the day in this debate?"

We have a product that competes in a competitive marketplace with other natural and recycled products. We **must** convince Washington and the regulators that commercial markets rarely respond to nuances in words. The markets will respond. Not all markets will respond the same way. While our elected officials and federal regulators are very comfortable regulating waste streams, they are not adept at promoting beneficial use of coal combustion products in commercial and competitive markets. The wrong regulatory signal will not be taken lightly by the markets we sell in to or our members relying on our industry for your jobs. I am sure you will all agree that those who favor hazardous waste regulations for coal combustion products are as passionate as we are, lest we forget that for them this

may be a war over "dirty coal" with the regulation of CCPs just the next step.

Never forget that we are working with a good resource that has been recognized domestically and internationally for its role in CO₂ reduction, as well as its many uses that benefit society. This resource is also the basis for our livelihood. The next step will be to press our case before our elected officials and regulators and let them know that words have meaning and that under RCRA when all else is about equal, the letter D is much better than the letter C! Our beneficial use and recycling is the good story!

Our next objective will be to prepare strong, meaningful, well-conceived comments to submit during the draft rule-making process. To accomplish this goal we will be looking for engaged professionals to join teams and make big work small. We have already seen the benefits of this process when we asked for and assembled two strong task teams to tackle a review of legislative language. Our Geotechnical and FGD in Agricultural task teams could not have performed better.

This really is an unprecedented period in the history of our association. These teams will be called upon again to prepare comments on the draft rule, but there will be many other areas that need the time, talents and treasures of our members. As one OMB staff person was overheard to say, the response in support of recycling and beneficial use and Subtitle D has been unprecedented. Now we need to do it again, only better.

Our association is also showing considerable strength in the face of a challenging

economy, our membership numbers are holding, our finances are strong, our renewals are timely and our coalitions and industry partners are effective by our side. As an industry association we are doing very well compared to our peer groups. To our members who have had to step aside because of the economy, we understand, but as circumstances improve please come back; our association is only as strong as our members and we need you all.

After much discussion and careful consideration we were able to unanimously pass a resolution presenting our position regarding EPA's attempt to regulate CCPs nationally. Tom Adams was able to deliver this resolution to EPA management. On its surface this would seem to be a fairly straightforward task, but since we have never done this before we had to feel our way, which led to some very good discussion. Because we are so diverse a group, drafting resolutions or comments will never be easy, nor should it. When we publicly document our position as an association it should mean something, and it does. Thanks to all who expressed their opinion about the process and content. We heard you and hope to hear more from you as you get more and more involved!

Finally...

As a recently re-elected officer, I want to say thanks for showing the confidence in the effort we are marshalling during this VERY active time in the history of our association. It is a privilege to work with such a fine group of people who are as passionate as I am about our industry. Thanks to our officers Charles and Lisa, the committee chairs Mike, Jenny, John and Fred for agreeing to serve, and to Mike Thomes for your service. Thanks also to Tom and the staff (Annely, Melissa, Dave and Harry) for the energy to keep us going. And to all the members and companies that have taken the time to visit EPA or OMB in Washington to press our case, solicit letters of support for our position or just make some noise. Nicely done!

Don't forget to check that face in the mirror as we drive forward.

See you all in Baltimore! ♦

NEW BRICKS, NEW MARKETS FOR FLY ASH

CalStar Products opens a new plant and seizes a “perfect storm” of opportunity

By David C. Goss, Former Executive Director ACAA, Consultant

After five years of product development and planning CalStar Products opened its first manufacturing plant earlier this year recycling coal fly ash into bricks and pavers. The original technology, developed by the late Henry Liu, Ph.D., meets official standards for strength set by ASTM International with 85 percent fly ash content.

Clay bricks require kilning. CalStar's bricks do not. Therefore, the energy saved is about 85 percent per brick, thus reducing carbon dioxide emissions 85 percent. The products “Come in eight colors. All of them green,” touts CalStar's website. Because the bricks are made with a high percentage of a recycled material they qualify for points toward certification by the Leadership in Energy and Environmental Design (LEED) program of the U.S. Green Building Council.

The company partnered with We Energies and state agencies to develop the manufacturing plant on a former brownfield site in Caledonia, Wis. Fly ash is transported by pneumatic truck from the utility's Oak Creek Power Plant in Milwaukee.

For now, CalStar's marketing is focused in the Upper Great Lakes region, though



CalStar's fly ash bricks. Photo: calstarproducts.com

demand is rising nationwide. Among their first customers was a developer in Tallahassee, Fla., constructing two buildings with fly ash bricks. CalStar has assembled a network of 29 brick dealers across the U.S. and anticipates opening six more manufacturing plants over the next five years.

The company's chief executive, Tom Pounds, stated CalStar is well aligned to take advantage of a “perfect storm” of opportunity in green building markets. In February, the company secured a \$15 million equity investment. “CalStar has all the elements we look for in a growth company,” said one investor. “They have an experienced leadership team, a long-term competitive advantage, great channel partners, and a solid pipeline of projects for 2010 and 2011.” ♦

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PROGRAM PAYS CONCRETE FIRMS FOR USING COAL ASH TO REDUCE GREENHOUSE GAS EMISSIONS

By Lura Schmoyer and Miranda Intrator, West Main Consultants

A program sponsored by The Climate Trust, an Oregon non-profit, is paying participants to use supplementary cementitious materials, such as coal fly ash, to replace traditional cement in concrete. The Cool Climate Concrete (C³) program's first phase in 2004 paid \$125,000 to participants for verifying 250,000 metric tons of avoided carbon dioxide emissions from their reductions in portland cement use. The Climate Trust has since committed an additional \$1.25 million in offset funds to West Main Consultants, a sustainable materials consulting firm, to manage a second phase. Under the second phase, an additional 200,000 metric tons of avoided CO₂ emissions will be verified, and up to \$800,000 is available in incentive payments for participants.

Companies eligible to participate are ready mixed concrete manufacturers and concrete products manufacturers that purchase portland cement and SCMs from suppliers and blend their own cement during concrete production. Under the program, when a company reduces portland cement use in concrete production beyond their established baselines by substituting SCMs, CO₂ emissions are avoided and offsets are generated. This strategy for reducing GHG emissions emerged because the majority of emissions related to concrete are from the production of portland cement; for every metric ton of portland cement produced nearly one metric ton of CO₂ is produced.

Eligible SCMs under the program include: ASTM C618 Fly Ash, ASTM C989 Grade 100 or 120 Ground Granulated Blast Furnace Slag (GGBFS), ASTM C1240 Silica Fume, Rice Hull Ash and Cement Kiln

Dust. These five SCMs qualify for use in the C³ program because they are byproducts of other processes and are therefore not associated with an increase in GHG emissions (except in the case of GGBFS, where associated emissions are accounted for under the program).

Offsets are verified through the program by establishing quarterly baseline cement to concrete ratios for a producer using three years of historical data of cement usage and concrete manufactured. Similar data is then collected at the end of each calendar quarter of participation to determine current cement to concrete ratios. Emissions avoided and offsets generated are directly related to the decrease of current cement to concrete ratios below a company's established baselines. The resulting offsets are purchased by The Climate Trust in exchange for incentive payments of \$4 per metric ton of avoided CO₂ emissions (one offset) paid to participants. Companies participating in C³ must continually reduce portland cement usage in order to continue generating offsets because baselines are updated annually.

As an example, consider a manufacturer with baseline cement to concrete ratio for calendar quarter 1 of 14.79 percent. At the close of the first quarter of this year, the manufacturer produced 27,000 cubic yards of concrete using 6,048 tons of portland cement. This manufacturer's current cement to concrete ratio is 11.2 percent $[(6,048 \text{ tons} \times 2,000 \text{ lbs/ton}) / (27,000 \text{ cy} \times 4,000 \text{ lbs/cy})]$. This decrease of the current ratio below the baseline results in avoided emissions of 1,425 metric tons, yielding an incentive payment of \$5,700.

As part of the program, a producer's baseline data is analyzed to determine

potential offsets that could be verified under the program at various portland cement reduction levels, and the offset payments at each level. Companies may also explore their own portland cement reduction scenarios using the offset calculator tool, which estimates potential offsets and incentive payments based on user inputs. As companies strive to become more sustainable, this tool may prove useful in establishing sustainability goals.

Additionally, quarterly monitoring reports for each company participating in the program document actual portland cement reductions and CO₂ emissions avoided. These performance-based reports are third-party verified, and can track progress towards corporate sustainability goals and provide quantifiable milestones for companies trying to reduce their carbon footprint.

By capitalizing on the innovative use of green materials through the C³ program, participating producers can help further not only the economic sustainability goals of the concrete industry through mix ingredient optimization and program incentives, but the environmental sustainability goals of the concrete industry through the use of industrial byproducts as a portland cement replacement strategy. As each participant reduces their production costs and carbon footprint, the entire concrete industry may benefit in a similar manner.

For more information, visit www.coolclimateconcrete.com or contact Lura Schmoyer at schmoyer@wm-consultants.com or 610-683-5730. ♦

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CCP BENEFICIAL USE SHOWS STEADY GROWTH

By David C. Goss, Former Executive
Director ACAA, Consultant

The results of ACAA's CCP Production and Use Survey for 2008 reflected a modest industry-wide increase in the beneficial application of coal combustion products. The increase was somewhat surprising given the negative aspects that the downturn of the economy has had on the construction sector. The increase was largely attributable to an increase in the total tonnage of CCP used in mine reclamation activities in Pennsylvania by members of ARIPPA. The total tons of CCPs reported this year were nearly five million tons greater than reported in 2007, of which approximately 3.5 million were used in mine reclamation.

Unfortunately, there was an industry-wide decline in the use of fly ash in concrete products of more than 1.1 million tons. This decline is expected to be even greater when the 2009 numbers are released later this year. The cement industry has experienced widespread reductions in cement powder production resulting in shutdowns of kilns and related staff changes. These actions will likewise affect the CCP industry as less fly ash is likely to be seen used in 2009. The numbers for 2008 indicate that other trends are likely to be more significant in 2009. The use of FGD gypsum in wallboard and panel products increased by roughly 300,000 tons. But the total tonnage of FGD gypsum increased by 5 million tons. Reflecting volumes from new scrubbers coming on line in 2008, FGD gypsum production will continue

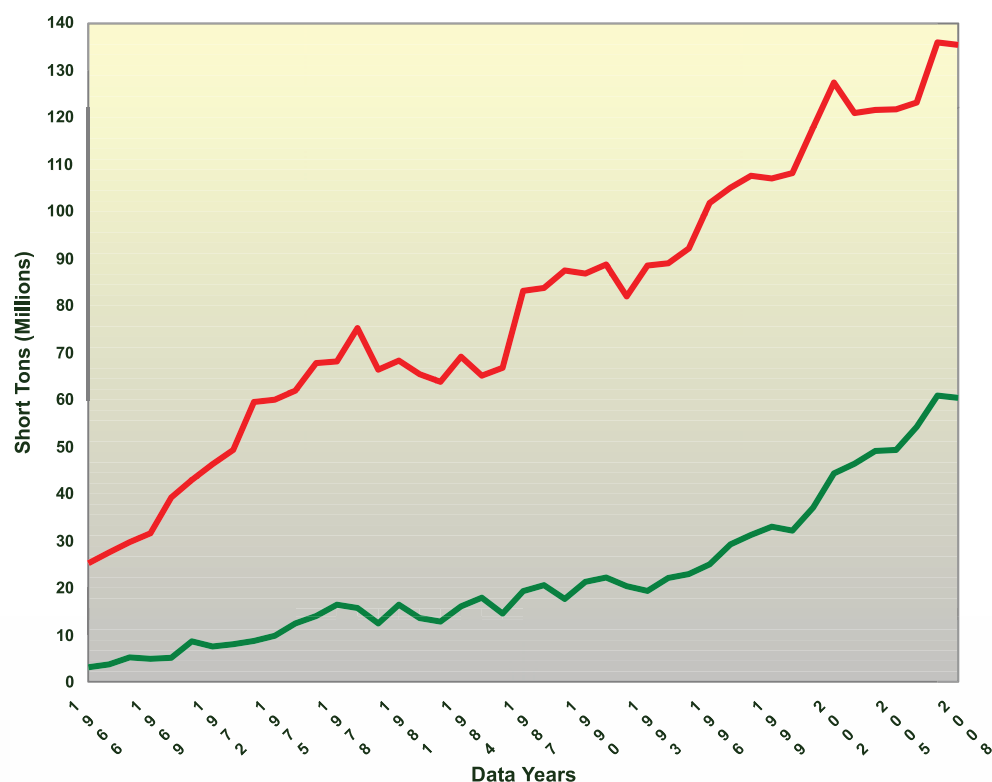


Chart 1
CCP Production & Use (1966–2008)

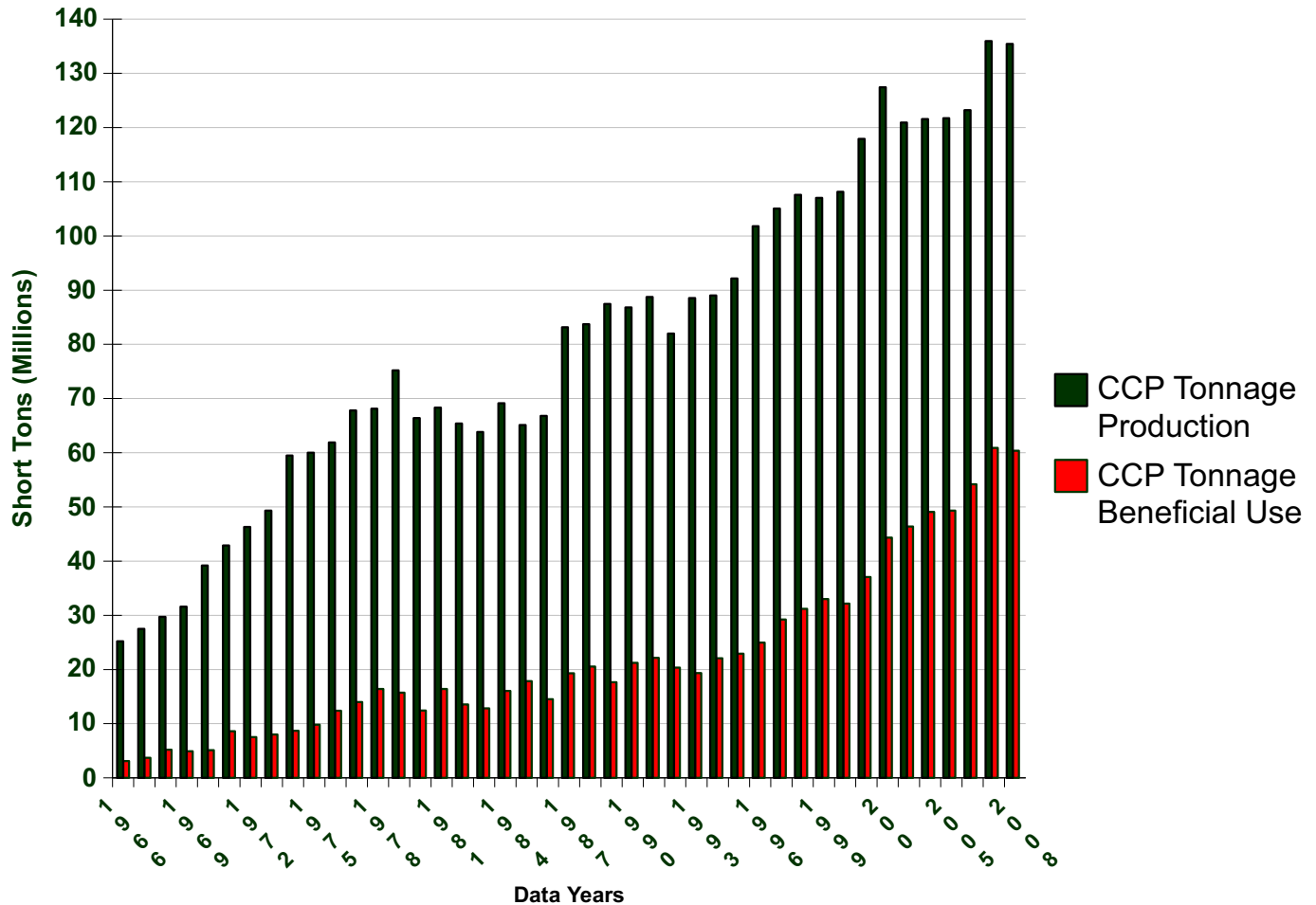
— CCP Tonnage Production — CCP Tonnage Beneficial Use

to increase. However, it is again anticipated that the manufactured wallboard and panel products will continue to decline until the housing markets return to pre-2007 levels. The following summaries address the main production and uses for various categories tracked by the ACAA survey.

PROJECTED CCP BENEFICIAL USE GOAL

In 2003, the industry, working with the U.S. EPA and U.S. DOE established a goal of 50 percent utilization of all CCPs by the year 2011. In 2008 that goal was reduced to 45 percent utilization as compared to 31 percent utilization in 2001.

Chart 2
Percent Production v. Use



This reduction acknowledges both the impact of the economic recession and the larger volumes of CCPs that are expected to be generated by new air emission control systems. Chart 1 reflects the utilization trends from 1966 to 2008.

At first glance the 2008 data would seem to indicate that the 45 percent goal may be achieved as anticipated. However, with the potential for regulatory changes that may affect the handling and disposal of CCPs, one can only speculate the impact any new regulations might have. The EPA has indicated that the use of CCPs in mine reclamation activities may no longer be counted under beneficial use applications for the purposes of the 2011 goal. Removing the tonnages for this category would have reduced 2008 overall utilization by several percentage points. See Chart 2.

Although the 2008 data seems to be positive, the economic impact of reduced CCP consumption that was experienced

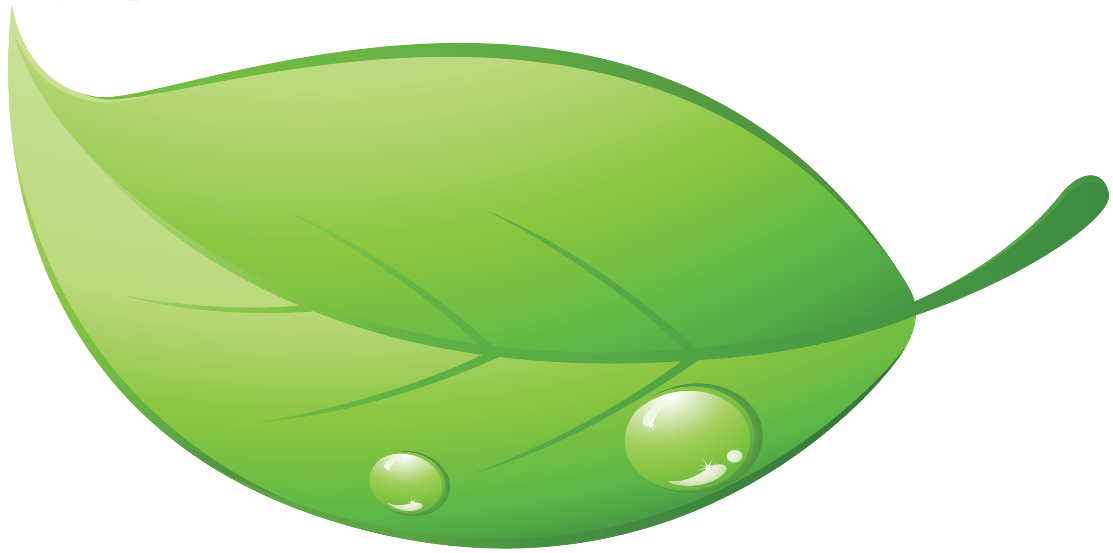
across the nation in 2009 may mean that 2008's data will represent a peak. The regulatory uncertainty is also likely to have an impact upon 2009 utilization numbers. ACAA members have reported that in many markets, the widespread media coverage of "toxic ash" or descriptions of CCPs as being hazardous in 2008 have created markets losses. The perception by end-users or the public of CCPs being something other than non-hazardous has been challenging. Producers of other materials that have competed with CCPs have emphasized that their materials are not considered hazardous by regulators or other groups. This has led to loss of some market share for CCPs. When coupled with the weak economy, the marketing of CCPs has become much more stressful.

CCP SURVEY BACKGROUND

In 1967, ACAA (then the National Ash Association) and Edison Electric Institute began tracking the quantity of CCPs being produced and distributed for use by U.S.

coal-fired, electricity generating power utilities. The purpose of the survey was and is the cumulative annual measurement of CCP production and beneficial utilization which reflects the results of industry and governmental efforts to expand the use of CCPs. Since the early years of the Survey, the scope of CCP production categories has expanded to include not only fly ash, bottom ash and boiler slag, but now includes flue gas desulfurization (FGD) gypsum (a synthetic gypsum), FGD wet and dry scrubber materials as well as fluidized bed combustion (FBC) ash. Although not included in the Survey's final consolidated statistics, extrapolated or otherwise, 'cenospheres sold' was added to the survey beginning in 2005. Reported CCP utilization categories have also expanded from an original ten to the current fifteen. Utilization categories provide a wide, informative range of products exemplifying environmental, economic and technical advantages and are the subject of many U.S. industry and government sustainability goals and objectives.

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Each year, voluntary participation in the survey comes from between 50 percent to 60 percent of U.S. coal-fired power plants. In 2008, the data represents nearly 58 percent of the coal-fueled electric generation. Additional data from the DOE's Energy Information Administration (EIA) is used to compare data provided from which to extrapolate final Survey figures. Note, reported extrapolations only apply to fly ash, bottom ash, FGD gypsum and FGD wet scrubber materials, not to boiler slag, FGD dry scrubber materials and FBC ash. EIA reports do not itemize these latter categories. These draw directly from submitted survey numbers.

NOTABLE CCP CATEGORY STATISTICAL CHANGES

Flue Gas Desulfurization (FGD)

In 2008, FGD gypsum production increased to 17,754,000 tons as compared to 12,300,000 tons in 2007. This is the beginning of production that will continue to increase as additional forced oxidation scrubbers are brought on line. Many utilities are adding these systems, in part to not only remove SO₂, but also to help address removal of other constituents.

Prior to the remanding of the Clean Air Interstate Rule (CAIR), some utilities had anticipated being able to have a co-benefit of increased mercury removal from these scrubbers. This removal will still take place, but not necessarily as part of a company's strategy to comply with CAIR or whatever regulations will replace this rule. The use of FGD in wallboard products production increased by almost 300,000 tons over 2007. FGD gypsum use-to-production percentage was only 60 percent as compared to 75 percent the year before. This reflects the large increase in overall production tonnage.

Fly Ash

Overall fly ash production increased by less than one million tons. Beneficial use decreased by 1.4 million tons in 2008 as compared to 2007. Fly ash use in concrete products dropped to 12.6 million tons in 2008. This was nearly 1,200,000 tons less than 2007. This decline largely reflects the decrease in concrete construction in the construction market. The volume of other uses for fly ash was similar to 2007. However, fly ash used in cement production declined by 500,000 tons. The fly ash use-to-production percentage was 41.6 percent.

Bottom Ash

Bottom ash is the most diversely applied CCP. Its use-to-production percentage for 2008 was 43.82 percent as compared to 40.35 percent in 2007. Its primary uses are in structural fill, road base, snow and ice control, aggregate material, concrete and as clinker for blended cement.

Boiler Slag

Although boiler slag has the highest use-to-production percentage of all CCP categories, 83.31, its overall production tonnage continues to decline slightly each year. The amount of boiler slag availability gradually reduces because of the continuing industry-wide retirement of cyclone and slag-tap boilers. Its major uses are as blasting grit and granules in roofing shingles.

BENEFICIAL USE TIED TO PERCEPTION AND SUSTAINABILITY

Prior to the incident at TVA's Kingston Station in December 2008, the industry was generally optimistic that beneficial use would continue to maintain its incremental growth well into the future. The growth in green building initiatives gave



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impetus to increased uses for fly ash, FGD gypsum and other CCPs that are used to contribute points toward green-rating systems. ACAA, working with architects, builders, regulators and end-users, was seeing increased acceptance of CCPs in green building projects. High volume fly ash mixes for concrete were being used extensively in building construction and landmark projects were demonstrating the numerous advantages of fly ash concrete.

Consensus standards organizations were developing guidance that could further improve the acceptance of blended ash specifications that would further support fly ash use. While visiting congressional staffs in Washington, ACAA Executive Director Thomas H. Adams discovered that many elected officials are well aware of the value that fly ash contributes to sustainability. Fly ash is often pointed out as a method of helping to reduce green house gas emissions and reducing environmental impacts. Historical CCP utilization trends tended to support this awareness as new applications were being developed each year for CCPs. Yet, at the end of 2008, CCPs had gained a label as a hazardous waste, despite evidence to the contrary. Widespread coverage of the Kingston spill changed the industry overnight from a contributor to sustainability to a potential generator of large volumes of hazardous waste. Despite industry's best efforts, this stigma will continue to impact beneficial use into the future. Unless the negative perception or CCPs can be removed through scientific proof and common sense, beneficial utilization is like to decrease dramatically.


CCP professionals within the energy industry, academia, marketing, transportation, equipment manufacturers and related trade associations must continue to meet the above challenges within the circle of their own influence as well as joining with others to educate and demonstrate the positive face of coal combustion products and their benefit to society. It won't be easy, but with the objective facts being made known to both the public and government agencies, the impact of market and negative governmental controls may be lessened to some degree. One cannot speculate how the pending EPA rulemaking will specifically impact

beneficial use, but there is no doubt that a hazardous or contingent hazardous label will further decrease CCP use. Utilities will be forced to decide whether or not the potential liability of using CCPs is justified, given the arguments by some of their "hazardousness." Even if in certain disposal-only settings CCPs might have to be handled as something other than non-hazardous, the threat remains of potential lawsuits over a material that is essentially

the same, wet or dry, beneficially used or disposed.

ACAA thanks everyone who participated in the ACAA survey collection and looks forward to working with you again in 2009. We hope our pessimistic comments related to the future do not come true and instead, beneficial use will continue to be promoted, supported and implemented. ♦


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WHATEVER HAPPENED TO OLD WHAT'S-HIS-NAME?

By David C. Goss, Former Executive Director ACAA, Consultant

When I retired from ACAA in 2009 I had anticipated a rather sedate life for a change. However, as many of you have experienced, this year was quite a ride. Did we ever expect back in January of '09 how much the world of CCPs was to change? We knew that Kingston was going to raise some issues, but the complete turnaround by the US EPA in their philosophical approach toward coal combustion products (now coal combustion residuals or residues – CCRs) was not anticipated.

Perhaps I should clarify that and say that I was optimistic and naive to expect that the EPA would continue to support beneficial use in the ways they had in the past. I considered Kingston to be a failure of a dike and impoundment, not the beginning of a new way to treat the material that has been so successfully used for decades. I did not anticipate the possibility that the Agency would consider classifying CCPs as hazardous in 2009 despite nearly 30 years of regulatory reviews that have substantiated the opposite conclusion. However, when politics, passion, the news media and environmental activists all come together, a storm can arise. The disregard for or perhaps the desire to ignore facts has created some significant challenges for ACAA, the utility sector and beneficial use in general.

It has been interesting to be an observer more on the sidelines than in the middle of the playing field. I compliment Tom for his patience and stamina in what I imagine has been a stressful year. In fact, I am sure most of you have measured this year in terms of stress, frustration and perhaps irritation. We are still waiting and hoping that new regulations will not completely eliminate or severely hamper future beneficial uses for CCPs (I can't change the




The Gosses and Mick.

terminology that easily). We should be pleased that the outpouring of support for a non-hazardous designation comes from many perspectives: Federal agencies, state regulators, consensus standards organizations, the mining industry, transportation providers and countless business entities engaged in the management and use of CCPs. I was not actively involved in the events leading up to the May 2000 determination, but I can't imagine any greater

support nearly 10 years ago than has been seen this year.

When I first announced my intent to retire in the summer of 2007, the economy was still robust and CCP uses were widespread. However, with the serious decline in the construction sector, I realize that many marketers and end-users have seen traditional opportunities disappear. Many companies have experienced

“It’s an important battle that we cannot afford to lose because sustainable actions are more important than ever. Let’s hope that common sense and fact-based decision-making prevails.”



Green builders worry about potential liability issues if fly ash becomes designated as hazardous.

reorganization and staff layoffs instead of market growth and continued prosperity. I had hoped to have been able to work with some of these firms as they developed new technology and advanced their business strategies beyond their existing marketplaces. That too, has been affected

by both economic withdrawal and pending regulatory changes. With construction down, so are sales and that means many individuals are affected negatively. There seems to be a foregone conclusion by some end-users that the EPA is going to say CCPs must be handled as a hazardous waste, even though the EPA has not made any public decision to that end. That "stigma" is a real impact on beneficial use, even before any new regulations are proposed. A number of ACAA members have cut back on operations, have seen market share dwindle and have had to counter inquiries from their clients about the safety of CCPs. Green builders are expressing concern that if fly ash, for example, has to be handled as hazardous under some scenarios, then these users will not use fly ash at all because of potential liability issues. Competitors are pointing to their products as being not hazardous and that further erodes fly ash use. I don't think many of us expected these changes.

Melissa (ACAA Communications Director) asked me to share how I have transitioned into retirement. Let's call it

semi-retirement. I have been very fortunate to be able to help Tom and other industry leaders behind the scenes by doing some projects related to CCP activities in support of beneficial use. I have seen genuine concern by these members about the future and together we have attempted to provide the EPA some insight on the negative impact on small business owners that a possible hazardous regulation would have. I have also been working on "other-than-ash issues," such as Colorado water law, rail transportation services, cement kiln dust, waste water management; most of which are new topics for me. It has been great being able to stay in touch with many of you and I look forward to continuing that for another year or two. I hope to spend more time in the mountains and when my wife retires at the end of 2010, we will probably catch up on some traveling. Until then, however, 2010 looks to be another year of potential change with challenges to beneficial use and ash management in general. It's an important battle that we cannot afford to lose because sustainable actions are more important than ever. Let's hope that common sense and fact-based decision-making prevails. ♦

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SUPERFUND LIABILITY AND USEFUL PRODUCT DEFENSE IN CCP TRANSACTIONS

By Joshua More, Schiff Hardin LLP

Liabilities associated with past and current coal ash management practices are now more apparent in the wake of recent concerns over federal regulation of coal ash as a hazardous waste. Such liabilities often arise from either the release of heavy metals, such as boron, to groundwater or surface water, or the failure of an engineered barrier. Liability typically occurs under common law tort and trespass theories, the Resource Conservation and Recovery Act (RCRA), or the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). This article focuses on CERCLA liability and the useful product defense.

CERCLA

CERCLA was created to provide for cleanup of industrial chemical toxic waste dumps and spills, such as Love Canal and Times Beach. CERCLA applies principally to situations in which significant environmental damage has occurred. The CERCLA process begins with a procedure for identifying and ranking the hazards posed by contaminated sites. On the basis of that ranking system, CERCLA establishes a national priorities list that then functions to ensure that the most dangerous sites are remediated first.

There are two types of cleanups recognized by CERCLA: (i) removals are short term measures taken to minimize the dangers to human health and the environment on an emergency basis, whereas (ii) remedial actions are long-term efforts that attempt to rid the site of dangers on a



The U.S. Supreme Court.

“Whether a generator or marketer can avail itself of the useful product defense will depend on a careful analysis of the facts and circumstances of each particular case.”

“The useful product defense is a denial that the party “arranged for” the disposal or treatment of a hazardous substance.”

permanent basis. CERCLA authorizes the U.S. EPA to arrange for cleanup on its own or to order parties potentially responsible for contamination to undertake cleanups. CERCLA also allows private parties to seek reimbursement from potentially responsible parties for cleanup costs.

CERCLA imposes liability upon: (i) the current owner or operator of a facility from which there has been a release or threatened release of a hazardous substance; (ii) any person who owned or operated a facility at the time the hazardous substance was disposed; (iii) any person who, by contract, agreement or otherwise arranged for the disposal or treatment of a hazardous substance or arranged with a transporter for transport for disposal or treatment of a hazardous substance; and (iv) any person who transported a hazardous substance to a facility from which there has been a release or threatened release.

The courts have held that CERCLA imposes strict, and in most cases, joint

and several liability. Strict liability means that liability attaches regardless of fault. For instance, the current owner of a contaminated site could be found liable under CERCLA even if the owner did not dispose or arrange for the disposal of hazardous substances onto the property. Joint and several liability means that a party, regardless of its contribution, can be found liable for the entire cleanup.

THE USEFUL PRODUCT DEFENSE

While liability under CERCLA is strict, courts have held that no CERCLA liability attaches to a party that did not arrange for the disposal or treatment of a hazardous substance, but instead sold a useful product. This is often referred to as the useful product defense and could be applicable when coal ash is beneficially used.

The useful product defense is a denial that the party “arranged for” the disposal or treatment of a hazardous substance. The contours of the useful product

defense have been crafted over time by the courts, which generally focus their analysis on whether a transaction was a legitimate sale or an arrangement for disposal, and whether the product was in fact useful. Unfortunately, there is no clear-cut rule for distinguishing between a sale and a disposal, and the determination necessarily turns on a fact-specific inquiry into the nature of the transaction. Accordingly, courts have set forth various tests and factors to aid them in distinguishing between a legitimate sale of a useful product and the strategic behavior of a manufacturer attempting to re-characterize its arrangement for disposal as a sale in order to escape liability. Where a transaction is a disposal simply shrouded in the guise of a sale, the court will not apply the defense.

While many courts have found that a transaction involving a by-product (a secondary or incidental product deriving from a process) is not a “sale” within the protective language of the useful product defense, not all courts have rejected the

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application of the defense to the sale of by-products. For instance, the Northern District of Illinois, rendering what appears to be the most applicable decision to the sale of coal ash, held that the sale of fly ash for use in road construction materials does not result in CERCLA liability because of the buyer's misuse of the material. *United States v. Petersen Sand and Gravel*, 806 F.Supp. 1346 (N.D. Ill. 1992).

In *Petersen Sand and Gravel*, the fly ash generator and marketer avoided CERCLA liability for the cleanup of contamination from fly ash by successfully arguing that their delivery of fly ash to a road base manufacturing company was not an "arrangement for disposal" under CERCLA, but rather it was the sale of a

useful product. The facts of this case are analogous to situations encountered by utilities and ash marketers that ship coal ash off-site for beneficial use.

The case involved claims stemming from the EPA's investigation of the Peterson Sand and Gravel ("Peterson") facility in Lake County, Illinois. Located on the property was a road base manufacturing company that stored fly ash used to manufacture road base. Peterson filed a CERCLA contribution claim against the ash generator and marketer for a share of the cleanup costs incurred at the site. Peterson claimed that the ash generator's and marketer's actions in shipping the ash to the property constituted an arrangement for disposal of fly ash waste at the

site and, therefore, the ash generator and marketer were liable as responsible parties under CERCLA. In response, the ash generator and marketer argued that the sale of fly ash was not an arrangement for disposal but rather a sale of a useful product. They noted that the ash had a commercial value and that the generator and marketer were compensated for the ash.

In assessing whether the generator and marketer arranged for disposal, the court reviewed the "Disposal Agreement" between the generator and marketer and noted that the contract recognized that some fly ash is useful and has commercial value. Under the contract, the marketer agreed to dispose of all fly ash and the generator agreed to pay for the disposal.

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The contract also indicated that the marketer would use its best efforts to sell all commercial-grade fly ash and provide the generator a credit for all commercial-grade fly ash sold against the amount the generator owed the marketer for disposing of fly ash unsuitable for commercial use. The court concluded that “seller liability for later misuse by the buyer of useful but hazardous ingredients in a manufacturing process was not intended by CERCLA’s authors; such liability would chill permissible manufacturing.”

Whether a generator or marketer can avail itself of the useful product defense will depend on a careful analysis of the facts and circumstances of each particular case. The Peterson case and other similar cases provide a useful road map for steps generators and marketers can take to maximize the potential availability of the useful product. As a general principle, generators and marketers should make every possible effort to manage coal ash as a product.

Some things to consider when contracting for beneficial use projects include:

1. Refer to the ash as a product and avoid language and a contractual structure that could be misconstrued as labeling the ash as a waste or the transaction as an agreement for disposal.
2. When appropriate, require payment from the party using the ash.
3. Maintain records demonstrating that the sale is of a useful product and how it impacts the bottom line.
4. Establish that a market exists for the ash.
5. Describe in the agreement the beneficial use of the ash and a description of how the ash will be used. ♦

Joshua R. More, Partner in Schiff Hardin LLP’s Environmental Law Group, regularly advises clients on the management of coal combustion by-products and may be reached at 312-258-5769 or jmore@schiffhardin.com.

This is the first article in a series that will discuss the legal liabilities that often arise from the management of coal ash.

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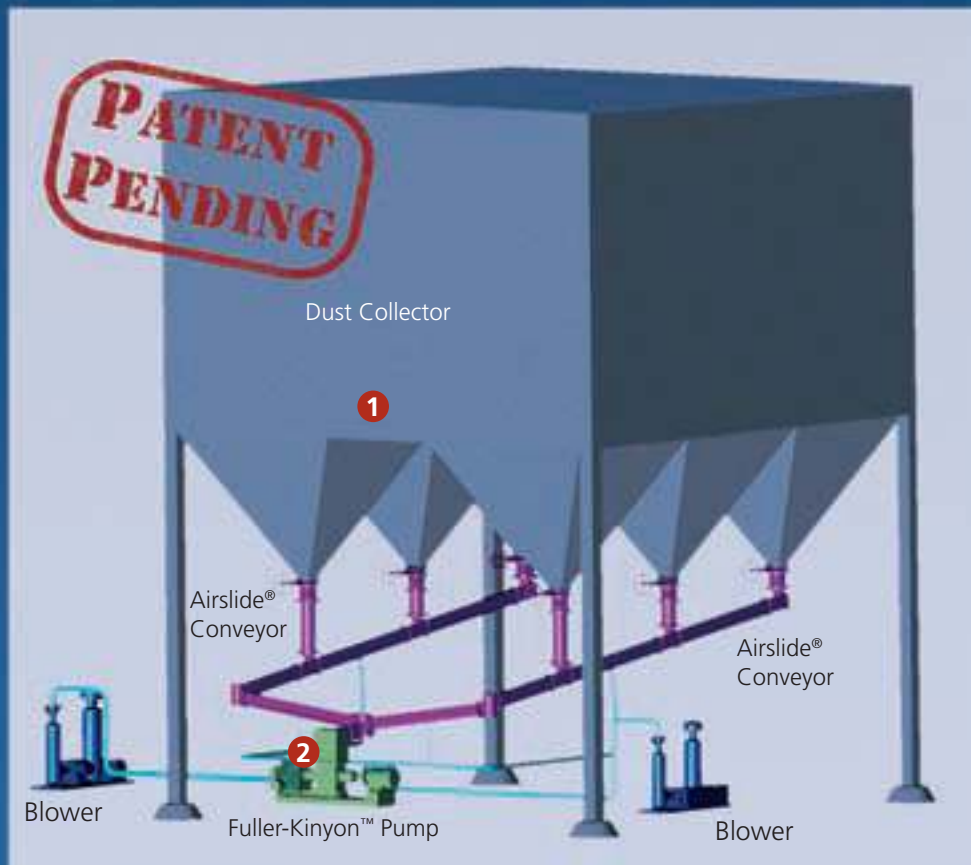
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VANCOUVER'S WINTER OLYMPICS GO FOR GREEN



*By Anne Weir,
Association of
Canadian Industries
Recycling Coal Ash*

Photos above and opposite:
Oval architectural detail (Photo
courtesy Rempel Bros. Concrete);
and the Sea-to-Sky highway that
connects Vancouver with the
Whistler Ski Resort.

The pursuit of excellence achieved during the Winter Games in Vancouver extended beyond the accomplishments of world class athletes. Extraordinary feats were also achieved in sustainable design and construction, including many venues certified by the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED). Construction also met Canada's master specifications, and national, provincial, and city goals for sustainability. Also, the Games offered an ideal showcase for demonstrating the technical and "green" benefits of fly ash mix designs from high strengths and finishing effects, to long project life expectancies and lower carbon emissions.

THE OLYMPIC VILLAGE

The village complex was designed to meet a 50-year project life span. The designer, Glotman Simpson Group, specified a low-cement, high volume fly ash concrete with high early-age strengths. Maximizing recycled content was key to achieving



LEED certification, including mixes containing 35 to 50 percent fly ash. Seven residence buildings were certified LEED Gold, while the eighth “Community Centre” building was certified LEED Platinum. Rempel Bros. Concrete Ltd. and Lafarge effectively addressed early-age strength requirements by adjusting mixes. They met an aggressive construction schedule, pouring one floor every five days. Development will continue through 2020 culminating in 5,000 residential units and community facilities, including interfaith spiritual centers, an elementary school, and childcare facilities, all situated in close proximity to park and harbor-side boardwalks.



Olympic Village residences. (Photo courtesy Lafarge)



Richmond Olympic Oval, site of speed skating events.
Insert: Oval architectural detail. (Photo courtesy Rempel Bros. Concrete)

RICHMOND OLYMPIC OVAL

The City of Richmond targeted LEED Silver certification for the Oval, designed for 8,000 spectators of speed skating events. The facility was constructed with a specialized, 7,250 psi, self-consolidating concrete. The mix design contained approximately 30 percent fly ash to create the smooth surface finishes necessary to do justice to decorative salmon motifs sculpted by acclaimed Musqueam artist, Susan Point. Through fine tuning mix proportions and procedures for placing/consolidation the desired effect was achieved — an illusion of salmon swimming upstream.

The Oval was built to a minimum 100-year design life. Its compressive strengths range from 3,600 to 7,250 psi for various concrete elements. Builders used fly ash at replacement levels of 24 percent to 31 percent to

achieve durability goals, increase recycled content and reduce material costs. All concrete had to meet the Canadian specifications for optional shrinkage limit of 0.04 percent at 28 days. The arena floor had to meet tight flatness tolerances to provide an excellent ice surface. The Oval's sustainable design is enhanced with First Nations' artistry in the form of sculpted concrete "runnels" that divert rainwater from the roof to service the venue's toilet and irrigation facilities.

WHISTLER SLIDING CENTRE

The Center, 80 miles north of Richmond, was sited on the southeast slope of Blackcomb Mountain, close to Whistler Village. The sliding track, designed for bobsleigh, luge and skeleton events, is a U-shaped structure stretching 1,600 yards over rugged, downhill terrain. For designer Stantec Engineering, materials

selection, design and assembly were crucial to facilitate concrete placement and meet stringent International Olympic Committee requirements for concrete density, cover and finish.

Shotcrete with 15 percent fly ash was used to achieve the specialized placement, long-term performance and improved sustainability required for the track structure. Prolonged workability was critical to the successful application of the thin shotcrete layer over refrigerant pipes used to freeze the track's surface. The increased compressive strength and reduced permeability typical of fly ash concrete provides better corrosion protection for reinforcing steel and refrigerant pipes. Measuring 7,250 psi at 28 days, the exceptionally smooth concrete surface needed for high-speed downhill race competitions, is strong and durable, having exceeded its 5,000 psi (28 day) design strength.



The Whistler Sliding Track curve under construction. (Photo courtesy of Stantec)



Aerial view of the Whistler Sliding Track .

(Photo courtesy of Vancouver Organizing Committee for the 2010 Olympic and Paralympic Winter Games)

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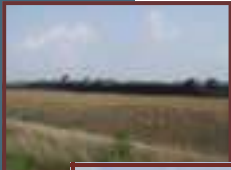


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Excerpts from technical guidance documents of the Portland Cement Association and the American Concrete Pavement Association:

"...cement and concrete industries rely on fly ash to enhance the performance and durability of concrete... fly ash has been a crucial element in infrastructure construction projects...for decades as it improves longevity, increases strength, reduces chloride permeability, enhances durability and improves cost effectiveness... fly ash is typically added to concrete mixtures to keep [curing] temperatures in check... and minimize cracking to ensure structurally sound, durable, and long-lasting concrete structures... particularly important for large concrete elements, fly ash helps to make concrete denser, stronger and less permeable to water borne salts that can corrode steel reinforcing bars inside infrastructure [to extend the life] of concrete... increasing the longevity of concrete infrastructure has huge positive implications for natural resource conservation and energy savings... there are also greenhouse gas savings realized with the use of fly ash in concrete mixtures... fly ash is a critical tool... there are other tools, but few as plentiful, effective, and economical."



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A serene view in Whistler.

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ACKNOWLEDGEMENTS

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POTENTIAL USE OF FGD GYPSUM AS AN AGRICULTURAL AMENDMENT

By Liming Chen, David Kost and Warren A. Dick

Production of FGD gypsum is expected to increase in the future. There are many potential benefits of recycling FGD gypsum as an amendment for agriculture and for other land application uses. A substantial amount of research data is accumulating that indicates when FGD gypsum is applied at rates, determined from well-defined principles of soil and agronomic science, soil quality and crop performance are enhanced. The environmental impacts are currently being evaluated at a national scale level and the U.S. Department of Agriculture is using the data to conduct a comprehensive risk assessment.

INTRODUCTION

Coal is a major natural resource. Large amounts are burned each year to produce electricity, heat or other forms of energy. The Clean Air Act Amendments of 1990 restrict sulfur dioxide emissions from coal-fired facilities that use high-sulfur coal and have spurred the development of flue gas desulfurization (FGD) scrubbers. These systems can successfully bring utilities into regulatory compliance and result in the decrease of sulfur deposition from air to the soil surface. They also generate large quantities of FGD products that must be landfilled, deposited in surface impoundments, or beneficially recycled.

Many scrubbing technologies exist to remove sulfur dioxide. When limestone forced oxidation scrubbers are used, FGD gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) is created. In general, it is a wet scrubbing process whereby the flue gases are first exposed to a slurry of hydrated lime. Calcium sulfite ($\text{CaSO}_3 \cdot 0.5\text{H}_2\text{O}$) is initially formed by capture of SO_2 by the lime slurry. The calcium sulfite is then oxidized by forcing

additional air into the system to form gypsum. During the oxidation process, washing of the by-product with water can remove undesirable chemical contaminants such as boron and mercury. The quality of the gypsum is very high and suitable for industrial and agricultural use. Currently, most of the FGD gypsum produced in the U.S. is used in the wall-board industry and only a small amount is used in agriculture. In 2005, EPA announced a multipollutant approach to reduce power plant air emissions through the Clean Air Interstate Rule and the Clean Air Mercury Rule through a cap and trade approach. Although both of those rules have since been withdrawn, we expect that wet scrubber usage and production of FGD gypsum will double or triple in the future.

A sustainable society cannot continue to extract resources to create products and/or by-products that are then subsequently disposed of in landfills. It is imperative that recycling of all kinds of materials is encouraged and becomes more common. Gypsum is one of the earliest forms of fertilizer used in the U.S. and has been applied to agricultural soils for more than 250 years. Agricultural applications represent important new alternative beneficial uses for FGD gypsum and the market with the greatest potential for expanding gypsum use. FGD gypsum can also augment or replace commercial mined gypsum, thus avoiding mining activities associated with gypsum extraction. But, it is important that this valuable resource of FGD gypsum is used appropriately and without negatively impacting our environment. In many respects, there are many similarities between the agricultural use of FGD gypsum and nitrogen fertilizers in that both can provide crop


production benefits, but if improperly used, these benefits can also lead to negative environmental impacts.

This article provides information for crop producers, soil and crop consultants, environmental consultants, environmental regulatory agents, FGD gypsum producers, and FGD gypsum marketers about the beneficial agricultural or land application uses of FGD gypsum.

BENEFITS FOR LAND APPLICATION

FGD Gypsum as a Source of Plant Nutrients. Gypsum is slightly soluble in water and is a quality source of calcium and sulfur for improving plant nutrition. Use of FGD gypsum as a sulfur fertilizer to enhance crop production has been proved in many crops such as corn, alfalfa, soybean, and canola. FGD gypsum can also improve crop nitrogen use efficiency. Corn yields were increased when reduced fertilizer nitrogen rates were applied with 100 lb/acre FGD gypsum as the sulfur source. These results show potential for FGD gypsum to both improve profitability and reduce nitrate contamination of water. Use of FGD gypsum as a calcium fertilizer for peanuts is also well known in the southeastern U.S. and has increased yields by 22 percent when applied at the 1.0 ton/acre rate.

Improvement of Soil Physical Properties. Soil structure is defined as the arrangement of primary mineral particles and organic substances into larger units known as aggregates with their inter-aggregate pore system. Soil structure has been shown to influence a wide variety of soil processes including water and chemical transport, soil aeration, erosion by water, seedling germination, and root



FGD gypsum as a soil amendment in Wisconsin to enhance alfalfa production.

penetration. Many soils from semiarid to humid regions have an unstable structure. These soils have a tendency to disperse, which leads to surface sealing. This sealing reduces water infiltration and gaseous exchange with the atmosphere, and can also have an adverse effect on seedling emergence. Flocculation is the opposite process of dispersion and application of gypsum can reduce dispersion, promote flocculation of soils and water infiltration and percolation, reduce soil erosion and improve water quality, seedling emergence and establishment.

Reduction of Phosphorus and Nitrogen Concentrations in Surface Water Runoff. Runoff from agricultural fields, urban lawns, and golf courses often contains excessive amounts of plant nutrients such as phosphorous and nitrogen. These nutrients stimulate algal growth in a process called eutrophication that can lead to oxygen depletion and resultant fish kills. Application of FGD gypsum has the potential to reduce phosphorus and

nitrogen runoff from soils, thus bringing about improved environmental quality.

Amelioration of Problems Associated with Subsoil Acidity. The solubility of gypsum is about 200 times that of lime (CaCO_3) making it an ideal material to ameliorate subsurface toxic aluminum concentrations brought about by low pH. Application of FGD gypsum to fields with subsoil acidity leads to crops with improved plant root growth into the subsoil. This results in plants being able to take up water and nutrients from a larger volume of soil and to increased crop yields.

Remediation of Sodic Soils. Sodic soils are noted for their dispersivity in water caused by the exchangeable sodium which causes extremely poor soil structure and reduced plant growth. FGD gypsum can remediate sodic soils by displacing sodium by calcium so that clay dispersion is reduced and clay flocculation is increased leading to better water infiltration rates and

hydraulic conductivity. Field studies conducted on sodic soils indicate that the yields of corn can be significantly increased by FGD gypsum.

No-tillage Crop Production on Clay Soils. No-tillage is defined as the planting of crops directly into the residues of the previous year's crop without any tillage (i.e. zero tillage). No-tillage offers a large number of benefits such as less soil erosion, increased carbon sequestration, increased crop yields, less labor, and better water quality and has been adopted by an increasing number of farmers in the United States. However, expansion of no-tillage crop production systems onto clay soils has been a slow process because clay soils used in no-tillage crop production often become compacted and exhibit poor aeration and water infiltration properties. Currently these soils produce optimum yields under no-till only when they are systematically drained and crops are rotated. Because gypsum can increase water penetration



Planting corn on FGD Gypsum plots

and improve internal soil drainage, application of FGD gypsum can significantly increase the amount of land suitable for no-tillage.

Synthetic Soils and Mixes. A synthetic soil may be defined as a plant growth medium created by the blending of two or more materials to have specific desirable physical, chemical, and/or biological characteristics for supporting plant growth. The uses of synthetic soils include urban landscape restoration, commercial plant nurseries, and sod farms. Synthetic soils have been created that contain FGD gypsum as a component. Studies using these synthetic soils have shown increased growth of tomato, wheat, and red maple trees.

Landscape and Sport Field Uses. Turfgrasses restrict easy incorporation of amendments into the soil even though turf managers often need to improve soil properties. Surface application of soluble gypsum, compared to agricultural lime, can provide calcium and sulfur for grasses and improve overall soil and turf quality.

TYPICAL COMPOSITION

Chemical composition of FGD gypsum is influenced by the type of coal, scrubbing process, and sorbent used in the desulfurization process. We have analyzed concentrations of elements in FGD gypsum from seven power plants in six states (Table 1). To provide a context for interpreting the composition data of FGD gypsum, the data are compared with

mined gypsum. It is easily observed that FGD gypsum would serve as an excellent source of calcium and sulfur for agricultural use. Heavy metal concentrations measured were those currently regulated by the U.S. EPA Part 503 (USEPA, 2010) for land-applied biosolids. The concentrations in the mined gypsum or FGD gypsum are compared to ceiling levels permitted by government regulations. It is important to note that these ceiling levels were developed for biosolids and may not apply to FGD gypsum. Work is currently underway by the USDA and USEPA to establish appropriate levels for FGD gypsum.

LOADING RATES OF FGD GYPSUM AND METALS

For efficient use of gypsum to enhance crop production, it is necessary to be able to determine the amount of gypsum that should be applied. The rate of FGD gypsum application depends on the specific purposes of using FGD gypsum for crop production or as a soil amendment and can be determined from well-defined principles of soil and agronomic science. After reviewing the articles published related to agricultural uses of FGD gypsum, we recommend rates of application of FGD gypsum for various functions as summarized in Table 2. Based on the specific purpose for applying FGD gypsum to soil, the appropriate rates can vary

Table 1. Concentrations of calcium, sulfur and environmental concern elements in FGD and mined gypsums from six states.

Element	FGD Gypsum	Mined Gypsum mg/kg	Ceiling Concentration ¹
Calcium	87900-243000	98300-247000	
Sulfur	65900-209000	52300-207000	
Arsenic	<0.64-3.0	<0.64-4.2	75
Cadmium	0.16-1.2	0.11-5.5	85
Chromium	1.8-13	1.3-96	600
Copper	<0.19-3.3	<0.19-5.6	4300
Lead	0.60-1.8	<0.39-2.1	840
Mercury	0.1977-0.6888	0.0001-0.0311	57
Molybdenum	0.59-1.8	0.65-2.6	75
Nickel	0.57-5.0	1.0-20	420
Selenium	<2.3-19	<1.2-4.9	100
Zinc	3.2-29	1.3-93	7500

¹Part 503 – Standards for the Use or Disposal of Sewage Sludge; 503.13, Table 1 and 503.23, Table 1 (USEPA, 2010).

greatly from less than 100 lb to 10,000 lb per acre. For some applications, especially where the higher rates are used, it is very likely that application will not be done annually. Instead application will occur initially at a high rate to initially remediate a specific soil situation and then, in subsequent years, much lower maintenance rates would be applied.

It is important that the agricultural uses provide benefit to the end user and be economically viable. At the same time, the use must not result in negative environmental impacts. Based on the concentrations of environmental regulated elements (EPA Part 503) in the FGD gypsums that we measured from seven power plants in six states, the amounts of these elements that are added to soil at a 10000 lb/acre FGD gypsum application rate are shown in Table 3.

NATIONAL RESEARCH NETWORK

Field experiments are necessary to determine the appropriate application rates for a variety of soil and crop types, and

to assess the potential for environmental effects associated with the application. Widespread adoption by farmers and regulatory agencies will also require thorough documentation of its effectiveness and safety. Therefore, a national network of research studies on the use of FGD gypsum in agriculture has been initiated by The Ohio State University to document the regional effectiveness of FGD

gypsum as a soil amendment. This project is being conducted in cooperation with the Electric Power Research Institute, state universities, the US Department of Agriculture, and various utilities.

A major advantage of the national research network is that it supports the acquisition of data for a wide variety of soil and crop types under relatively uniform practices.



Table 2. Rates of application of FGD gypsum for various functions.

Function	Suggested rates of application	Reference ¹
Sulfur fertilizer to enhance crop production	100-500 lb/acre	Chen et al., 2008 DeSutter and Cihacek, 2009
Calcium fertilizer to enhance crop production (e.g. peanuts)	1000-4000 lb/acre	Grichar et al., 2002
Soil amendment to remediate subsoil acidity	3000-10000 lb/acre	Chen et al., 2005
Soil amendment to remediate sodic or sodium affected soils	2000-20000 lb/acre	Xu, 2006
Soil amendment to improve water quality (e.g. by reducing phosphorus concentrations in surface water runoff)	1000-9000 lb/acre	Norton and Rhoton, 2007
Soil amendment to improve soil physical properties and water infiltration and percolation	1000-9000 lb/acre	Sumner, 2007
As a component of synthetic soils for nursery, greenhouse, and landscape use	5-20% of the medium	Bardhan et al., 2004
As a lawn care and sport field product	4000-14000 lb/acre	Schlossberg, 2007

¹For additional information about application of FGD gypsum for various functions, please read the presentations from three workshops of agricultural uses of FGD gypsum, which can be obtained online at <http://www.oardc.ohio-state.edu/agriculturalfgdnetwork>.

A standard protocol was developed to promote quality control and overall scientific validity through adoption of uniform methodology among the sites in the network. The basic protocol for each site involves four replicate blocks with seven plots each, for a total of 28 plots. Each block of seven plots represents three rates of FGD gypsum application, three rates of commercial mined gypsum application, and a control plot with no application.

Sampling and analysis parameters include gypsum chemistry, soil chemistry, vadose zone water chemistry, crop yield and chemistry, and earthworm biomass and chemical uptake. Concentrations of 29 elements including As, Cd, Cr, Cu, Hg, Mo, Ni, Pb, Se, and Zn in the samples are analyzed.


A large amount of environmental data has been collected as part of the national

network project. These data are currently being used to help conduct a comprehensive risk assessment of agricultural and other land application uses of FGD gypsum. This effort is headed up by the US Department of Agriculture and is occurring at a pace that is appropriate, but which will also provide timely information into the debate about the use of FGD gypsum as an agricultural amendment and for other land application uses. ♦

Table 3. Amounts of As, Cd, Cr, Cu, Hg, Mo, Ni, Pb, Se, and Zn added to soil based on the amount of FGD gypsum application.

Element	FGD gypsum application at 10,000 lb/acre	Maximum allowable annual loading rate ¹ lb/acre	Allowable Cumulative loading rate ²
Arsenic	0.0065 – 0.03	1.8	36.6
Cadmium	0.0016 – 0.012	1.7	34.8
Copper	0.0019 – 0.033	67.0	1340
Lead	0.0060 – 0.018	13.4	268
Mercury	0.0020 – 0.0069	0.76	15.2
Nickel	0.0057 – 0.050	18.8	375
Selenium	0.023 – 0.19	4.5	89.3
Zinc	0.032 – 0.29	125	2500

1, 2Part 503 – Standards for the Use or Disposal of Sewage Sludge; 503.13, Table 4 and Table 2 (USEPA, 2010).



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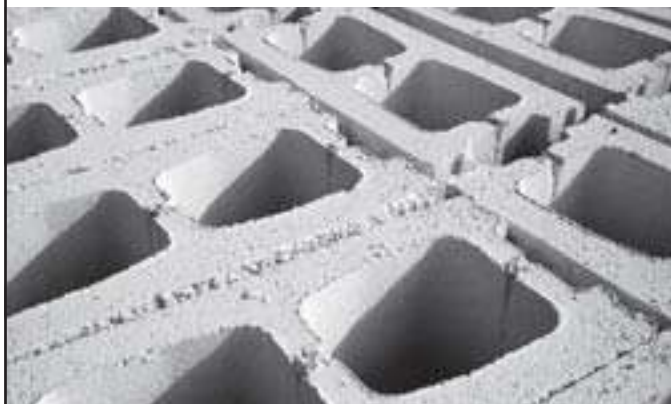
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