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Improving Coal Ash Quality and Utilizing Disposed Ash

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A NEW SOLUTION FOR A LONG-STANDING DILEMMA

"The cost of disposing of coal ash just went up. Again."

By Jimmy C. Knowles and Bill Fedorka

While the utility industry has become accustomed to hearing this familiar phrase over the last several decades, previous increases in ash disposal cost are expected to pale in comparison to increases coming after October 14, 2015. On that date, the requirements of the U.S. Environmental Protection Agency’s (EPA) final rule regulating new and existing coal ash landfills and ponds will go into effect. These new requirements are nearly identical—and just as costly—as those for municipal solid waste landfills.

What about the millions of tons of coal ash previously disposed of in unlined ponds? According to the EPA, many of these impoundments will need to be closed and the ash either covered or removed.

Fortunately, the EPA has provided a path to avoid high disposal costs and the long-term risks associated with the new requirements. The solution: "encapsulated beneficial use." This approach is consistent with what the industry has been doing for years: using ash as a performance-enhancing additive in concrete and other composites. Consequently, utilities have an even greater incentive to see that coal ash goes to beneficial uses such as concrete—namely, reducing their disposal costs and improving environmental stewardship.

From the perspective of a commercial customer for coal ash, the decision to use ash has become more difficult. Every year there is less fly ash being produced and the quality of that fly ash is deteriorating. In some markets, fly ash beneficiation has helped improve the quality, thereby increasing the supply. And yet, even markets with access to quality product lacked the year-round availability of fly ash necessary to keep up with the seasonal fluctuations.

Coincidentally, hundreds of millions of tons of previously disposed coal ash were sitting idly in ponds all over the country. The industry was in need of a beneficiation technology that could not only process poor-quality fly ash into a high-quality additive for concrete but also transform previously disposed coal ash, such as pond ash, into a quality product for encapsulated beneficial use.

ENTER STAR

The technology, known as staged turbulent air reactor (STAR), was first commercialized in 2008 and the latest facility came online early 2015 at Santee Cooper's Winyah Generating Station (WGS). The Winyah STAR Plant processes fly ash as it is produced at WGS. More importantly, however, it also processes coal ash that was produced decades ago as it is reclaimed from on-site ash ponds.

For years, The SEFA Group has been a long-term service provider to Santee Cooper—initially for ash marketing and more recently for ash beneficiation and marketing. When Santee Cooper was faced with the task of cleaning out and removing millions of tons of coal ash from several of their ponds, they turned to SEFA for help. In 2013, SEFA first successfully demonstrated commercial-scale beneficiation of pond ash at its McMeehin STAR Plant. The following year, SEFA decommissioned its
currently existing carbon burnout beneficiation plant at WGS and replaced it with the next-generation STAR plant that could interchangeably benefit both freshly produced fly ash and previously disposed coal ash reclaimed from ponds.

Santee Cooper required an extremely flexible coal ash beneficiation technology. Each day, the Winyah STAR Plant adjusts to a wide range of coal ash from varied sources. For example, the Winyah STAR Plant routinely operates using only reclaimed coal ash from ponds and yet is able to switch its feed source at a moment’s notice to process 100% dry fly ash as the WGS comes online.

The Winyah STAR Plant routinely processes coal ash with residual carbon contents ranging from 5% to over 25%. Because the plant is a stand-alone solution, it does not depend on WGS in any way and operates normally, even when all the WGS units are offline. In fact, even if any or all of the WGS units are decommissioned in the future, the plant could continue operating at full capacity for decades, limited only to processing the on-site pond ash.

Uninterrupted supply and consistent quality translate to increased demand for fly ash. Customers lose confidence in fly ash when they cannot rely on it being available when needed or if the quality of the fly ash causes problems with their production and processes. The Winyah STAR Plant allows Santee Cooper to maximize the annual amount of coal ash used from WGS by providing a continuous supply of quality product to its customer base.

Unless reclaimed pond ash is used at Winyah to augment feed material, the supply of STAR fly ash would never keep up with demand. Like most coal-fired power plants, the recent trend at WGS has been for less coal to be burned, especially during the spring and fall months when customer demand for fly ash is at its highest. Reclaimed coal ash from ponds provides continuous feed material for the Winyah STAR Plant and ensures uninterrupted supply for customers. For power plants, that offers the benefit of elimination or reduction in disposal costs and tangibly demonstrates its long-term commitment to environmental stewardship.

**CONSISTENT QUALITY WITH CONTINUOUS PERFORMANCE**

The enhanced quality of STAR fly ash is a critical element of its compelling value proposition. Typical by-product fly ash will have varying amounts of unburned carbon, which negatively affects the quality of products made from it, and which subsequently increases both the need and cost of the customers’ quality control. Regardless of the carbon content of the source feed, STAR fly ash has little to no carbon remaining and therefore the presence of STAR fly ash does not negatively affect the customers’ quality control practices in any way. The quality characteristics of Winyah STAR fly ash remain constant, regardless of whether it is produced from reclaimed pond ash or from fly ash produced by the WGS plant.

Of course, many of the other characteristics of STAR fly ash are changed for the better. For example, STAR processing improves the early strength and ultimate strength gain of any fly ash used in concrete, primarily by increasing the fineness of the fly ash.

In the case of pond ash, due to prolonged exposure to water, the ash does not have the strength activity necessary to be marketed as specification-grade fly ash unless it is calcined at the high operating temperatures of a STAR plant.

STAR processing also removes additional contaminants from fly ash including, for example, ammonia, which would otherwise be a nuisance or represent a quality control problem for customers. Consequently, Santee Cooper is supporting research to develop diversified markets for Winyah STAR fly ash as additives in coatings, plastics, rubber, and other products.

**LONG-TERM COST IMPLICATIONS**

The landfill industry is highly regulated and more stringent environmental regulations have made it more costly to own and operate landfills. Significant amounts of capital are necessary to permit, construct, operate, and monitor sites. New coal combustion residuals (CCR) regulations are intended to mirror nonhazardous municipal solid waste (MSW) landfill rules and standards (RCRA Subtitle D). As a consequence, it has been projected to cost more than $1 million per acre to permit, construct, operate, close, and monitor a landfill in compliance with the new regulations. Permits will require 30 years of environmental monitoring after a landfill closes. It should go without saying that a financial commitment of this magnitude needs to be evaluated and planned well in advance.¹

In June 2014, the EPA published an economic impact analysis (EIA) for MSW landfills to study the impact of proposed amendments to the Standards of Performance. Figure 1 illustrates one finding from the EIA with respect to MSW landfill cost increases. As discussed previously, the new CCR regulations mirror the most part those for MSW landfills because both are controlled under RCRA Subtitle D. The EIA presents a model originally published in 2005 to help estimate costs² for a hypothetical landfill based on known market conditions and cost data.

**EVALUATING THE BENEFITS IN MORE WAYS THAN ONE**

A cost analysis comparing two options—1) The “do-nothing,” or 100% landfilled options; versus 2) investment in STAR and removing material offsite through sales of thermal beneficiated ash—helps to demonstrate the potential cost difference.

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¹ The cost to dispose of MSW at a landfill is commonly known as a “tip fee” or “gate fee.” In September 2012, the average national spot market price to dispose of one ton of waste in a U.S. landfill was roughly $45, up 3.5% over 2011. This compares to average national tip fees of approximately $32 in 1998 and $8 in 1985. Between 1985 and 1995, the national average tip fee increased by 29%. In the subsequent 10-year period, the national average tip fee increased by 7% per year.

² Landfill costs fall into the following categories: site development, construction, equipment purchases, operation, closure, and post-closure. Site development includes site surveys, engineering and design studies, and permitting fees. Construction costs encompass building the landfill cells as well as development of permanent on-site structures needed to operate the landfill. Evacuation of the landfill site comprises a notable portion of the construction costs. Installation of a liner can also vary greatly in cost depending on the site’s geology. Operating costs are relatively small when compared to the capital costs and include staffing, equipment, leachate treatment facilities, and general maintenance.
To estimate the net present value (NPV) of a new landfill development project for CCRs, it was assumed that the site development costs, which include all engineering and permitting, would total a fixed $1 million. The calculated operating factors and cost assumptions can be seen in Fig. 2.

For the "do-nothing" option, five 33-acre cells would need to be developed over the 20-year period to handle the 7.9 yd³ of fly ash disposal. The NPV of all costs was determined to be $84 million dollars assuming a 7% discount rate and inflation of 2.5%. This represents an equivalent, "all-in" disposal cost of $20.82 per ton average over the 20-year period. The cost per acre, in today's dollars, would be approximately $985,000 per acre (see Fig. 3).

If nearly 6.5 million tons of ash were disposed of on site, the utility or landfill owner still has to deal with the 30-year post-closure period and all its associated costs, not to mention the perpetual liability of all that material buried underground.

Even if only 85% of the available fly ash could be beneficiated and taken offsite, only one cell would need to be developed with a life of nearly 40 years. Beneficiation would eliminate the liability and 30-year post-closure costs on 5.5 million tons of fly ash. At the end of the 20-year period, the beneficiation facility would be paid for, with plenty of years of productivity ahead as life extension costs are paid through the operation and management of the facility. Even if the power plant went dark or was mothballed, the STAR could still reclaim material from disposal sites, using it as raw feed.

For the 85% beneficiation option, the NPV of disposal costs would reduce to less than $19 million. Assuming a capital cost for a STAR facility in the $50 million range, the total investment for the beneficiation plus disposal option would be $69 million ($19 million disposal NPV plus $50 million beneficiation investment). This represents a savings of $15 million in today's dollars.

In addition, the beneficiation option would avoid disposal of 6.7 million yd³ of material, and avoid all post-closure landfill costs, which, according to new regulations, will extend 30 years after closure. The sales of ash from the beneficiation facility would cover all operations and maintenance associated with the beneficiation facility and includes capital for life extension that will allow the plant to operate well past the 20-year period included in the analysis. In addition to the financial advantages, using STAR technology enhances public sentiment because of its broad environmental benefits and the opportunity to be a proactive industry leader.

**SUMMING UP**

Ultimately, each utility tailors its coal ash management program to its specific circumstances and there will not be a single magic bullet that will solve all of its problems. More likely, each utility will address its unique issues using a combination of several different ash management practices. Even so, it will be increasingly difficult to avoid the skyrocketing cost of ash disposal unless ash can be diverted from disposal to beneficial use. Fortunately, there is now a tool available:

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3 An average value of $423,000 (adjusted from $350,000 in 2005 dollars) per acre was used for the landfill construction costs in accordance with the Duffy model. Likewise, the costs for installation of a cap and post-closure care were estimated to be $80,000 and $50,000 per acre, respectively.
SITE DEVELOPMENT OPERATING FACTORS AND COSTS FOR “DO NOTHING” OPTION

Operating Factors
1500MW / 75% Capacity Factor
9600 Btu/kWhr / Bituminous Coal
12,500 Btu/lb. Heat Factor
10% Ash content / 85% Fly Ash
321,667 Fly Ash Tons Per Year
23% Moisture - Conditioned Ash
1 Yd. Conditioned ash = 1 Ton

Operating Cost Assumptions
33 Acres Per Cell
60 Feet Maximum Height of Cell
3:1 Angle of Exterior Slope
$2.00 per ton hauling cost
$3.50 per ton to place/compact
$100,000 per year (misc. cost)

Fig. 2

the staged turbulent air reactor (STAR). STAR has the technical flexibility to continue to transform coal ash from both current operations and existing landfills and ponds into a consistent, high-quality product that can be sold as a value-added product for encapsulated use. This technology prevents coal ash from becoming or continuing to be a liability and expense as a landfill or pond waste product.

Fig. 3

Jimmy C. Knowles, Vice President of Market Development and Research, joined The SEFA Group over 30 years ago and has served in a variety of positions with the company.

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