A NOVEL APPROACH TO THE HANDLING AND DISPOSAL OF COAL COMBUSTION PRODUCTS

Alex W. Hohne

Synthetic Materials, LLC, 6009 Brownsboro Park Blvd, Louisville, KY 40207

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ABSTRACT

Recently, there has been a movement to more rigorously regulate and eventually eliminate surface impoundments and wet stacks of coal combustion products (CCP's). The Environmental Protection Agency, in reaction to the Tennessee Valley Authority (TVA) Kingston release of ash into the Clinch and Emory Rivers, has requested information on the structural integrity of all 300+ impoundments currently being operated at coal fired power plants in the United States.

Concern over our future ability to permit new surface impoundments or expand existing impoundments is growing. The liability posed by the continued use of existing impoundments is also a serious concern to many utilities. The risk must be understood and weighed against the cost of converting CCP disposal to dry stacking or even landfill disposal. This paper puts forth a proven cost effect approach, developed by Synthetic Materials. It allows disposal of the two major CCP's, coal ash and gypsum. This approach enables the elimination of higher risk wet-stacking and an economically advantageous conversion to dry stacking of CCP's.

BACKGROUND

A growing volume of CCP's are recovered for beneficial use in manufacturing and construction each year. Dry storage (landfills), wet stacking or surface impoundments are the most common disposal practices for CCP's that are not beneficially used. The risk associated with wet stacking has most recently been magnified by the structural failure of a fly ash wet stack at TVA's Kingston Fossil Pant. Additional regulation is expected as a result. The additional regulation, at both Federal and State levels, will make wet stacks and surface impoundments more difficult and expensive to permit and maintain. Construction of new or expanded impoundments or wet stacks in high risk areas will likely be severely restricted.

Historically, the cost to construct and install necessary infrastructure has been a major driving factor behind selection of the disposal method. In a typical coal fired power plant with flue gas desulphurization (FGD), it is necessary to install a dry ash handling system and a gypsum dewatering system to implement dry disposal of the CCP's generated. These combined facility costs to process the CCP's generated is significant, in many cases requiring over $100 million in capital as well as significant ongoing O&M costs. Conversion of existing plants to dry CCP collection can result in significant generating unit downtime that reduces utility revenue. The cost of conversion may be offset by reduced disposal costs and potential revenue from the marketing of a portion of the CCP's collected. However, when life of facility cost is considered, this is rarely a net positive revenue situation for the utility.

Managing existing CCP surface impoundments may present a sizable liability in the future. The additional regulation and oversight expected will encourage alternatives to impoundments and wet stacks to be more carefully considered. The legacy of the existing impoundments and wet stacks represents a sizable liability until they can be completely closed. Acceleration of closure may be desirable to reduce the overall risk profile for the utility

APPROACH

The preferred and most environmentally responsible method of managing CCP's is beneficial reuse. Fly ash is most commonly used as a high-performance substitute for Portland cement or as a raw material utilized in clinker production. Cements blended with fly ash are widely accepted in almost all applications. Building material applications for fly ash range from grouts and masonry products to cellular concrete. Many asphaltic concrete pavements also contain fly ash. Geotechnical applications include soil stabilization, road base, structural fill, embankments and mine reclamation. Fly ash also serves as filler in wood and plastic products, paints and metal castings.[1]

FGD gypsum is used in almost thirty percent of the gypsum panel products manufactured in the United States. It is also used in agricultural applications to treat undesirable soil conditions and to improve crop production. Other FGD materials are used in mining and land reclamation activities.[2] FGD gypsum use is becoming more common in Portland cement production, replacing natural gypsum as a set regulator.

Implementation of the 1993 Clean Air Act has greatly increased the scrubbing of flue gas emissions from coal fired power stations. This has subsequently increased the production of FGD gypsum. As FGD production increases in the United States, the challenge becomes the proper disposal of the remaining CCP's in a cost effective and environmentally acceptable way.

Historically, the management of each of the CCP's has been considered individually. Dry fly ash collection and handling systems have been installed to allow for the beneficial reuse of ash and to avoid disposal in impoundments. Gypsum dewatering systems are installed to allow for the processing and sale of gypsum cake to wallboard and cement manufacturers. In areas with limited or no marketability for the CCP's, the

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[1] American Coal Ash Association (ACAA), "ACAA – Promoting & Advancing Coal Combustion Products", http://acaa.affiniscape.com/displaycommon.cfm?an=1&subarticlenbr=40, (accessed March 10, 2009)
[2] Ibid, http://acaa.affiniscape.com/displaycommon.cfm?an=1&subarticlenbr=41

expense to install these systems has been difficult to justify when ponding or wet stacking is an available option.

Wet stacking or impoundments are not without their own problems. Waste water impoundments are rigorously designed structures, which require close control of construction activities. The impoundments require full time technical oversight to properly construct and maintain the facility function and safety factor. Likewise, requirements for monitoring are expected to increase, especially for older impoundments. Common repairs to breaches or leaking wet stacks require significant cost to investigate and repair.

Fortunately, there is a method to allow co-disposal of varying proportions of fly ash and/or gypsum that is practical, requires less capital, fewer additional personnel, and utilizes proven technology. The SYNMAT process can produce a material which is more suitable for safe disposal in a landfill, while eliminating the risk associated with impoundment design and construction.

Dewatering gypsum using horizontal belt filters is common in the utility industry. The technology and equipment application are well documented. The challenge is to adapt the application of standard dewatering techniques to fly ash. An effective method has been developed by Synthetic Materials which allows the ash and gypsum to be dewatered simultaneously. The primary equipment utilized for this process is a modified horizontal belt filter system that is properly engineered to meet the hydraulic and material handling requirements for a combined gypsum/fly ash feed stream.

In the process, synthetic gypsum slurry is delivered to the first feedbox on the horizontal vacuum belt filter. Following gypsum cake formation, fly ash slurry, at approximately 20% solids, is distributed on top of the gypsum cake through a secondary feed box. The gypsum cake acts as a filter media for the fly ash slurry, allowing the fly ash to be dewatered on top of the gypsum cake. The combined cake discharges to a common conveyance for mixing.

Full scale operation of this system has demonstrated that a minimal gypsum layer of 1/16” is sufficient to assure adequate dewatering of fly ash while maintaining high fly ash solids retention on the gypsum cake. Fly ash moistures as low as 12% have been recorded while maintaining normal capacity processing rates on the filter system.
The results will vary slightly for each site. Through trial and laboratory analysis, Synthetic Materials is able to model and calculate the expected results based upon the characteristics of the fly-ash and gypsum to be managed at a particular site.

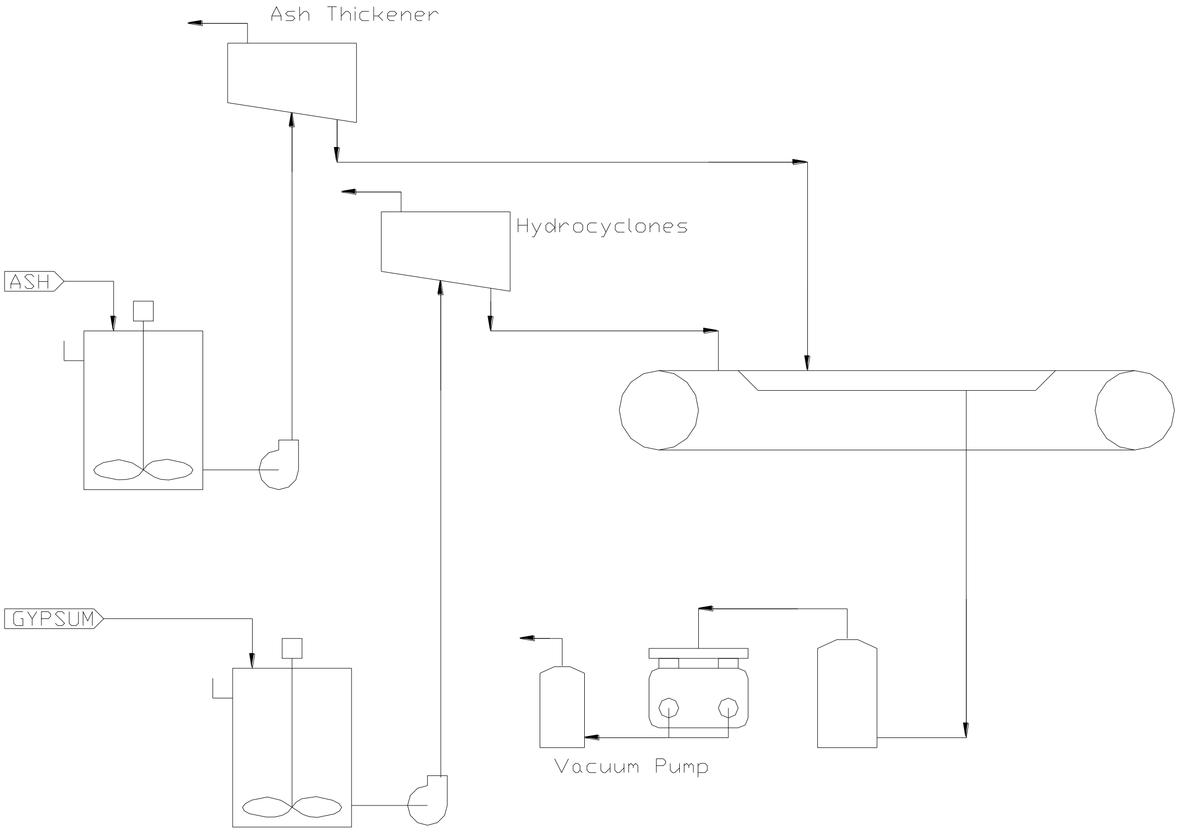

Figure 1

Figure 1 represents a simplified process flow diagram. The gypsum slurry can either be fed to the belt filter directly from the absorber or concentrated through hydrocyclones. The gypsum slurry is fed onto the horizontal belt filter through a distribution box. A vacuum is applied to the filter belt to dewater the gypsum. After initial cake formation, concentrated fly ash slurry is delivered to the top of the gypsum cake through a second distribution box. Depending on the existing system, it may be necessary for the fly ash to first be concentrated through thickeners to establish a minimum density of 20% solids. The arrangement of the multiple distribution boxes is shown on the photo in Figure 2.

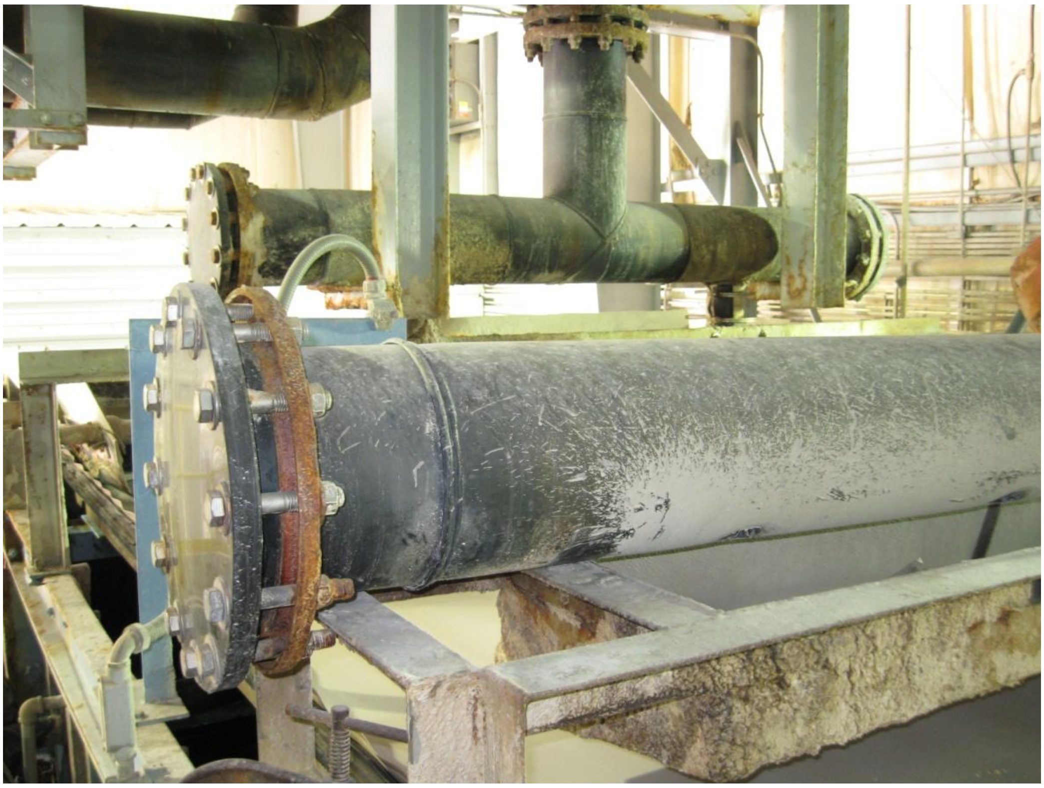

Figure 2

The fly ash slurry is deposited on top of the gypsum cake and is dewatered with the gypsum cake as the belt advances as shown in Figure 3. The characteristics of the combined cake will vary based on the thickness of the gypsum cake and the mass flow and materials characteristics of the fly ash in relation to the gypsum. The resulting mixed and dewatered product can be easily stored, handled, transported and deposited in a landfill. In addition, the fly ash can be mechanically separated from the gypsum and the CCP's managed separately. The dewatered product is shown in the photo in Figure 4.


Figure 3

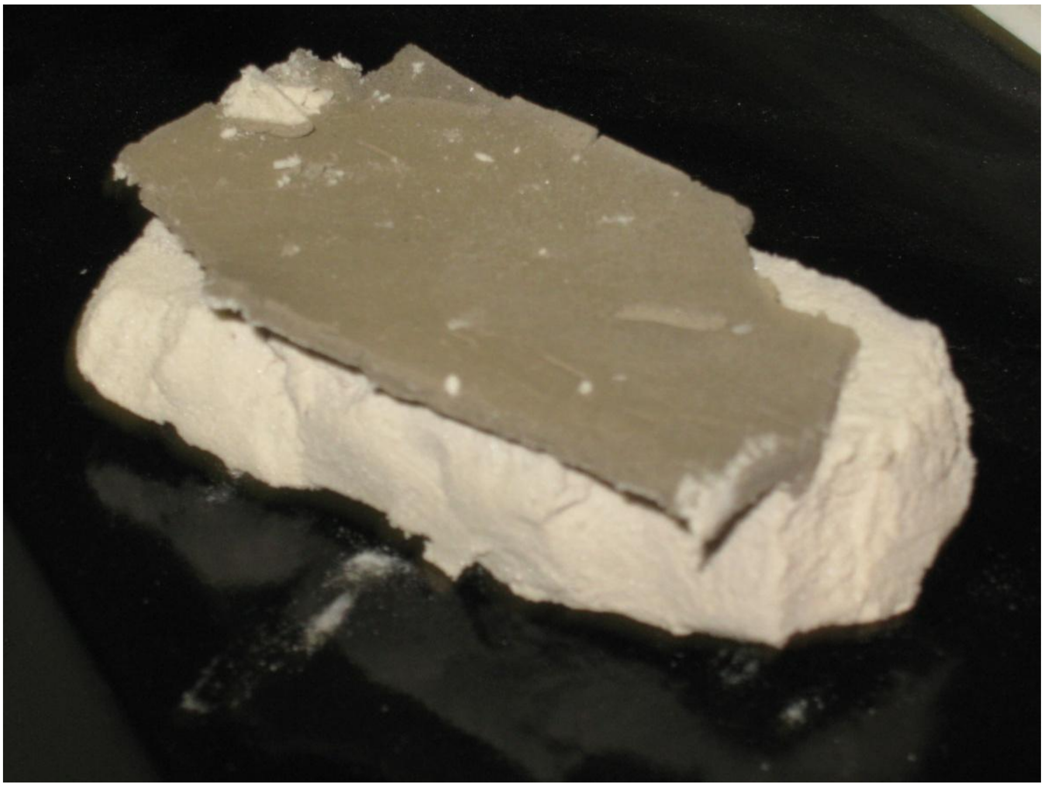
Figure 4

The advantages to this process are significant. Using properly engineered tankage and auxiliary equipment, the SYNMAT process will allow the simultaneous dewatering of concurrent gypsum production, concurrent fly ash production, and the incorporation of dredged fly ash and/or gypsum production from existing surface impoundment. Additionally, a properly designed facility can simultaneously dewater gypsum and ash for landfill disposal while also dewatering gypsum for beneficial reuse applications.

The costs associated with this system are considerably less than those associated with the design and installation of the typical dry ash collection systems and silos required to handle the fly ash separately from the gypsum. Also, O&M costs are reduced by managing both CCP's through a single facility. Utility downtime associated with the installation of the system may be considerably less as the only downtime required is to tie-in for the gypsum slurry and the ash slurry lines.

Mitigation/ remediation of existing fly ash and gypsum impoundments can be achieved through dredging and utilizing a separate feed system to deliver the dredged material to the proper location on the filter system. This recovery system could be either part of the permanently installed system or comprised of portable systems utilizing the same operating concepts.

TESTING

Proof of concept testing has been accomplished and continues at Synthetic Material's Cumberland City, TN dewatering facility using Class F fly ash from the Cumberland Fossil Plant. Gypsum cake thickness was varied and monitored, as was the mass feed rate of the fly ash slurry.

Since the Cumberland Fossil Plant is equipped with a dry fly ash handling system, ash was brought in by truck and slurried in an agitated tank. This fly ash slurry was then applied to the gypsum cake on a 58 square meter horizontal vacuum belt filter system. Free moisture of less than 20% was achieved in the dewatered fly ash product. Full scale development testing is underway that will result in an optimum facility design for all operating parameters.

Design of the process is also impacted by the physical properties of the gypsum and the fly ash. No testing has been accomplished with Class C fly ashes. The plant water balance must be considered as part of the process design and evaluation. As previously indicated, the application and costs of the system will be site specific due to logistic considerations as well as for variable process parameters.

CONCLUSION

The preferred utilization for CCP's is in a beneficial use application. Due to increased production and market saturation, 100% beneficial reuse is rarely achievable and utilities must plan for disposal when the market is not available. There continues to be a need to handle CCP disposal at the utility plant site in an efficient, environmentally sound, and cost effective manner. It is likely that additional regulation will make wet disposal of fly ash and gypsum more difficult and much more expensive. Expansion or construction of new impoundments will become environmentally and economically unfeasible.

Synthetic Materials has demonstrated an innovative application of technology that provides an economically feasible alternative for the operation of dry stack or landfill disposal of CCP's. By co-dewatering ash and gypsum, a capital cost reduction of over 50% may be realized and significant O&M cost reductions can be achieved by eliminating the primary source of risk.