

# **Advanced Multi-Product Coal Utilization By-Product Processing Plant**

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Principal Authors: Thomas Robl and John Groppo

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Center for Applied Energy Research  
2540 Research Park Drive  
University of Kentucky  
Lexington, KY 40511

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## **ABSTRACT**

The objective of the project is to build a multi-product ash beneficiation plant at Kentucky Utilities 2,200-MW Ghent Generating Station, located in Carroll County, Kentucky. This part of the study includes the examination of the feedstocks for the beneficiation plant. The ash, as produced by the plant, and that stored in the lower pond were examined.

A mobile demonstration unit has been designed and constructed for field demonstration. The demonstration unit was hauled to the test site on trailers that were placed on a test pad located adjacent to the ash pond and re-assembled. The continuous test unit will be operated at the Ghent site and will evaluate three processing configurations while producing sufficient products to facilitate thorough product testing. The test unit incorporates all of the unit processes that will be used in the commercial design and is self sufficient with respect to water, electricity and processing capabilities.

Representative feed ash for the operation of the field testing unit was excavated from a location within the lower ash pond determined from coring activities. Approximately 150 tons of ash was excavated and pre-screened to remove +3/8 inch material that could cause plugging problems during operation of the demonstration unit.

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## **EXECUTIVE SUMMARY**

The project area is located in Carroll County, Kentucky, approximately one mile northeast of Ghent, Kentucky. The lower ash pond is situated immediately adjacent to U.S. Highway 42 on the southwest corner of the Ghent power plant site. Disposal of ash into the 120-acre pond began when the Ghent power plant became operational in 1973 and continued over a period of 20 years until the upper ash pond became operational in 1993. The Ghent power plant has four separate generating units. Units 1 and 2 burn a high sulfur coal and an Appalachian low sulfur compliance coal. Units 3 and 4 have multi-fuel burners and are fueled by a mixture of low sulfur subbituminous and bituminous coal. The coals burned within these units were subjected to major and trace elemental analyses, mercury analysis, and loss-on-ignition (LOI) tests.

During this reporting period, the construction of a field demonstration unit to beneficiate the ash stored in the lower ash pond was completed. The field demonstration unit will be operated on site to evaluate several flowsheet configurations and obtain data critical to determining the final flowsheet design. In addition, the field demonstration unit will be used to generate bulk quantities of beneficiated ash in order to conduct larger scale mortar and concrete testing.

The field demonstration unit was hauled to the Ghent site on trailers which were placed on a test pad located on the edge of the ash pond. The equipment was un-packed and assembled so that final plumbing and wiring connections could be made.

A representative stockpile of feed ash was produced from a location within the lower ash pond identified from coring activities reported previously. The raw feed ash was excavated with a back hoe and transported to the edge of the pond where it was screened to remove extraneous material (+3/8 inch) that would likely cause plugging problems during field testing operations. A stockpile of approximately 150 tons of screened ash (-3/8 inch) was produced, a quantity that should be sufficient to complete all of the anticipated testing.

## **INTRODUCTION**

This project will complete the final design and construction of an ash beneficiation plant that will produce a variety of high quality products including pozzolan, mineral filler, fill sand, and carbon. All of the products from the plant are expected to have value and be marketable. The ash beneficiation process uses a combination of hydraulic classification, spiral concentration and separation, and froth flotation. The advanced coal ash beneficiation processing plant will be built at Kentucky Utility's 2,200 MW Ghent Power Plant in Carrollton, Kentucky. The technology was developed at the University of Kentucky Center for Applied Energy Research (CAER) and is being commercialized by CEMEX Inc. with support from LG&E Energy, Inc., the UK CAER, and the U.S.DoE.

This technical report includes activities that were conducted during the second quarter of 2005. The focus of the effort was the installation of a mobile processing facility at the Ghent site to evaluate three different processing flowsheets. The objectives of this effort will be to determine the final flowsheet design while producing sufficient processed products to enable large-scale testing in mortar and concrete. Additional activities conducted during the quarter were the excavation, preparation and blending of 150 tons of pond ash that will be used during pilot plant evaluations.

## Highlights for the Quarter

Our principal activities centered on preparation of equipment for the field tests, field site preparation, transport of the field test equipment to the site, and mining of the sample. In addition, product test protocols were adopted and some product testing was completed.

## Transport and Installation of the Field Apparatus

All of the equipment necessary to operate the mobile processing plant was assembled onto two trailers, packed for transport and hauled to the test site. A visit was held at Ghent to select the site for locating the trailers. Of the 3 possible test site locations (Figure 1), site A was selected because it provided the simplest access to both feed ash and process water. Access to the site is available via an access road that required some grading that was provided by LG&E. The test pad where the trailers would be located was also graded by LG&E (Figure 2).

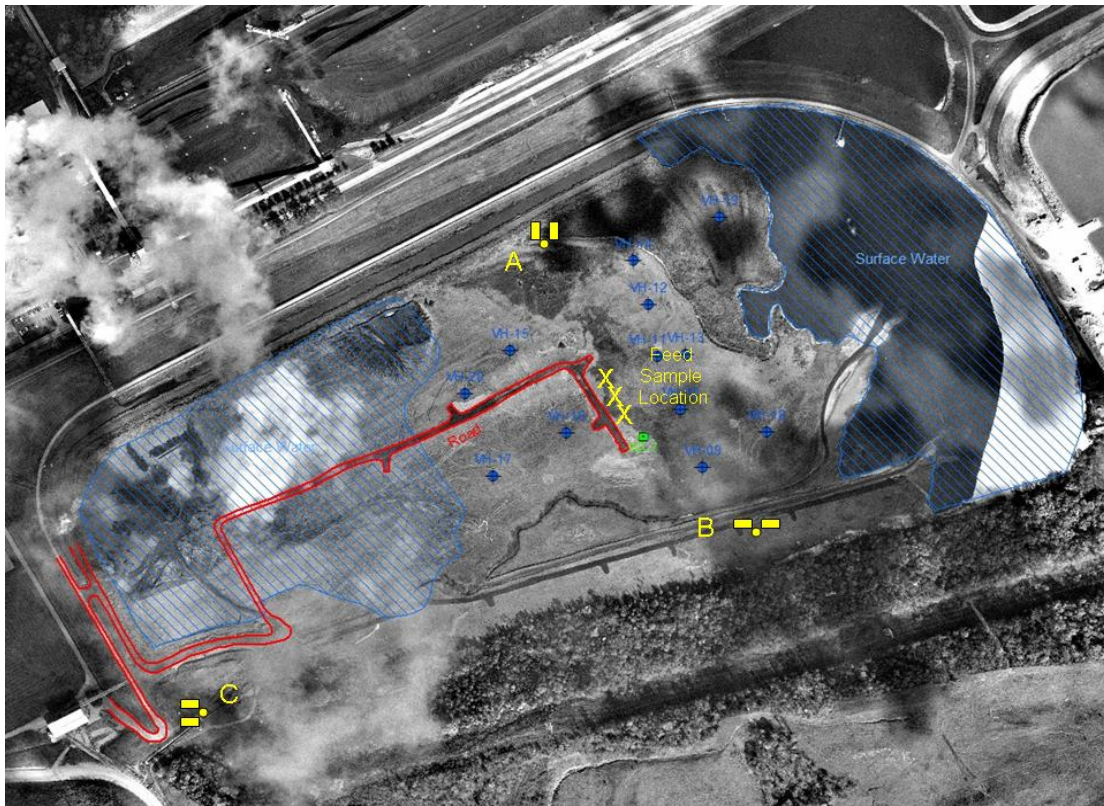


Figure 1. Location of test site.





Figure 2. Test pad before trailer placement.

The trailers were hauled to the Ghent site on June 15, but inclement weather delayed actual placement until June 17, when the access road was allowed to drain and dry. Each of the trailers were hauled onto the access road (Figures 3, 4 and 5) and parked on the test pad where the equipment was unpacked and assembled. (Figure 6). A diagram of the site layout is shown in Figure 7.



Figure 3. Transporting box trailer along access road.



Figure 4. Transporting flatbed trailer along access road.



Figure 5. Trailers parked on test pad.



Figure 6. Field test apparatus assembled on test pad.

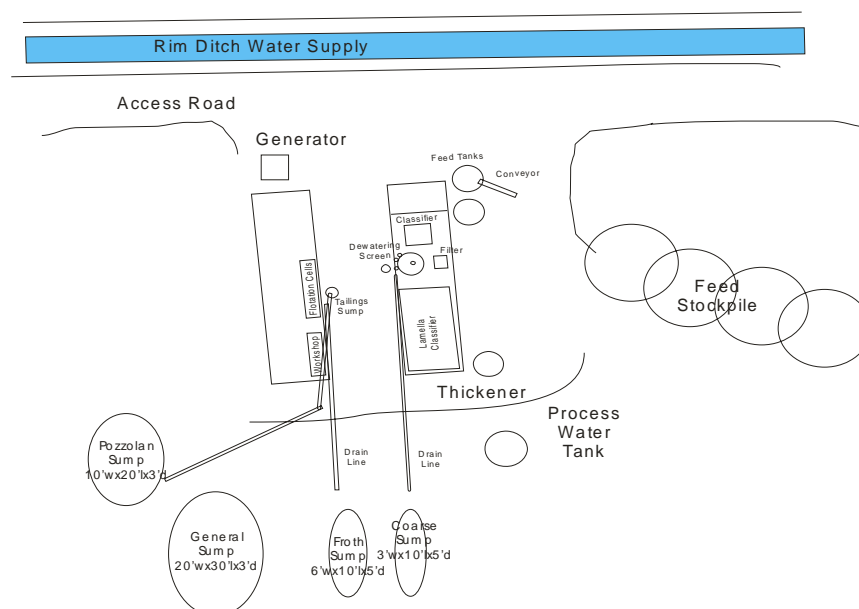


Figure 7. Diagram of site layout.



## Description of Field Test Apparatus

Feed System. The feed system consists of two 500 gallon tanks (Figure 8). Water is metered into the first tank while ash is introduced with a conveyor that is fed with a Bobcat loader. The mixture is agitated with a mechanical stirrer while slurry is pumped from the bottom of the tank with a centrifugal pump (100 gpm) and circulated back into the top of the tank. Additional water or ash is added to achieve the desired pulp density, which is monitored with a Marcy density scale. Once the desired pulp density is achieved, the slurry is diverted into the second 500 gallon tank through a 6 mesh trash screen to ensure that extraneous sticks, weeds or other coarse debris is excluded from the feed slurry. The second feed tank is also agitated with a mechanical stirrer while slurry is pumped back into the top of the tank with a 100 gpm centrifugal pump. The dual tank feed system provides for a more consistent slurry pulp density.



Figure 8. Feed tanks, hopper, conveyor and loader.

Primary Classifier. The primary classifier (Figure 9) is designed and operated primarily to remove the coarsest materials, those greater than ~100 mesh (150  $\mu\text{m}$ ). Core evaluations reported previously showed that there is significant variation in the quantity and grade of the +100 mesh fraction while the -100 mesh material is much more consistent. Thus efficiently removing the +100 mesh fraction will provide a more consistent slurry to the other unit processes. Feed slurry is pumped into a constant-head box where it flows at a constant rate into the classifier. Fine particles (-100 mesh) overflow a launder at the top of the device while particles that are too coarse to remain in suspension (i.e. +100 mesh) settle and are removed as a thickened slurry from a tapered chamber at the base of the

device with a variable speed pump. Since the separation is based on the settling velocity of the coarse particles, separation efficiency does not change as the size distribution of the feed changes.



Figure 9. Primary classifier.

Secondary Classifier. The secondary classifier was fabricated from  $\frac{1}{4}$ " steel plate. It consists of four chambers, which are included at  $45^\circ$  from the horizontal. The sides of the chambers are 48" the width is 48". Each chamber contains three racks which are slotted at 1" intervals. A total of 15 lamella made of  $\frac{3}{8}$ " thick plastic cardboard were used in three of the cells. The first cell was designed to remove the coarse particles used 6 lamella at a wider spacing. The classifier plenum employs 5 feed points (Figure 10). As coarse particles settle, they are collected in hoppers under each chamber and removed as a slurry by variable speed pumps (Figure 11) while suspended fine particles overflow the device at the opposite end.



Figure 10. Secondary classifier with feed distributor and lamella plates.

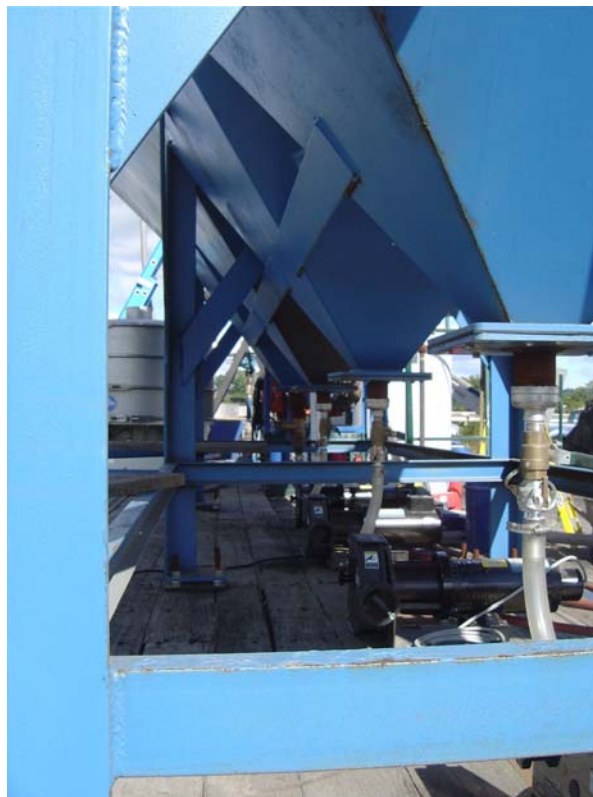


Figure 11. Underside of secondary classifier.

Flotation Cells. A bank of 6 Denver mechanical froth flotation cells are contained in a separate trailer. Each cell consists of a 2'x2'x2' box with a mechanical agitator (Figure 12). Each cell is separated by a wall with a gate valve to enable separate adjustment of slurry level. Froth is removed from each cell with mechanical scrapers and flows into a common launder while tailings exit the last cell through a gate valve. Reagents will be metered into the air intakes of the first cell. Retention time will be varied by controlling the feed rate.



Figure 12. Flotation cells.

## **Feed Sample Excavation and Preparation**

In order to conduct field testing it was first necessary to prepare a representative quantity of feed ash, prepare it in a manner that would be consistent with the methods envisioned for commercial scale operations, and blend it to be reasonably consistent. The location where the test sample was excavated (see Figure 1) was selected based on results of coring studies described in previous reports. Feed from this region of the pond is reasonably representative with respect to size distribution and chemistry.

In order to excavate the feed ash, a back hoe was leased and hauled to the site. Using the back hoe (Figure 13), a trench measuring approximately 8' wide x 8' deep x 60' ft long was excavated (Figure 14). The excavated ash was transported with the backhoe to the edge of the pond adjacent to the test pad, stockpiled and allowed to dry (Figure 15).

The stockpiled ash was then screened by reconfiguring the feed hopper, conveyor and vibrating screen. Using a Bobcat loader, stockpiled ash was fed onto the conveyor, which in turn fed the vibrating screen which was equipped with a 3/8 inch x 4' diameter screen. The ash passing the screen (-3/8 inch) was conveyed to another stockpile using an additional conveyor (1' x 26') that was leased for this purpose. Oversize material (+3/8 inch) was collected in wheel barrows, dumped and allowed to dry. The oversize consisted of weeds, sticks, bottom ash and primarily clumpy balls of fine ash. So as not to bias the sample, the dried oversize was periodically crushed with the Bobcat tracks and fed back onto the screen until the oversize consisted of only weeds, sticks and bottom ash. While this process was lengthy and labor intensive, it was deemed essential to remove extraneous material in order to prevent plugging during testing. Feed preparation was continued until a stockpile of approximately 150 tons of -3/8 inch ash was generated (Figure 16). A random composite sample of the stockpiled feed ash was collected and the size distribution (Table 1) showed that the feed was comprised of essentially fine ash (90.3% -100 mesh).





Figure 13. Backhoe excavating ash.



Figure 14. Excavated trench.





Figure 15. Transporting excavated ash.



Figure 16. Stockpile of -3/8 inch feed ash.

Table 1. Size distribution of feed ash stockpile.	
Size Fraction (mesh)	Weight %
-3/8 inch +16	0.1
-16+30	0.6
-30+50	2.2
-50+100	6.8
-100	90.3
Total	100

### **Additional Activities**

In addition to installing the field test unit and preparing the feed sample, several other activities relevant to this project also took place. A technical presentation was presented at the World of Coal Ash meeting held in Lexington, KY on April 11-15, 2005.

A site visit was made to Cemex's U.S. Laboratory in Tampa, FL on April 18, 2005. Discussions were held with Dr. Hugh Wang, Dr. Chengqing Qi and Dr. Waltter Lopez on field test and concrete testing protocols. In addition, a project summary was presented.

A day long in-house training class was held on Microsoft Project Professional for CAER staff involved in the Ghent Project.

An evaluation using a polycarboxylate dispersant (Grace ADVA-100) in place of the NSF for a de-floccing agent on the Ghent material was completed. Only 1/8 of the dosage of the polycarboxylate was needed, which is important as it is much more expensive and must be more effective to be useful. Two laboratory-scale classifier tests were conducted with the Ghent material as feed using polycarboxylate. Good yield and recover were obtained.

### **CONCLUSIONS**

Construction of the mobile demonstration plant has been completed. The entire plant was disassembled, packed onto trailers and hauled to the test site. A location and strategy for trailer placement was selected. The test site was prepared and the trailers were placed in the selected location. All of the equipment was un-packed and re-assembled, electrical and plumbing connections were made and the field test unit was tested for leaks and proper electrical wiring. A representative feed sample was excavated from the ash pond and pre-screened at 3/8 inch to remove extraneous debris and coarse ash to prevent plugging during testing. The feed ash stockpile contains approximately 150 tons of -3/8 inch ash, a quantity that should be sufficient to complete the anticipated test work.