

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

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Principal Authors: John Groppo and Thomas Robl

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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 Utility's 2,200-MW Ghent Generating Station, located in Carroll County, Kentucky. This part of the study includes an investigation of the secondary classification characteristics of the ash feedstock excavated from the lower ash pond at Ghent Station.

The secondary classification testing was concluded using a continuous demonstration-scale lamella classifier that was operated at a feed rate of 0.3 to 1.5 tons/hr. Feed to the secondary classifier was generated by operating the primary classifier at the conditions shown to be effective previously. Samples were taken while the secondary classifier was operated under a variety of conditions in order to determine the range of conditions where the unit could be efficiently operated.

A Topical Report was prepared and included all of the pertinent processing data generated during Budget Period 1 of the project as well as results of beneficiated ash product evaluations in mortar and concrete, schematic plant designs with mass and water balances for the four flowsheets tested with equipment lists, capital and installation costs, expected product outputs and equipment justifications.

A proposal for continuation of the project to Budget Period 2 was also prepared and submitted, with the exception of a Letter of Commitment from Cemex. The proposal is currently under internal review with Cemex and a decision is expected by the end of September, 2006.

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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.

A mobile demonstration plant with a feed rate of 2.5 tph was constructed and operated at the Ghent site. The plant was used to evaluate four different flowsheet configurations for beneficiation of the stored ash at Ghent Station as well as to generate several tons each of various processed ash products. The processed ash products were used for performance evaluations in mortar and concrete, as well as process addition in the manufacture of cement clinker. Performance evaluations are still in progress.

Secondary classification testing was concluded using inclined lamella plates as settling surfaces for coarser ash particles. Evaluations included using primary classification overflow as feed with and without flotation to produce UFA. While flotation did provide a lower grade UFA by removing fine carbon, some of the carbon reduction was attributed to changes in stockpile feed grade. A dispersant dosage of 2 to 2.5 g/kg was adequate to provide UFA grade (3.8 to 4.4  $\mu\text{m}$ ) and recovery (53 to 68% 5 $\mu\text{m}$  recovery). The UFA yield without incorporating flotation was ~33% and lower (~20%) when incorporating flotation. Flotation also reduced the amount of unburned carbon in the UFA product from 4.5% to 2.5% LOI.

A Topical Report was prepared detailing all of the pertinent data generated during Budget Period 1 of the project and included results of beneficiated ash product evaluations, schematic plant designs with mass and water balances for the four flowsheets tested along with equipment lists, capital and installation costs, and expected product outputs. Specific equipment justifications were also included, based upon results of site testing with the mobile demonstration plant.

A proposal for continuation of the project to Budget Period 2 was also prepared and submitted, with the exception of a Letter of Commitment from Cemex. The proposal is currently under internal review with Cemex and a decision is expected by the end of September 2006.

## **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 research that was conducted during the second quarter of 2006. The focus of the effort was to complete testing on secondary classification to produce an ultra-fine ash (UFA) product. The feed to the secondary classifier was the overflow from the primary classifier, with and without froth flotation to remove fine carbon. Operating conditions to the secondary classifier were evaluated along with the physical configuration of the classifier, in order to generate pertinent scale-up data. Bulk products produced from demonstration plant testing are being evaluated for use in mortar and concrete.

A significant amount of the effort expended during this reporting period was devoted to completing the required Topical Report and Budget Period 2 Proposal.

## **FIELD DEMONSTRATION TESTING**

### **Secondary Classification**

The final three field tests were run during the reporting period on May 8<sup>th</sup>, 2006 (tests 92-94). The entire circuit was tested, i.e. primary classifier, froth flotation, and secondary classifier. For these tests, the length of the lamellae was extended and the secondary classifier was deepened by eight inches.

The results of the tests were similar to those reported previously. The deepening of the classifier did not appear to adversely affect its performance, at least within the bounds of these tests. The size distribution of the feed and products from the test 92 is presented in Figure 1. The final cleaned products from the lamellae classifier were very fine, with mean diameters of ( $D_{50}$ ) of 3.5, 3.3 and 3.0  $\mu\text{m}$  for the three tests. A yield of 18% and 5  $\mu\text{m}$  recovery of 55% at a product grade of 3.0  $\mu\text{m}$  was ultimately achieved during test 94, which is well within the bounds of the yield-grade data range for the 3 cm lamellae spacing.

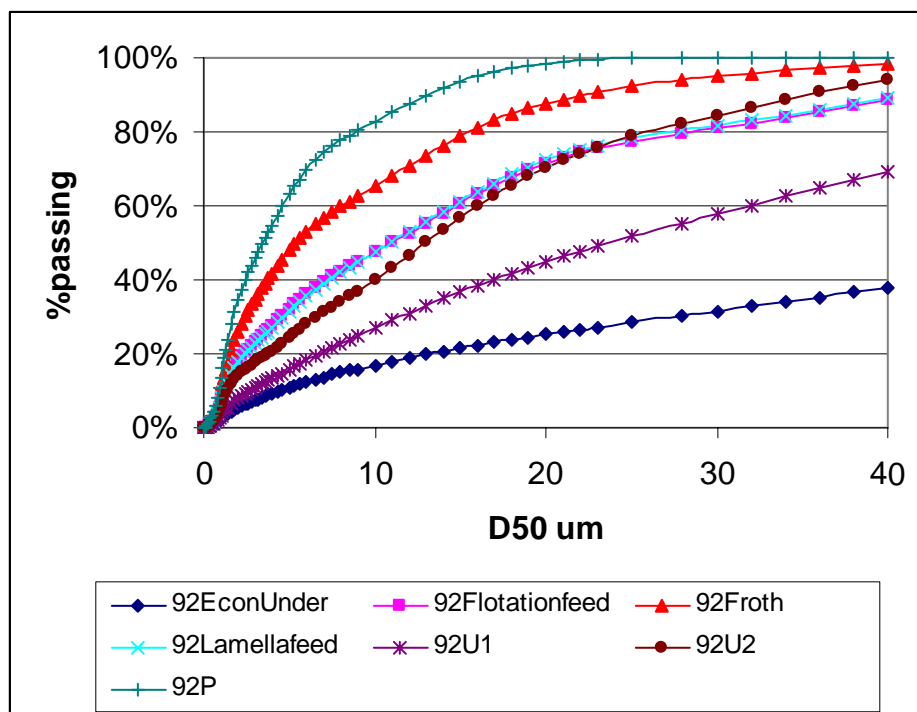


Figure 1. Size Distribution of Products from Test No. 92.

Several operational problems were encountered during the tests. The feed rate to the secondary classifier and the flotation circuit varied significantly due to an electrical failure and the plugging of the primary classifier underflow pump. The feed rate to the secondary classifier was 101, 94 and 49 l/min (26.8, 24.9, 12.9 gpm) over the tests series. Our target was ~110 l/min. The dispersant dosage varied from 1.3 to 4.6 g/kg well outside our target of 2.0 to 2.5 g/kg. This was in part due to feed fluctuations and in part due the metering pump, which developed an air leak.

## Dryer Design

Discussions were held with technical representatives from Louisville Dryer Co., Louisville, KY to determine the most appropriate thermal drying approach for the UFA product. Since the UFA product is so fine ( $d_{50}$  of 3-6  $\mu\text{m}$ ), it was surmised that an entrained flow dryer would require a significant particulate capture system. A preliminary recommendation was made for a rotary steam tube dryer using an auxiliary source of heat for steam generation. Using this indirect drying method is more thermally efficient while minimizing the amount of air passing through the system and significantly simplifies the particulate removal system. Feed and product specifications were provided along with a request for a preliminary price quotation.



## **REPORTING**

### **Topical Report**

As required in the work statement, a Topical Report was prepared summarizing the work completed in Budget Period 1 of the project. The Topical Report summarized the following test work:

#### **Product Evaluations**

- Product Evaluations in Mortar
- Product Evaluations in Concrete
- Product Evaluations as Process Addition

These evaluations were conducted on products generated by the mobile demonstration plant operating at the Ghent site. Bulk products generated with a variety of flowsheet configurations were evaluated.

#### **Process Evaluations**

Four different flowsheet configurations were evaluated during Budget Period 1. Flowsheets were generated for each configuration and schematic diagrams were developed using a design basis of 50 tph dry solids feed rate. The flowsheets were mass balanced using data collected during site testing to determine equipment sizes.

#### **Plant Costs**

Equipment costs were estimated for each flowsheet using single vendor quotes for specific equipment items. Installation costs were also summarized using guidelines recommended by Architecture and Engineering firms familiar with similar types of projects.

#### **Equipment Justification**

Based upon the data generated during site testing, justifications were prepared for the following unit operations: plant feed system, primary classification, spiral concentration, froth flotation, thickener, pozzolan filter, and secondary classifier.

#### **Budget Period 2 Proposal**

A proposal for continuation of the project to Budget Period 2 was prepared and submitted. This proposal included all of the required documentation with the exception of a Letter of Commitment from Cemex. The proposal is currently under internal review with Cemex and a decision is expected by the end of September 2006.