CARBON BURN-OUT at the WATEREE STATION of SOUTH CAROLINA ELECTRIC & GAS

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Abstract

Carbon Burn-Out (CBO) combusts residual carbon in fly ash, producing a very consistent, less than 2% carbon, high-quality pozzolan. The process is continuous and is fueled solely by the residual carbon. Heat is recovered and sent back to the power plant that originally produced the high-carbon fly ash. The CBO process is an improvement on bubbling fluid bed technology.

Progress Materials, Inc. has developed this technology, with support from EPRI and EPRI members. A one tph CBO pilot plant was constructed and operated on a wide variety of ash sources. Data gathered at this plant during test programs provided the design parameters for full-scale CBO plants. Extensive concrete testing was also undertaken in order to demonstrate the superior characteristics of very low-carbon Class F fly ash from Carbon Burn-Out.

In 1997, South Carolina Electric & Gas contracted with Progress Materials to provide a Carbon Burn-Out facility at Wateree Station. Initial site work began in December, 1997, on a plant designed to process 180,000 tpy of ash. Start-up activities will commence in mid-1998. Following commissioning, the SCE&G plant staff will operate the Wateree CBO plant.

Heat from residual carbon combustion is recovered from both the flue gas and from the hot product ash. This recovered heat is returned to Wateree Station by heating a portion of the power plant's condensate stream. This portion of the condensate stream bypasses several feedwater heaters, thereby reducing the amount of extraction stream required, while increasing the quantity of steam available to the turbine-generator.

This paper presents information about the design and construction of the Wateree Carbon Burn-Out plant, which was in start-up at the *Proceedings* publication date for

By the early 90's, this marketing effort, coupled with a reasonable supply of ash, led to a market that would willingly accept essentially all concrete-quality fly ash that the several SCE&G coal-fired stations produced. However, the sources' ash carbon content was often marginal at best and non-saleable to the concrete market at worst. In addition, SCE&G recognized that changes in combustion conditions designed to meet Low NO_x regulations would lead to a further diminishment in fly ash quality. As quality was already marginal at several stations, further diminishment would essentially shut this fly ash out of the local concrete market, which was strong and growing. SCE&G determined to avoid that outcome, and undertook an extensive review of ash beneficiation technologies. Carbon Burn-Out was selected for installation at the Wateree Station, a two-unit, 772 MW plant southeast of Columbia, SC.

Early in 1997, fifty tons of Wateree high-carbon fly ash were processed in the one tph The LOI of the Wateree fly ash exiting the CBO pilot plant was less than 2%. This material was shipped to Southeastern Fly Ash Co., SCE&G's ash marketer, for extensive laboratory tests and ready-mix field trials. Results demonstrated that concrete mixes made with CBO fly ash replacing varying percentages of portland cement had nearly identical plastic and hardened characteristics to control mixes containing only cement. In short, the CBO fly ash provided significant benefits to the concrete mixes without undesirable 'side effects'.

The philosophy governing the Wateree CBO plant design includes several important elements:

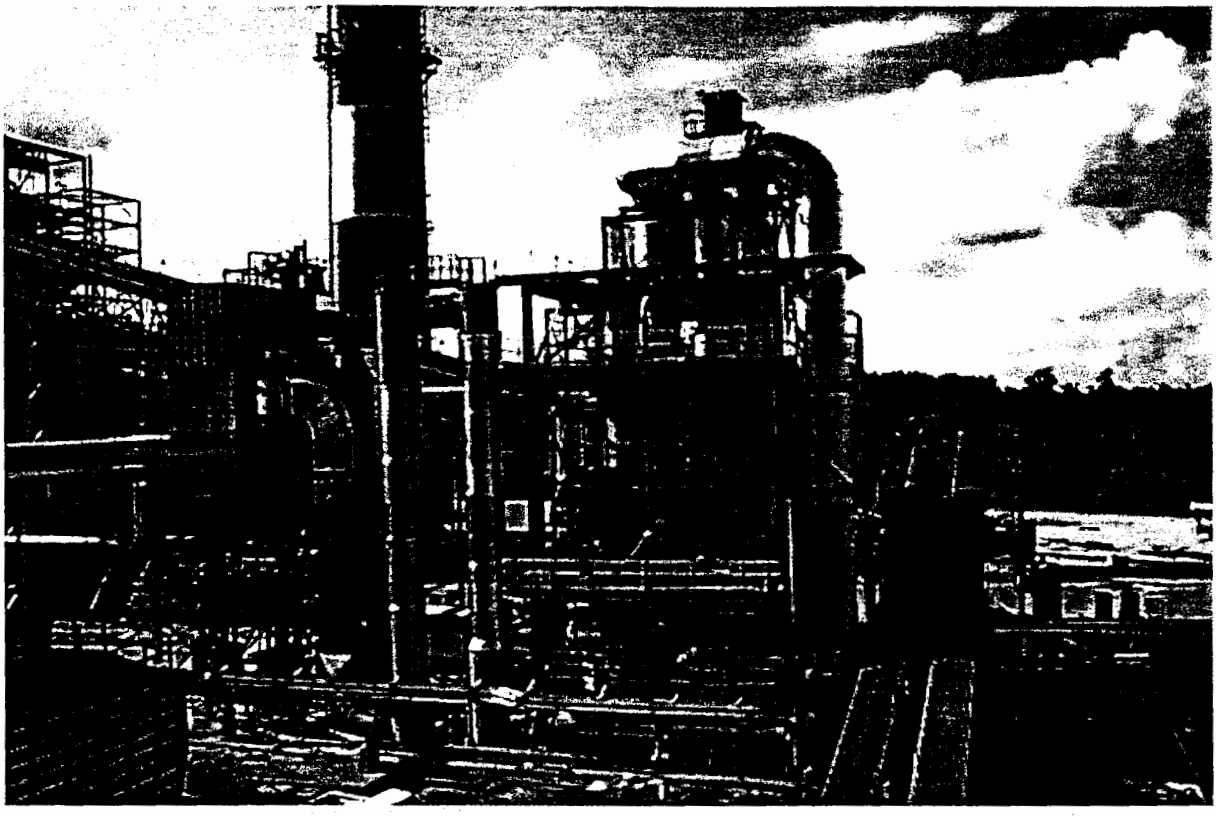
- avoid any negative impact on power plant operations from an upset condition in the CBO plant
- maximize recovered heat to the power plant
- include provisions for receiving high-carbon ash from other sources

- minimize operational labor requirements
  - 'utility-grade' equipment
  - extensive instrumentation

    - sophisticated control system
    - open plant layout for easy maintenance access
- maximize market value of Carbon Burn-Out product ash
    - CBO control system keyed off ash product quality, not feed LOI
    - New storage and load-out system
        - Re-route ash truck traffic
        - Provide round-the-clock product loading
        - Two loading stations, both on scales
        - 14,000 ash storage to maintain product availability during outages

The process flow at CBO Wateree may be easily summarized:

- high-carbon ash is pneumatically conveyed from silos to the CBO plant
- FD fan provides fluidization and combustion air to CBO fluid bed combustor
- feed ash is metered into the combustor
- carbon combusts on a continuous basis
- material exits CBO combustor
    - product fly ash
    - flue gas
- heat exchange occurs between hot product ash + hot flue gas and condensate from the power plant
    - product ash and flue gas exits at < 300° F
    - heated condensate returns to power plant's feedwater heater system
- product ash is separated from flue gas via cyclone and baghouse
- ID fan maintains entire CBO system at a slight negative pressure, transports product ash through the heat exchanger, and transports cooled, particulate-free flue gas to power plant stack.
- product ash is pneumatically conveyed to load-out area



CBO plant with Wateree stack in background

Referring to the above photo, the fluid bed combustor is within the tower at right-center. The heat exchanger is the inverted "U" in the center, and the product ash/flue gas separation takes place in the tower at left-center. FD and ID fans are behind the heat exchanger, as is the condensate pump and piping system. The CBO Control Room is just off the right border.

The CBO site was selected for offering minimal duct runs while maintaining open access to all existing power plant systems. The ash product storage and load-out system is ~ 200' behind the photographer.

The CBO fluid bed combustor was designed and fabricated by DB Riley, using PMI's process design parameters. The combustor is a refractory-lined steel box divided into two cells to allow precise process control. The bed consists of only fly ash. For ease of maintenance, nearly all penetrations are through the roof. Start-up burners, fired by No. 2 oil, are provided above the bed and also in the air plenum below the bed. These burners are shut down once the bed reaches the residual carbon auto-ignition temperature of ~ 950° F.

CBO fluid bed temperature control is precisely maintained by a 'recycle' system metering cooled product ash back to the bed, where the returning product ash acts as a

thermal load. The rate at which this ash is metered into the bed is determined by the temperature profile in the fluid bed at any point in time; increasing temperatures signal for more cool ash, declining temperatures signal for less. Pilot plant work first demonstrated this to be a very effective temperature control technique. It has the added benefit of 'smoothing out' minor variations in ash product LOI.

Environmental permitting for the Wateree CBO project was relatively straightforward. There is no solid waste stream from the CBO process at all -- incoming high-carbon ash exits as a combination of product ash and flue gas. Wateree's heat rate is materially improved, resulting in less coal combusted for a given amount of electricity produced. Fly ash disposal at Wateree is eliminated. Although not specifically addressed in the permitting process, the regulatory agencies recognized that fly ash use in concrete provides significant CO_2 reductions via cement replacement.

In summary, Carbon Burn-Out at the Wateree Station will process 180,000 tons of high-carbon fly ash annually. The product ash will be less than 2% carbon. There will be 475,000 MM BTUs per year of useful heat recovered back to the Wateree units. Ash storage and load-out are intended to minimize freight costs and maximize ash availability. Start-up is underway in mid-1998, with full operations anticipated by year-end.