CARBON BURN-OUT SYSTEM
WATEREE STATION

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Abstract

South Carolina Electric & Gas Company decided to investigate designing and constructing a Carbon Burn-Out system to bring the unburned carbon content of fly ash down to the level acceptable for use in the manufacture of concrete. A joint project between SCE&G and Progress Materials Inc. produced a Carbon Burn-Out CBO) plant that has been constructed at Wateree Station located in Eastover, South Carolina.

Introduction

The Clean Air Act (CAA) of 1990 began for South Carolina Electric and Gas, what has been and will continue to be a search for technologies and hardware in order to comply with "The Act" and improve the quality of our coal combustion products. We saw the proverbial "hand writing on the wall" in the early part of 1991 and it said, "the carbon content in your coal after low NO_x burner installation is going to significantly increase." As we review our situation now in the latter part of 1998, we absolutely know that the hand writing did not lie. We are installing low NO_x burners on the last of our coal fired units and we are losing our ASTM C-618 concrete quality ash sales due to high carbon content in the fly ash.

South Carolina Electric & Gas (SCE&G) currently has about 2600MW of coal fired electric generation. We produce approximately 400,000 tons per year of conventional fly ash and bottom ash. In addition, our newest plant, Cope Station, produces a total of approximately 200,000 tons of Flue Gas Desulfurization products and bottom ash. We have historically utilized approximately 80% of all the conventional coal combustion products (CCP's) that we generate. This has made a significant impact on generating revenues by avoiding disposal costs and saving valuable existing space in our ponds and land fills. The position and policy of our upper management is that we should continue to maximize utilization and minimize disposal of our CCP's. The market for sales of our fly ash has been established by Southeastern Fly Ash Company (SEFA) over a period of many years and it is currently very good. In order to continue selling into that market, and to increase our sales, we realized that we would have to find, invest in, and install new technology to lower the carbon content our fly ash. We began an extensive search

and review of all the carbon removal technologies under development, some being very recent and untried. The various types of processes included electrostatic, froth floatation, and carbon burning. As these various technologies developed, we began to narrow our evaluation.

For the SCE&G coal fired generating plants, the carbon burning technologies seemed to offer the most advantages for us. The advantages included: 1) heat recovery, 2) no solid waste, 3) no liquid wastes, 4) maximum avoided disposal tons and 5) a premium sales ash product. In May 1997 we committed to a technology pioneered by Progress Materials, Inc. Detailed design engineering began that month and in late December 1997, we broke ground for construction of a Carbon Burn-Out system (CBO). Plans are to truck fly ash from two other plant sites (McMeekin Station and Urquhart Station) to the Wateree CBO . These three plants will contribute approximately 180,000 tons of raw feed/high LOI. (12% - 13%) fly ash to the fluidized bed for carbon reduction and heat recovery. The CBO technology was initiated and patented by Progress Materials Inc. in the early part of 1990. PMI is a Florida Progress Company located in St. Petersburg, Florida. It was further developed and pilot plant tested with the assistance of the Electric Power Research Institute (EPRI).

Another benefit derived from this process is the overall reduction of carbon dioxide emissions. CO_2 is generated in the calcining process (changing limestone to lime) and in the burning of fossil fuel needed to make the calcining reaction take place. For every ton of fly ash used as cement replacement, 0.8 tons of CO_2 is <u>not</u> created.

<u>Station Description</u>

Wateree Station, constructed in the early 1970's, is composed of two base-loaded 385 MW Riley Stoker supercritical units. The plant is located on the Wateree River in Eastover, South Carolina.

Each boiler has a capacity of 33,000 gallons, has full flow deep bed condensate polishing and both units are on oxygenated water treatment.

Carbon Burn-Out Design Features

- Fluid Bed Combustor (FBC)

  The combustor is a bubbling fluid bed, operating at ambient pressure. It combusts residual carbon in fly ash, operating on a self-sustaining basis with high-carbon (>6% C) fly ash continuously feeding into the FBC, and low-carbon product ash (<2% C) continuously exiting the combustor. It is very important to note that the fuel for combustion in the FBC is the residual carbon in the fly ash. Start-up is by No. 2 oil, with the start-up burner system shut off after residual carbon begins auto-ignition. In this respect, the FBC operates much like a PC boiler.

  The air required for proper fluidization of the ash bed is also the combustion air. This air is provided by an FD fan and an ID fan, controlled so that the entire CBO system operates under a slight negative pressure. These fans provide the motive power for carrying product ash and flue gas through the entire system: FBC, heat exchanger, particulate clean-up. Again, this system's design and operation is nearly identical to that of a typical PC boiler.

  The fluid bed is a refractory-lined vessel divided horizontally by an air distribution plate. Below this plate, a plenum receives air from the FD fan. Moderate air velocity through the air distribution plate provides uniform fluidization while minimizing ash entrainment with the flue gas. The material bed is ~ 4' deep when fluidized and consists solely of fly ash. The Carbon Burn-Out FBC contains no heat exchange surface; temperature control in the combustion zone is provided by recirculation of cooled product ash back into the FBC.

  The primary control point for FBC operations is the carbon content of the ash product. Because of very good horizontal and vertical mixing within the FBC, the carbon content of the bed is nearly identical to the carbon content of the ash exiting the FBC. Ash samples are taken directly from the bed and analyzed for carbon content by a rapid test method. Trends diverging from the design set-point initiate a control response: decreasing carbon signals for an increase in high-carbon ash feed

rate while increasing carbon signals for a decrease in feed rate. Because of this control method, Carbon Burn-Out responds automatically to changes in feed ash carbon content. The carbon content of the product ash remains constant, and is independent of the feed ash carbon content.

- Heat Recovery

  Hot product ash and flue gas exits the FBC at ~ 1350° F and passes through the tubes of a shell and tube heat exchanger. The flue gas and product ash exit at ~ 300° F. Condensate from the selected Wateree unit flows around the tubes, and the heated condensate returns to the low pressure feedwater heaters. The water side of the system will be on oxygenated water treatment. Recovering heat into the feedwater heater system directly increases the amount of steam reporting to the turbine-generator.

- Particulate control

  Following the heat exchanger, cooled flue gas and product ash are separated by a cyclone and baghouse. Particulate-free flue gas then passes through the ID fan, and flows to the selected Wateree stack, downstream of the power plant's ID fans. The duct from the CBO plant is fitted with the same CEMS instrumentation used by the power plant.

- Ash System

  High carbon ash from McMeekin and Urquhart Stations arrives by truck at Wateree and is received into two 250 ton capacity silos. High carbon ash produced at Wateree is received in the existing silo, now fitted with an ash transport system to the CBO plant.

  Ash pneumatic transport is by dilute-phase, low-pressure air systems. All systems are standardized for ease of maintenance.

Product ash is conveyed to a 1200 ton capacity silo cluster, fitted with dual load-outs including scales. This system will be available round-the-clock, and operated by truckers transporting the product ash to customers. The ash load-out area is located several hundred feet from the power plant, and has its own access road to avoid conflicts with power plant operations.

To accommodate both low ash production during power plant outages and reduced ash demand in winter, a free-standing concrete dome is being constructed adjacent to the load-out silos. This dome, with an ash capacity of 14,000 tons, includes a reclaim system for recharging the load-out silos.