Ammonia Removal from Coal Fly Ash by Carbon Burn-Out

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Introduction

Carbon Burn-Out (CBO) has been found to be a very robust system for both carbon and ammonia removal for various types of ash feed stocks. Ash feed stocks containing carbon contents ranging from 7% to 90% and ammonia concentrations approaching 1000 ppm have been successfully processed.

Commercial application of CBO began at the Wateree Station of South Carolina Electric and Gas, which was placed in service in early 1999 to process 180,000 tons per year of raw fly ash. A second unit, capable of processing 200,000 tons per year, was built at the Winyah Station of Santee Cooper and placed into service in 2002.

Winyah CBO begins operation in 2002

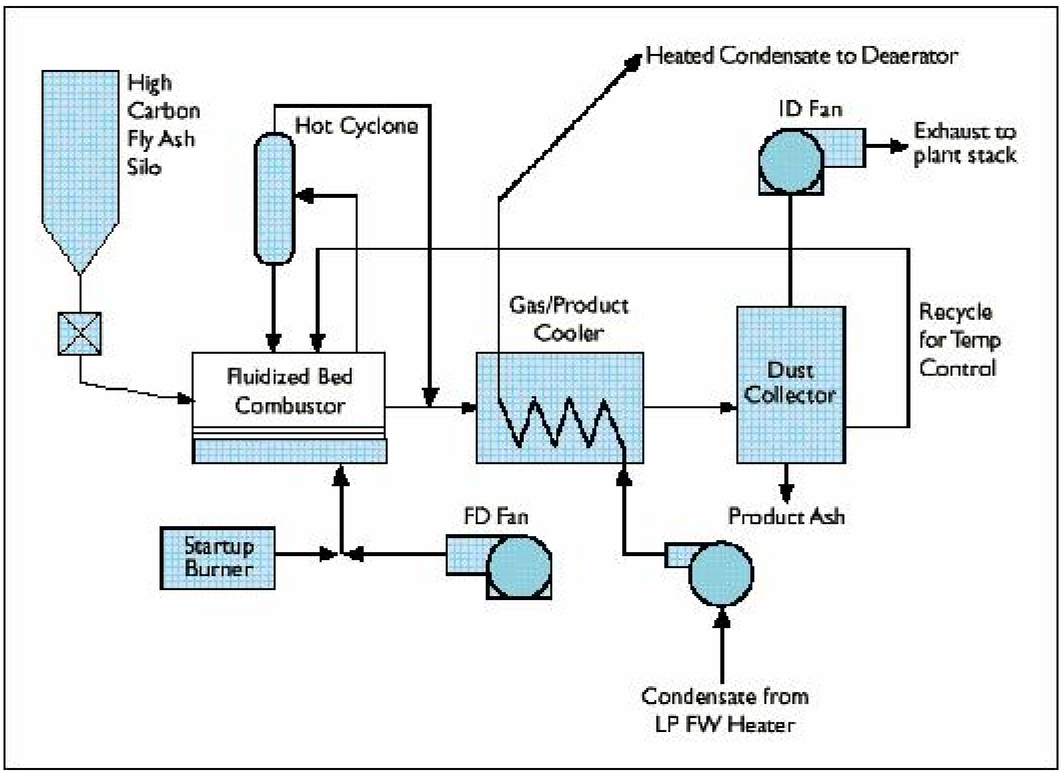
Carbon Burn-Out is a thermal process designed to combust the residual carbon in fly ash. The CBO process begins with high carbon fly ash being pneumatically transported to the CBO storage silo. The high carbon fly ash is then metered into the fluid bed. A forced draft fan provides both fluidization and combustion air.

The fluid bed is then heated to a temperature of approximately 1000° F. At this temperature self sustained combustion begins and fly ash feed is added to maintain combustion rate. Fluid Bed exhaust gas and processed fly ash then flow through the Gas/Product cooler. This feature allows for the recovery valuable heat, which is returned to the host power plant's steam cycle.

Once the fly ash exits the gas product cooler, the low carbon fly ash is transported to product storage or directly to load-out operations.

The CBO process is illustrated in Figure 1:

FIGURE 1:



The CBO-process consistently produces fly ash that exhibits consitent pozzolanic activity, air entrainment, and LOI at 2.5% or less. CBO processed ash has gained excellent market acceptance in its market areas.

Recently, fly ash marketers have expressed concern about ramifications from post-combustion NOx reduction techniques using ammonia. Coal fired power generation facilities are under increasing pressure for NOx emission reductions. Recent United States EPA rule changes will require many coal fired utilities to meet NOx emissions limitations of 0.15 lbs./ MMBTU or less.

In order to meet these requirements, many utilities will use a combination of combustion management and post-combustion processes. Combustion management techniques include low NOx burners, over-fire air systems, gas re-burning technology and flue gas re-circulation. These methods can contribute to higher residual carbon levels in fly ash, especially when operating for maximum NOx removal.

Post-combustion processes include Selective Catalytic Reduction (SCR) and Selective Non-Catalytic Reduction (SNCR). Use of either of these treatment technologies will result in fly ash contaminated with ammonia slip, which may be then un-marketable, depending on the concentration.

Given the industry's concerns, Progress Materials conducted investigations as to ability of the Carbon Burn-Out process to remove ammonia residues from fly ash.

Several different ammonia contaminated fly ash feed samples were processed using the Carbon Burn-Out system. Fly ash samples were acquired from generating stations that use either SCR or SNCR as their treatment technique. Reagents used in these systems include both urea and ammonia.

During CBO processing, feed and product samples were analyzed for ammonia content to determine ammonia removal efficiency. Table 1 illustrates ammoniated fly ash samples processed by Carbon Burn-Out. Ammonia content of the feed and product, NOx control device used and reagent are illustrated.

Table 1:

Feed Ash (PPM)	Product Ash (PPM)	Control Device	Reagent
60	< 5	SCR	Ammonia
230	< 5	SNCR	Ammonia
300	< 5	SNCR	Ammonia
500	< 5	SNCR	Ammonia
650	< 5	SNCR	Ammonia
700	< 5	SNCR	Urea
735	< 5	SNCR	Urea

Results indicate that under normal Carbon Burn-Out operating conditions essentially all ammonia was liberated from the fly ash feed material.

The next phase of the study involved the determination of the fate of released ammonia in the flue gas. To quantify the extent of thermal decomposition of ammonia, flue gas ammonia concentrations were measured at the fluid bed exhaust and the exhaust stack.

Results of testing designed to duplicate full scale operations indicate that between 94 and 98% of the ammonia introduced into the system is being thermally decomposed. Samples acquired at the fluid bed exhaust and exhaust stack produced similar concentrations and decomposition efficiencies.

Conclusions

The Carbon Burn-Out process successfully treated ammoniated fly ash. Ammonia concentrations between 300 ppm and 750 ppm were evaluated and in all cases the Carbon Burn-Out process reduced ammonia concentrations below detectable levels.

Carbon Burn-Out technology has the necessary conditions for thermal decomposition of the liberated ammonia released from the fly ash. Full scale Carbon Burn-Out conditions result in 94 to 98% of the liberated ammonia undergoing thermal decomposition to harmless nitrogen and water.

Finally CBO pilot demonstrations proves that fly ash ammonia contamination can be eliminated without any process changes.