STI's Commercial Beneficiation of High LOI Fly Ash

James D. Bittner and Stephen A. Gasiorowski
Separation Technologies Inc., 10 Kearney Road, Needham, MA 02494
Tel: 781-455-8824, Fax 781-433-0289

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Separation Technologies, Inc. has been operating commercial fly ash beneficiation systems since 1995. STI's electrostatic beneficiation reduces the carbon content of coal fly ash, producing a consistent, low LOI ash for use as a substitute for cement in concrete applications.

The Technology

In the STI separator, material is fed into a thin gap between two parallel planar electrodes. The particles are triboelectrically charged by interparticle contact. The positively charged carbon and the negatively charged mineral are attracted to opposite electrodes. The particles are then conveyed by a continuous moving belt and conveyed toward opposite ends of the separator. The counter current flow of the separating particles and continual triboelectric charging by mineral collisions provides for a multi-stage separation and results in excellent purity and recovery in a single-pass unit. The high belt speed also enables very high throughputs, up to 40 tons per hour on a single separator. By controlling various process parameters such as belt speed, feed point and feed rate, the STI process produces low carbon fly ash at LOI contents of 2%±0.5% from feed fly ashes ranging in LOI from 4% to more than 25%. Start up and shut down of the system is also very rapid. Balance of plant equipment startup is actually the limiting factor since the separator reaches steady state operation in a matter of seconds.

The separator design is relatively simple and compact. The belt and associated rollers are the only moving parts. The electrodes are stationary and composed of an appropriately durable material. The belt is made of plastic netting material. The separator electrode length is approximately 20 feet and the width is dependent on the capacity desired. A machine designed to process 40 tons per hour is approximately 30 ft. long, 5 ft. wide and 9 ft. high. The power consumption of the separator is about 1 kilowatt-hour per ton of material processed with most of the power consumed by two motors driving the belt. The required balance of plant consists of systems to convey dry fly ash to and from the separator. The compactness of the system allows for flexibility in installation designs: two STI separators with a combined processing capacity of 450,000 tons/year have been installed in a truck loading bay of an existing 44 ft. diameter fly ash silo.

The small gap, high voltage field, counter current flow, vigorous particle-particle agitation and self-cleaning action of the belt on the electrodes are the critical features of the STI separator. The process is entirely dry, requires no additional materials other than the fly ash and produces no waste water or air emissions. The recovered materials consist of fly ash reduced in carbon content (LOI) to levels suitable for use as a pozzolanic admixture in concrete, and a high carbon fraction which can be reburned at the generating plant. Utilization of both product streams provides a 100% solution to fly ash disposal problems.

Commercial Operations

STI currently has commercial installations at U.S. Generating's Brayton Point Station (two separators), Carolina Power & Light's Roxboro Station (two separators), and Constellation Power Source Generation's Brandon Shores Station (one separator). Over 1.1 million tons of STI processed fly ash has been sold to concrete producers from these installations.

Unburned Carbon Fuel Value

The reburning of high-LOI fly ash in utility boilers is a relatively simple method of utilizing this unburned carbon (UBC). Furthermore, recovery of the residual energy contained in the high-carbon fly ash increases the value of the beneficiation process directly to the power plant operation in the form of reduced fuel costs.

New England Power (NEP) and Salem Harbor Station demonstrated the combustibility of high carbon ash from the STI process and its use as a fuel in 1995.[1] To assess the combustion properties of high-carbon ash, drop-tube furnace combustion tests and full-scale field trials injecting ash into a commercial boiler were conducted. Trials at the Salem Harbor Station have proven the viability of burning the high-carbon ash as a supplemental fuel. Burnout efficiencies were greater than 85% and flame shape and stability were unaffected. Particle and gas emissions and opacity all remained acceptable. Based on the success of these reburn trials, STI and New England Power installed a permanent system for burning the high-carbon fly ash and began commercial operations in July 1997.

In August 1996, CP&L conducted a series of "test" burns using high-LOI ash produced by the STI ProAsh LLC facility.[2] Wet conditioned high-carbon fly ash was placed on the coal conveyer using a portable conveyor with a variable speed belt. The portable conveyor was calibrated and then used to achieve a coal/ash ratio of 9.5%. A 23% LOI ash with an estimated heating value of 3000 Btu/lb and a 12,000 Btu/lb coal was used for the tests. Since completion of the test burn, low-NOx burners have been installed on Unit 3. As a result, the high-LOI ash from the ProAsh LLC facility has been as high as 45% LOI. The heating value of this ash is about 6000 BTU/lb.

During the test period, over 800 tons of high-LOI ash was added to six different mills at the plant. The tests showed that the energy from the high-carbon fly ash was recovered. A significant change could not be detected in steam-side performance heat rate (9322 vs. 9323). Air emissions and precipitator performance were not impacted during the tests.

Assuming 400,000 tons of ash were processed at an average LOI of 15%, ProAsh LLC could produce enough high-LOI ash to displace approximately 60,000 tons of coal. Additional savings for the utility could be realized from avoided disposal costs.

Additional STI Technology for Fly Ash Beneficiation

STI has also developed a process that removes ammonia from fly ash. The process can reduce the ammonia concentration on contaminated ash containing up to 2000 mg NH_3 / kg (ppm) to less than 50 mg/ kg. Design of a commercial size operation is underway which will handle 40 tons per hour of contaminated ash.

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[1] Coates, M.E., Sload, A. W., *Recycling Carbon-Enriched Fly Ash into a Utility Boiler*, Proceedings of the Third Conference on Unburned Carbonaceous Material in Utility Fly Ash, U.S. Department of Energy Federal Energy Technology Center, pp. 27-30, 1997.

[2] Carolina Power & Light, *Addendum to Final Report: Recycling Residual Fly Ash Derived From Coal Burning Electric Generating Facilities*, August 1998