PROJECT facts

U.S. DEPARTMENT OF ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

ENVIRONMENTAL WATER AND RESOURCES

06/2000

FLY ASH BENEFICIATION FOR CARBON REMOVAL AND POZZOLAN ENHANCEMENT

PRIMARY PROJECT PARTNER

Michigan Technological University
Houghton, MI

MAIN SITE

Michigan Technological University
Houghton, MI

TOTAL ESTIMATED COST

$1,114,938

COST SHARING

DOE	$898,703
Non-DOE	$216,235

Description

New coal combustion technologies designed to reduce the production of smog-generating nitrogen oxides (NO_x) also generally increase the amount of unburned carbon in the ash. Increased carbon content in the ash impairs its use in cement and concrete products, which are the largest market for coal ash. Ashes with a carbon content above 3% are generally not usable in Portland cement products. Carbon in the ash interferes with additives used too increase the amount of air entrained in the concrete, reducing its resistance to repeated freezing and thawing. Coal ash that does not meet specifications for carbon content must be disposed of as a waste product, resulting in increased costs for both utilities that generate ash and users of cement and concrete.

A patented froth flotation process developed by the Institute of Materials Processing at Michigan Technological University (MTU) beneficiates high carbon fly ash by removing over 90% of the carbon. The resulting materials are high-quality fly ash and a separate stream of 890% pure carbon that is suitable for a variety of other uses. The process is effective on both low and high carbon ashes and can be scaled for high-throughput systems handling from 5 to 100 tons/hour, with processing costs estimated at between $6 and $12/ton, including both capital and operating costs. Mineral Resource Technologies, LLC (MRT) of Atlanta, Georgia, has the exclusive patent rights for commercialization of the MTU process.

The MTU/MRT process works in four steps. First, the fly ash is slurried with water. Second, hollow ash cenospheres are removed gravitationally. Third, conditioning agents are added to create a hydrophobic surface on carbon particles and froth flotation is used to remove the carbon. Fourth, the remaining fly ash is collected, dewatered, and dried for shipment. Froth flotation is a proven technology that has been used in the minerals processing industry for over 80 years. Equipment for the process is readily available, and systems are adjustable to match existing plant facilities, minimizing total costs.

The MTU/MRT process has significant advantages over existing dry and wet separation processes. The MTU/MRT process purifies fly ash using low doses of environmentally friendly conditioning agents. In contrast, other wet separation processes use kerosene for conditioning the ash. Kerosene is expensive to use since the demand per ton is high, and it leaves an odor in both the ash and carbon as well as creating potential problems in disposing of kerosene-contaminated wastewater.

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Fly Ash Beneficiation for Carbon Removal and Pozzolan Enhancement

Other dry separation technologies are generally less efficient than the MTU/MRT process, and are not as effective on high carbon ash streams. Also, studies indicate that some dry separation processes remove mostly graphitic carbon, resulting in a product with a lower adsorption capacity than the carbon from the MTU/MRT process.

Wet processing has the additional advantage of removing the mineral basanite from the surface of the fly ash particles. Basanite is a gypsum-like mineral that interferes with the early set and strength development in concrete.

Goal

To ensure the most cost-efficient delivery of electrical power, the DOE is conducting research and development to improve coal combustion by-product (CCB) management. The research program emphasizes characterization and reuse of CCBs to help stimulate markets for new materials such as those produced under the DOE's Clean Coal Technology program. Over the next 5 to 10 years, the program's goals are to develop processes leading to a 100% increase in the current FGD by-product utilization rate, a 10 % increase in the national rate of overall CCB utilization, and a 25% increase in the number of CCB applications considered "allowable" under state regulations.

Benefits

- Enhanced value and quality of ash for use in cement and concrete products.
- Potential markets for carbon include water purification, activated carbon, and metallurgical coke.
- MTU/MRT system produces ash that can be used as is or further treated for higher value applications as an industrial filler in plastics, rubber, and specialty products.

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PROJECT PARTNERS

Mineral Resource Technologies, LLC
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(commercialization of process)