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Project Summary

Effects of E-SO_x Technology on ESP Performance

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This report describes field measurements and supporting laboratory studies related to the development of the flue gas cleanup process known as E-SO_x. It describes work performed as a part of pilot-scale studies of the E-SO_x process at Ohio Edison's Burger Station.

This Project Summary was developed by EPA's Air and Energy Engineering Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The E-SO_x process involves removal of sulfur oxides prior to the inlet of an electrostatic precipitator (ESP) with an aqueous spray of an alkaline material. The entering fly ash and resultant particulate matter are then removed in the ESP. A research program to develop and demonstrate the process has been performed under the sponsorship of the U.S. EPA, the Ohio Coal Development Office, and the Babcock & Wilcox Company (B&W).

Slaked lime slurry without the use of recycled material was the source of alkalinity for all experiments. Pebble lime was transferred pneumatically from tank trucks to a storage bin, and the lime was then slaked and placed in a slurry tank. The slurry was metered and injected into a spray chamber through two B & W Mark 4 nozzles. Dilution water was added to the slurry prior to reaching the nozzle, depending on the calcium to sulfur ratio and approach to saturation desired. At the exit of the spray chamber and ahead of the ESP are two rows of Droplet Impingement Devices (DIDs) which are temperature-controlled pipes to prevent entry of large wet particles into the ESP. The flue gas and uncollected particulate matter which exited the ESP were returned to the main ductwork ahead of the main unit's ESP.

Measurement Program

The ESP, the fly ash, and fly ash/sorbent mixtures were characterized by measuring:

- Inlet and outlet mass concentrations,
- Inlet and outlet mass vs particle sizes with cascade impactors,
- Real-time outlet mass concentration trends with an Environmental Systems Corporation P5A mass emissions monitor,
- Secondary voltage-current relationships and operating points,
- Inlet velocity traverses,
- Inlet and outlet temperature traverses,
- Laboratory and in situ resistivity,
- Chemical analysis of bulk and size-fractionated samples, and
- Ash cohesivity and Bahco particle size.

Baseline measurements were performed without the DID array,whereas the sorbent injection tests necessarily were performed with the DID array. In addition to preventing penetration of large moist particles into the first field of the ESP, the DID array minimized gas velocity non-uni-

formity due to flow disturbances caused by the sorbent injection nozzles.

Emissions caused by rapping systems in pilot-scale ESPs are usually not representative of full-scale systems. Therefore, the test program was conducted with rapping systems de-energized during the time period that outlet measurements were underway. Rappers were energized between tests to avoid excessive electrode build-ups. This testing strategy allowed the overall and particle size dependent efficiencies to be compared with the "no rap" projections of the mathematical model.

Since the first test series with sorbent injection indicated that particulate emissions exceeded the program goal of 0.1 lb/10^6 Btu (43 ng/J), a second test series was performed following an effort to improve the gas velocity and temperature distributions at the ESP inlet.

Conclusions

1. Analysis of particle size fractions collected on impactor stages at the inlet and outlet of the E-SO_x ESP showed a large increase in the relative calcium content of the finer size fractions across the ESP.
2. Massive reentrainment of ash/sorbent mixtures could be induced without electrode rappers in service by lowering the operating temperature of the ESP inlet. The reentrainment could be reduced by elevating the average inlet operating temperature 10 to 20°F (5.5 to 11°C) with no accompanying change in secondary voltage and current.
3. ESP performance for the E-SO_x process, as evaluated at the Burger station with the coal, lime, and conditions present during testing, is dominated by two factors not represented in the existing EPA-SRI versions of the mathematical model of ESP performance: instantaneous reentrainment of low resistivity ash/sorbent particles and deagglomeration of slurry residue within the ESP.
4. Significant improvement of the velocity and temperature profiles downstream from the DID array allowed outlet particulate emissions to be reduced to less than 0.1 lb/10^6 Btu with 50% SO_2 removal. However, the severe reentrainment problem within the ESP was still present, especially at temperatures below 160°F (71°C).
5. Additional work would help develop a quantitative understanding of the chemical and physical properties of slurry residues which result in poor ESP performance. Slurry additives designed to increase dust layer tensile strength and reduce reentrainment showed no beneficial effects during the brief test periods that were possible in the current program. Additional testing with these additives could involve longer term and more stable process operating conditions.

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The complete report, entitled "Effects of E-SO_x Technology on ESP Performace," (Order No. PB93-107 258/AS; Cost: $19.00; subject to change) will be available only from:
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