TECHNICAL PROGRESS REPORT

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POC-SCALE TESTING OF A DRY TRIBOELECTROSTATIC SEPARATOR FOR FINE COAL CLEANING

By

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WORK DESCRIPTION

Introduction

The Proof-of-Concept (POC) triboelectrostatic separator (TES) has now been successfully installed at the Virginia Tech pilot-plant. As a result, most of the personnel assigned to this project during the past quarter have been performing work elements associated with the installation and shakedown testing of the electrostatic separator, tribocharger system, product conveying systems and nitrogen purge system (Tasks 4, 5.1 and 5.2). A representative from Carpco also carried out training in the operating features of the unit during the past month. Most of the shakedown test work has now been successfully completed. However, several minor operational problems associated with the pilot-scale equipment are currently in the process of being resolved.

Sample Acquisition

A bulk sample of mill rejects (1500 lbs) was received from the American Electric Power (AEP) Glen Lyn power plant. This sample was used for the shakedown testing of the TES process. Arrangements have been made for the delivery of Glen Lyn mill rejects on a regular basis for the detailed testing phase of this project. Costs associated with this acquisition and delivery of this material have been fully covered by AEP.

Process Design

Details related to the design and operation of both the TES separation chamber and the various turbocharging designs have been provided in previous technical progress reports. For reference, the following layout schematics and engineering drawings have been provided in Appendix I.

- TES Unit Carpco Drawing: General Arrangement No. 4-4898
- TES Unit Carpco Drawing: Electrical Schematic No. 4-4918
- Product Conveying System AFC Drawing: Multi-Conveyor System No. CP8172

Procurement and Fabrication

The TES unit and the associated materials handling systems have been delivered from the suppliers, together with the locally purchased nitrogen purge system. The TES unit was provided by Carpco and the helical screws used for conveying of the particulate solids was procured from AFC, Inc.

Installation

The installation of the TES unit, screw conveyors, tribocharger and nitrogen purge system was completed during the quarter. The TES unit was installed on the bottom floor of the Virginia Tech pilot-plant testing facility (Figure 1).

During operation of the pilot-scale TES circuit, pulverized feed is manually dumped into the feed bin and transferred via an inclined feed screw into a sealed surge bin (Figure 2). Once in the surge bin, the fresh feed is blended with the middlings product from the electrostatic separation chamber (Figure 3). A vertical screw conveyor is then used to carry the blended material to the second floor of the pilot-plant facility (Figure 4) where it is discharged into a transfer chute that directs the material into the top of the tribocharger (Figure 5). Two different chargers have been constructed to date, i.e., a stationary tribocharger equipped with fixed copper rods (Figure 6) and a two-stage vertical turbocharger equipped with high-speed rotating vanes (Figure 7).

After passing through the tribocharger system, the charged particles are directed through an insulated (glass) feed inlet box located just above the electrodes (Figure 8). The feed inlet box passes through a perforated plate that serves to straighten/distribute gas in a laminar pattern down through the separation chamber. This arrangement directs the feed particles between oppositely charged sets of four-roll electrodes (Figure 9). The electrodes are constantly cleaned by means of two sets of twin brushes located behind each set of electrodes. When desired, maintenance and/or replacement of the electrodes is performed through removable panels located on each side of the TES unit (Figure 10).

The bottom of the separation chamber is equipped with clean coal (left) and refuse (right) splitters that can be adjusted during operation to achieve a given product quality (Figure 11). Particles that are misplaced or poorly charged pass between the splitters and form a middlings product. The three different products are collected in partitioned product bins built into the bottom TES unit. The products are continuously removed by means of three different variable-speed screws, i.e., reject screw, middlings screw and clean coal screw (Figure 12). As indicated previously, the product from the middlings screw conveyor is blended back with fresh feed in the surge bin and recycled back through the charger and separator. The reject product is discharged into a barrel on the left side of the TES unit (Figure 13), while the clean coal product is discharged into a barrel on the right side of the unit (Figure 14). Particulate material that accumulates in each screw prevents inert (nitrogen) gas that is constantly injected into the separation chamber from escaping.

The control and monitoring panel for the TES unit is mounted on the front of the TES unit for easy access (Figure 15). The unit is equipped with a complete

instrumentation package that allows the on-line monitoring of humidity, oxygen and internal pressure (Figure 16). To improve safety, the unit is equipped with a backup oxygen sensor to ensure that faulty readings do not allow operation under potentially explosive conditions. The speed of the inclined and vertical screws can also be adjusted to any set value using digital controllers mounted on the back wall of the pilot-plant facility (not shown). The installation has been inspected by the Virginia Tech Environmental Health and Safety Services.

Shakedown

Shakedown testing was carried out using AEP Glen Lyn mill rejects crushed to pass 2 mm. In general, most of the installed circuitry was found to perform well within the design specifications. However, during some of the preliminary test runs, some initial operational problems have been encountered. For example, the vertical screw conveyor was found to have a lower capacity than that specified by the manufacturer. Follow-up tests performed by the manufacturer now indicate that the discharge chute from the surge bin is improperly designed. The bin has now been shipped back to the manufacturer for modification at no cost to the project. These modifications are expected to be completed by the first week of August 1999.

Another technical problem that occurred during shakedown testing was the relatively poor performance of the tribocharging system. The preliminary tests were performed using a stationary tribocharger system equipped with several series of stacked layers of copper pipes. Data collected using the stationary charging system suggests that this approach does not provide the necessary degree of particle contacting for good charging. To correct this problem, shakedown tests are currently in progress using a

high-intensity turbocharger developed during the early phases of this project. This system uses high-speed rotating blades to create efficient contacting between particles and the rotating vanes and charger wall. The turbocharger has been designed to operate as a two-stage system to ensure that good contacting and charging is achieved. Data from the charger shakedown tests will be reported in the next technical progress report.

Sample Analysis/Characterization

Analysis and characterization of samples continued throughout the quarter as outlined in the project work plan.

SUMMARY AND CONCLUSION

During the past quarter, most of the project work centered on activities related to the installation and shakedown of the POC equipment. Detailed testing of the system will take place during the next quarter after operational difficulties associated with the materials handling and tribocharger systems are corrected.

Figure 1. Front view of the TES unit.

Figure 2. Feed bin and inclined feed screw.

Figure 3. Surge bin for blending of recycle product (middlings) and new feed.

Figure 4. Upward view of vertical screw.

Figure 5. Top of vertical screw and sloped transfer chute to charger.

Figure 6. Static tribocharger (shown not connected to transfer chute).

Figure 7. Side view of mechanical turbocharger and variable speed control.

Figure 8. Glass feed inlet inside separation chamber with perforated flow straightener.

Figure 9. Inside of separation chamber showing cylindrical electrodes and cleaning brushes.

Figure 10. Side view of TES unit showing removable panel for electrode replacement.

Figure 11. Lower section of separation chamber equipped with adjustable flow splitters.

Figure 12. Bottom of TES unit showing clean coal, middling (recycle) and reject screw inlets.

Figure 13. Reject discharge screw located on left side of TES unit (N_2 tank in background).

Figure 14. Clean coal discharge screw located on right side of TES unit.

Figure 15. Control and instrument readout panel located on the front of the TES unit.

Figure 16. Operational sensors mounted on the upper left side of the TES unit.

APPENDIX I

Layout schematics and engineering drawings

NAME	DATE	TIME	LOCATION	STATUS
VERONICA POLYMERONE	1-1-12	10:12	1000-1011	1000-1011
MARTIN POLYMERONE	1-1-12	10:12	1000-1011	1000-1011
MARTIN POLYMERONE	1-1-12	10:12	1000-1011	1000-1011

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