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Advanced Hybrid Particulate Collector, a New Concept for Air Toxics and Fine-Particle Control

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Abstract

A new concept in particulate control, called an advanced hybrid particulate collector (AHPC), is being developed at the Energy & Environmental Research Center (EERC) under U.S. Department of Energy (DOE) funding. The AHPC combines the best features of electrostatic precipitators (ESPs) and baghouses in a manner that has not been done before. The AHPC concept combines filtration and electrostatics in the same box, providing major synergism between the two collection methods, both in the particulate collection step and in transfer of dust to the hopper. The AHPC provides ultrahigh collection efficiency, overcoming the problem of excessive fine-particle emissions with conventional ESPs and solves the problem of reentrainment and recollection of dust in conventional baghouses.

The objective of the project is to develop a highly reliable AHPC that can provide >99.99% particulate collection efficiency for particle sizes from 0.01 to 50 μm, is applicable for use with all U.S. coals, and is cost-competitive with existing technologies.

Phase I of the developmental effort consisted of design, construction, and testing of a 200-acfm working AHPC model. Results from both 8-hour and 100-hour tests show that the concept works well, achieving greater than 99.99% collection efficiency for fine particles at high filtration velocities.

The 8-hour tests evaluated the effects of coal type on-line versus off-line cleaning, variable A/C ratios, bag type, and flue gas conditioning. The AHPC maintained a flow rate of 130 scfm and a temperature of 149°C (300°F) during all the 8-hour tests.

Conclusions for the 8-hour tests are summarized as follows:

- Tests achieved particulate collection efficiencies of 99.99% for all particle sizes from 0.01 to 50 micrometers.
- Excellent AHPC performance was achieved for both the subbituminous and bituminous coals.
- No significant difference in time intervals between bag-cleaning cycles between on-line and off-line cleaning. Time intervals between bag-cleaning cycles averaged 15 to 20 minutes at an A/C ratio of 3.66 m/min (12 ft/min).
  An increase in the A/C ratio from 3.66 m/min to 4.80 m/min (12 ft/min to 16 ft/min) decreased the time interval between cleaning cycles from 15 minutes to 10 minutes.
- No significant difference in AHPC performance was noted using either the polytetrafluoroethylene (PTFE)-only GORE–TEX bags or the graphite-impregnated PTFE bags.
- Flue gas conditioning, using NH_3/SO_3, greatly enhanced AHPC performance by increasing the time interval between cleaning cycles from 20 minutes to 100 minutes or more while maintaining a 99.99% dust collection efficiency.

All 100-hour tests were operated at 3.66 m/min (12 ft/min) and AHPC temperature of 149°C (300°F) except for the 100-hour test when mercury sorbent was injected. During that test, the AHPC temperature was lowered to 135°C (275°F) to improve the sorbent performance. Results are as follows:

- Particulate collection efficiencies of 99.99% for all particle sizes from 0.01 to 50 μm were achieved.
- No significant differences in AHPC performance between the subbituminous and bituminous coals. Time interval between bag-cleaning cycles ranged from 25 to 35 minutes.
- Emissions of seven trace elements, arsenic, cadmium, chromium, lead, mercury, nickel, and selenium, were measured. Only two elements, mercury and selenium, were detected in measurable quantities in vapor form.
- With sorbent injection, total mercury removal efficiency ranged between 50% and 75%.
- No increased particulate emissions were noted during mercury sorbent injection.

In summary, the performance of the AHPC met all the program objectives in Phase I. Greater than 99.99% particulate collection efficiency for all particle sizes from 0.01 to 50 μm was achieved with both a subbituminous and a bituminous coal. Excellent operability was observed, and pressure drop was easily controlled at a filtration velocity of 3.66 m/min (12 ft/min). Plans for Phase II are to scale up the AHPC to the 4000–5000-acfm pilot size and test on a slipstream of a full-scale boiler.

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