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Project Summary

Pilot-Scale Assessment of Conventional Particulate Control Technology for Pressurized Fluidized-Bed Combustion Emissions

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This report presents the results of a performance evaluation of conventional particulate control technology applied to the EPA/Exxon pressurized fluidized-bed combustion (PFBC) miniplant in Linden, NJ. The EPA mobile electrostatic precipitator (ESP) and fabric filter pilot facilities were slipstreamed downstream of the miniplant's tertiary cyclone to simulate the flue gas stream exiting a PFBC combined-cycle gas turbine. Results presented include control-device operating characteristics and performance based on mass and fractional efficiencies. ESP mass efficiency varied from 80 to 90 percent and appeared to be sensitive to miniplant operating conditions. The mobile baghouse efficiency was 99.3 percent. The EPA mathematical performance models for the ESP, fabric filter, and venturi scrubber were exercised to generate a basis for an economic analysis of conventional particulate control alternatives. Costs of control for a 350 MW PFBC ranged from 0.33 to 0.51 mills/kWh for fabric filters and from 0.30 to 0.57 mills/kWh for ESPs. Venturi scrubbing costs were considerably higher (0.66 mills/kWh).

This Project Summary was developed by EPA's Industrial Environmental 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 and Objectives

Fluidized-bed combustion (FBC) systems being developed for steam and electrical power generation and process heating employ a number of concepts, including atmospheric and pressurized combustion, temperature control by fuel-to-air ratio, heat transfer surface, and particulate circulation. These FBC systems offer attractive advantages over conventional combustion in costs, resource utilization, and environmental impact.

Current FBC development programs use calcium-based sorbents (limestones and dolomites) for *in-situ* control of sulfur oxides (SO_x) in the combustor, while lower combustion temperatures limit to some degree the formation of thermal nitrogen oxides (NO_x). Particulate matter (PM) emissions from an atmospheric FBC system are controlled by conventional technology. In contrast, the pressurized fluidized-bed combustion (PFBC) process uses the hot, high-pressure flue gas exiting the combustor to drive a gas turbine to generate additional power, and conventional technology for control of PM emissions is not applicable.

There has been considerable discussion of the degree of PM removal required ahead of the gas turbine to prevent excessive corrosion and/or erosion of the turbine. High-pressure, high-temperature PM control technology (e.g., ceramic filters) has been investigated to provide a flue gas cleansed of PM to ensure acceptable turbine operating and maintenance costs and life expectancy. Recently, turbine designers have reduced the limitations on PM concentration and size distribution required so that a secondary or tertiary cyclone system can achieve the required level of PM control. The residual particulates, while acceptable for the gas turbine, must be further controlled to meet environmental standards.

This study assessed a pilot-scale application of conventional PM control technology (i.e., an electrostatic precipitator (ESP) and a fabric filter (baghouse)) to a PFBC cyclone-cleaned exhaust. The program's objectives were accomplished using EPA's mobile ESP and baghouse slipstreamed from the 630 kW EPA/Exxon Research and Engineering Company miniplant in Linden, NJ.

The mobile ESP pilot assessment was conducted during April and May 1979, and the mobile fabric filter program was accomplished in June 1979.

Specific program objectives were to:

- Test the applicability of conventional PM control technology to cyclone-cleaned PFBC emissions.
- Evaluate respective control device operating characteristics and performance levels.
- Exercise EPA/IERL-RTP's control device performance models to establish a basis for cost analysis.
- Generate cost-of-control estimates for an ESP, a baghouse, and a venturi scrubber.

Results presented in this report are specific to the EPA Exxon miniplant and the slipstreamed mobile ESP and baghouse; extrapolation to other systems may be risky.

Conclusions

The study pointed to the following conclusions:

- Conventional PM control technology appears applicable to cyclone-cleaned PFBC emissions.
- ESP operating characteristics and performance were influenced by PFBC operating conditions and sorbent type. Cold-side ESP performance was better than hot-side performance on a normalized gas treatment basis.
- Fabric filtration affords an appreciably higher degree of control at approximately the same costs as an ESP.
- This PFBC process is apparently subject to peaking sulfur dioxide (SO_2)/sulfur trioxide (SO_3) emission levels, which cause acid dew-point excursions and seriously impact control hardware specifications and operating conditions.
- There were both similarities and differences in conventional control device operating characteristics for the PFBC process and for conventional coal-fired boilers.

Recommendations

Recommendations generated by the study include:

- Conduct further pilot-scale control evaluations of the PFBC process to optimize control device design and operating conditions.
- Address the extent of and resolution of the apparent SO_2/SO_3 excursions associated with this and possibly other PFBC processes.

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The complete report, entitled "Pilot-Scale Assessment of Conventional Particulate Control Technology for Pressurized Fluidized-Bed Combustion Emissions," (Order No. PB 82-230 921; Cost: $13.50, subject to change) will be available only from:

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