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QUARTERLY TECHNICAL PROGRESS REPORT

FINAL

Report Period: First Quarter FY94 (10/93-12/93)

Engineering Development of Advanced Coal-Fired Low Emission Boiler Systems
DE-AC22-92PC92158

Riley Stoker Corporation
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Contract Period (total): October 1, 1992 to August 31, 2000

TECHNICAL PROGRESS

Topical Reports. The Preliminary Engineering Design, Design Deficiency Analysis, and Research, Development, and Test Plan are listed as separate deliverables under two tasks. All three will be combined in one document to be called the Design and Development Report. A partial draft was provided to DOE for the purpose of supporting our oral presentation of December 9 in Pittsburgh. Additional material will be added to the report, and the final Design and Development Report will be issued in the next quarter.

Papers, presentations. The paper "Concept Selection for a Low Emission Boiler System (LEBS)" was presented at the 1993 IJPSC in Kansas City MO. The paper presented an overview of the project, but focused on low temperature heat recovery, and its integration into the advanced steam cycle. A copy of the paper is attached.

TVC testing. The first test run was completed on December 6. Riley was unable to witness or set up independent sampling equipment for NOX and precursor measurement for this run. NOX levels dropped to very low levels when the TVC was taken fuel rich. In addition to lacking the NH3 and HCN measurements, the NOX measurement was somewhat disturbing in that the value dropped immediately on transition from near stoichiometric to 0.7 SR, but continued to drop over a period of about 20 minutes while stoichiometry and other gases were stable. The final level was about 30 ppm.

A second run which we witnessed, but did not sample, was completed December 17. This was conducted almost entirely near SR = 1.0 while Textron investigated temperature-load relationships to address concerns from Run 1.

A third run was completed over the December holiday break on Dorchester coal to address concerns Textron had about the Illinois test coal. All subsequent tests will use the Illinois coal.
TVC testing is scheduled in January and February 1994. The plan is to complete as much testing within that time period as possible, accelerating the original five month test schedule and prioritizing on investigating the rich zone NOx behavior. Riley will support the tests with NOx precursor measurements by wet chemistry, as well as independent NOx measurement, for all subsequent tests.

**Boiler, firing system design.** Elevation drawings were developed for dry wall-fired, conventional U-fired slagging, and TVC fired slagging units. We are assuming "very clean" coal fired wall conditions for the TVC fired boiler, vs. "moderate to severe" for conventional U-fired with the same coal, based on a reduction of ash loading in the boiler for the TVC. Should the TVC path be proven for NOx control, Task 4 will need to include a detailed evaluation of ash loading and chemistry on slagging tendency and boiler size.

We are investigating the feasibility of modifying a conventional U-fired design for low-NOx operation as an alternative to the TVC. The approach taken to date for NOx reduction in existing U-fired units is to retrofit with delayed-mixing burners with staging air at various places, similar to the approach with dry fired units. Designs typically do not go below SR of 1 in the slagging chamber. One alternative, based on model results, is an intense-mixing burner fired into an overall reducing chamber at 0.7-0.8 SR. The conventional U-fired design gives over 1 second residence time in the slag chamber, and models indicate that NOx and precursors may decay to very low levels given this time in a reducing, very hot, environment. Refractory life is a major concern under these conditions with the high sulfur, high iron design coal. A second practical limit on deep-staging of the chamber is the requirement that temperature be kept as high as possible to permit slag to be tapped under all operating conditions. Temperature is maximized near unit stoichiometry.

The concept of staged fuel addition or reburning for the U-fired system is being examined as a potential combustion NOx control approach. This concept has high potential due to the high temperature and long residence time available in the slagger. Some field trials with coke oven gas reburn produced very low NOx results. Modeling of this concept was identified as a priority task. The model development will include matching field data for air staging on slagging units to the predictions.

**Emissions control.** Selection of an SO2 control process continues to be a high priority task. Sargent & Lundy completed a cost comparison of several regenerable processes, most of which have NOx control potential as well: Active coke, NOXSO, copper oxide, SNOX, ammonia (for SO2 only, ammonium sulfate byproduct), and a limestone scrubber for comparison.

Further activity focused on the moving bed copper oxide process being developed in a separate internal DOE program. The process chemistry has been around for a long time in other contacting configurations- parallel passage by Shell/UOP, fluidized bed in subsequent DOE studies. Sargent & Lundy estimates of cost are favorable, although many of the assumptions are unproved. Impact of the process on plant efficiency is more favorable than some alternative regenerables, and there are some very attractive integration features for NOx and particulate control. The major weaknesses are lack of a vendor and status for commercial readiness within the time scale of this program. There is some risk in selecting this concept but the potential for system integration, very high levels of both SOx and NOx control, and heat rate benefits may justify an ambitious development program within LEBS.
Commitment to the moving bed copper oxide process as a regenerative, post-combustion combined SOx/NOx control increased with additional technical evaluation as well as the interest expressed by team member Tecogen in taking the lead for development and commercialization of this process. Tecco, Riley, and Sargent & Lundy are exploring both technical and commercial issues related to the process, and investigating the potential synergism with independent DOE and state-funded development programs.

Low temperature heat recovery. Mass flows and terminal temperatures were developed for the parallel air and condensate heating arrangement which we believe most efficiently recovers low grade heat. The condensate heating portion of the equipment may be viewed as an extended economizer, and we are working on design and cost estimates internally. Sargent & Lundy are requesting size and cost estimates on plate-type air heaters from vendors. We are also costing heat-pipe air heaters.

Roderick Beittel
Program Manager

ATTACHMENT:


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