Reduction of Water Use in Wet FGD Systems

Final Report

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Disclaimer

Abstract

This is the Final Report for project DE-FC26-06NT42726, "Reduction of Water Use in Wet FGD Systems." This project began in January 2006 and is terminated effective September 30, 2008. This Final Report contains background information in the form of an Executive Summary, a discussion of the original approach to the project, results obtained, and conclusions.

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References

1. Cooperative Agreement DE-FC26-06NT42726, current through Amendment 2, dated April 2006.
2. “Reduction of Water Use in Wet FGD Systems,” Final Report, DOE Award Number DE-FC26-06NT42726, dated September 2008.

Executive Summary

Cooperative Agreement DE-FC26-06NT42726 was established in January 2006, and is current through Amendment 2, April 2006. The current reporting period, April 1, 2008 through June 30, 2008, is the eighth progress-reporting period for the project. However, this report will be the final report (instead of a quarterly report) because this project is being terminated.

Efforts to bring this project to a close over the past several months focused on internal project discussions, and subsequent communications with NETL, regarding the inherent difficulty with completing this project as originally scoped, and the option of performing an engineering study to accomplish some of the chief project objectives. However, NETL decided that the engineering study did indeed constitute a significant scope deviation from the original concepts, and that pursuit of this option was not recommended. These discussions are summarized in the Results and Discussion, and the Conclusion sections.

In the initial reporting period, a project kickoff meeting was held at Plant Crist. During that meeting, the following Project Schedule was introduced:

Activity	Target Date
Submit draft test plan for DOE review	FY06 Q4
Initiate heat exchanger design	FY07 Q1
Complete fabrication of pilot heat exchanger	FY07 Q2
Deliver pilot heat exchanger to MRC	FY07 Q3
Complete baseline tests	FY07 Q4
Complete parametric and steady state tests	FY08 Q1
Initial corrosion testing	FY08 Q2
Complete corrosion testing	FY08 Q3
Submit cost/benefit report	FY08 Q4

The objective of this project by a team lead by URS Group was to demonstrate the use of regenerative heat exchange to reduce flue gas temperature and minimize evaporative water consumption in wet flue gas desulphurization (FGD) systems on coal-fired boilers. Furthermore, the project intended to demonstrate that regenerative heat exchange to cool flue gas upstream of the electrostatic precipitator (ESP) and reheat flue gas downstream of the FGD system would result in the following benefits to air pollution control (APC) systems on coal-fired power plants:

1. Improve ESP performance due to reduced gas volume and improved ash resistivity characteristics,
2. Control SO_3 emissions through condensation on the fly ash, and
3. Avoid the need to install wet stacks or to provide flue gas reheat.

Finally, operation at cooler flue gas temperatures offered the potential benefit of increasing mercury (Hg) removal across the ESP and FGD systems.

This project planned to conduct pilot-scale tests of regenerative heat exchange to determine the reduction in FGD water consumption that can be achieved and assess the resulting impact on APC systems. An analysis of the improvement in the performance of the APC systems and the resulting reduction in capital and operating costs were going to be conducted. The tests were intended to determine the impact of operation of cooling flue gas temperatures on FGD water consumption, ESP particulate removal, SO_3 removal, and Hg removal, and to assess the potential negative impact of excessive corrosion rates in the regenerative heat exchanger. Testing was going to be conducted on Columbian coal (with properties similar to low-sulfur Eastern bituminous coal) and SO_3 will be spiked onto the flue gas to simulate operation with higher SO_3 concentrations resulting from firing a higher sulfur coal, or operating with a selective catalytic reduction (SCR) unit. The project was also going to include associate planning, laboratory analytical support, reporting, and management activities.

The URS project team finalized a conceptual alternative approach to demonstrate, via an engineering study, the use of regenerative heat exchange to reduce flue gas temperature and minimize evaporative water consumption. This idea was presented in summary format to NETL for consideration. NETL determined that this alternative approach deviated from the original project objectives, and that it would be in the best interest of all parties involved to cancel the project.

Results of Work

Approach

(Note: For completeness, and to maintain project history, the original approach to the work for this project is outlined below).

This project will consist of six tasks, as outlined below. The project team will consist of URS Group, Inc., as the prime contractor, the Electric Power Research Institute (EPRI), Southern Company, the Tennessee Valley Authority (TVA), and Mitsubishi Heavy Industries of America (MHIA). Testing will be conducted at the Mercury Research Center (MRC) located at Southern Company's Plant Crist in Pensacola, FL. The MRC is operated by Southern Research Institute (SRI). The following is a brief outline of the six tasks to be performed on this program.

1. Task 1: Project Planning. In this task, the project team will develop a detailed project plan. This plan will describe the host site where testing is to be conducted, the project schedule, test methods to be employed, and test design and operating conditions. A QA/QC plan and Health and Safety plan will also be prepared as part of this effort. During the planning effort, a project kickoff and review meeting will be held between the DOE Contracting Officer's Representative (COR) and the project team at the MRC to discuss and make decisions required in the planning process.

2. Task 2: Pilot Plant Assembly. In this task, the pilot test unit to be used to test the effects of regenerative heat exchange will be assembled. Pilot testing will be conducted Plant Crist Unit 5 using on-site Columbian coal. The pilot unit will be configured to support the collection of flue gas samples at the heat exchanger inlet, ESP inlet, and FGD inlet and outlet. In addition, automated data collection capability will be provided to support short-term and long-term testing capabilities.

3. Task 3: Pilot Testing of Integrated Flue Gas Treatment Systems. In this task, a series of test campaigns will be conducted to evaluate the impact of regenerative heat exchange on the operation of the APC systems. Initially, the pilot system will be started and operated for one-week to reach conditions of steady-state operation at typical flue gas temperatures to collect baseline performance data. The following measurements will be collected:
    - FGD evaporative water consumption
    - SO_3 concentrations
    - Particulate loading
    - Total Hg concentrations
    - LOI of ash
    - Fly ash resistivity

The next set of tests will be conducted with the air heater operating to produce flue gas at lower temperatures. Parametric studies will be conducted to assess the impact of varying the temperature of the flue gas exiting the air heater, and of spiking SO_3 into the flue gas. Finally, and based on the results of the parametric tests outlined above, operation at a flue gas temperature that provides optimum operating performance will be conducted with and without SO_3 spiking. At the conclusion of this task, the data will be reviewed to assess the performance of the integrated APC system when operating at lower flue gas temperatures.

4. Task 4: Pilot Testing of Corrosion in the Regenerative Heat Exchanger. At the conclusion of the integrated APC testing, longer-term tests will be conducted to determine if excessive corrosion is observed in the small pilot heat exchanger when operating at lower flue gas temperature. Test conditions during this campaign will be selected based on results of the integrated APC system tests. Corrosion rate data will be collected from the smaller heat exchanger to assess the effects of corrosion when operating at lower flue gas temperature on selected, lower-cost materials of construction such as carbon steel. Evidence of corrosion will be inspected periodically during this test campaign. In addition, SO_3 measurements at the heat exchanger will be collected to support analysis of the results from the corrosion inspections.
5. Task 5: Assess the Benefits and Costs of Regenerative Heat Exchange. Results of the testing in Tasks 3 and 4 will be used to assess the benefits and cost of regenerative heat exchange. Mass balances will be determined for baseline operation and for optimized operation with and without SO_3 spiking. The differences in evaporative water loss from the FGD system between baseline and optimum operating conditions will determine the reduction in water consumption that can be achieved using regenerative heat exchange. Commercial alternatives for regenerative heat exchangers will be evaluated to estimate capital costs and performance impacts. The performance of the ESP will be evaluated to determine if additional particulate removal can be achieved in retrofit situations. The impacts of regenerative heat exchange on Hg control will be evaluated. Finally, cost estimates for baseline operation and optimized operation will be prepared to identify the most cost-effective applications of regenerative heat exchange.
6. Task 6: Management and Reporting. The team will prepare all management reporting documents required by the DOE. A kickoff meeting will be held, and semi-annual briefings will be conducted. The project team will also prepare and present a technical paper of project results at the DOE/NETL Annual Contractor's Review Meeting during the project duration. At the end of the project, the team will prepare an overall project Final Report.

Results and Discussion

MHIA had proposed using a gas-gas heat exchanger that is currently located in the Hiroshima Heat Extractor plant in Japan. This GGH is 0.05 MWe and capable of 180 m^3/hour flue gas flow. Fully insulated, the unit measures approximately 16" x 8" x 9' long, and would be installed in a horizontal position at Plant Crist. It would take approximately fourteen weeks to ship the unit from Hiroshima to Pensacola, and an additional three weeks in Pensacola for preparation prior to installation. This was the selected option of providing a GGH, although the cost was more than anticipated when the budget was prepared. The alternative solution of obtaining cut sheets from MHIA, translating them into English, soliciting bids from domestic heat exchanger manufacturers, evaluating bids, selecting a fabrication shop, and assuring a satisfactory product was delivered on time and at a reasonable cost, was determined to be too risky to meet project demands. Additionally, the cost of this option was likely to be higher than that proposed by MHIA.

The rough order of magnitude (ROM) cost quoted by MHIA for delivery of the GGH to Pensacola was $110,000. This cost included the entire unit on a skid with a controls package, but did not include external piping and periphery instrumentation. The cost of preparation in Pensacola prior to delivery to the MRC was also specifically excluded.

URS previously completed a thorough re-examination of the project budget, and concluded that the costs described above could not be accommodated within existing project budgets. Additionally, concerns were expressed regarding the use of a small-scale system, as outlined in the test plan, to extrapolate to results for a full-size operating power plant. Maintaining proper gas characteristics in a small slipstream would also prove to be very difficult. Consequently, URS recommended to NETL that a scope change for this project be considered. This scope change would essentially entail elimination of scaled field testing in favor of an engineering study that examines currently available technologies to reduce fresh water usage in coal fired power plants equipped with Flue Gas Desulfurization (FGD) systems by minimizing evaporative water loss in the FGD system.

NETL provided careful consideration to the URS recommendation to perform an engineering study. However, based on concerns with obtaining required co-funding as stipulated in the project contract, along with uncertainty that the results of this proposed study would provide any new and distinctive insights in the area of water usage reduction, NETL directed URS to not proceed with this study. In a telephone call from the NETL Project Manager to the URS Project Manager, the direction to terminate work on this project was conveyed.

Conclusion

Activities conducted during this eighth and final project-reporting period focused a revision to the Statement of Project Objectives (SOPO) to reflect the closeout of this project.