DOE/PC/79796-T24

DOE/PC/79796--T24

DE92 015747

ENHANCING THE USE OF COALS BY GAS REBURNING-SORBENT INJECTION

Quarterly Report No. 10
For the Period
January 19 through March 31, 1990

Prepared for
U.S. Department of Energy
Gas Research Institute
State of Illinois Department of
Energy and Natural Resources

Prepared by
Energy and Environmental Research Corporation
18 Mason
Irvine, California 92718

April 16, 1990

U.S. DOE PATENT CLEARANCE IS NOT REQUIRED
PRIOR TO THE PUBLICATION OF THIS DOCUMENT

TABLE OF CONTENTS

LEGAL NOTICE ii

1.0 SUMMARY 1-1

2.0 INTRODUCTION 2-1

3.0 PROJECT DESCRIPTION 3-1

4.0 PROJECT STATUS 4-1

4.1 Task 1 - Project Management 4-1

4.2 Task 2 - Installation and Startup 4-1

5.0 PLANNED ACTIVITIES 5-1

6.0 REPORT DISTRIBUTION LIST 6-1

LEGAL NOTICE

This report was prepared by Energy and Environmental Research Corporation (EER) as an account of work sponsored by the Gas Research Institute (GRI), the United States Department of Energy (DOE), and the State of Illinois Department of Energy and Natural Resources (ENR). Neither, GRI, DOE, ENR, nor members of GRI, DOE, ENR, nor any person acting on their behalf;

a. Makes any warranty or representation, express or implied with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately-owned rights, or

b. Assumes any liability with respect to the use of, or for damages resulting from the use of, any information, apparatus, method, or process disclosed in this report.

1.0 SUMMARY

The objective of this project is to evaluate and demonstrate a cost effective emission control technology for acid rain precursors, oxides of nitrogen (NO_x) and sulfur (SO_x), on two coal fired utility boilers in Illinois. The units selected are representative of pre-NSPS design practices: tangential and cyclone fired. A third unit, wall fired, is "on hold" because of funding limitations. The specific objectives are to demonstrate reductions of 60 percent in NO_x and 50 percent in SO_x emissions, by a combination of two developed technologies, gas reburning (GR) and sorbent injection (SI).

With GR, about 80-85 percent of the coal fuel is fired in the primary combustion zone. The balance of the fuel is added downstream as natural gas to create a slightly fuel rich environment in which NO_x is converted to N_2. The combustion process is completed by overfire air addition. SO_x emissions are reduced by injecting dry sorbents (usually calcium based) into the upper furnace. The sorbents trap SO_x as solid sulfates that are collected in the particulate control device.

This project will be conducted in three phases at each site: (1) Design and Permitting, (2) Construction and Startup, and (3) Operation, Data Collection, Reporting and Disposition. Technology transfer to industry will be accomplished through the formation of an industry panel. Phase I of the project commenced on June 5, 1987 and concluded on May 15, 1989. It included five tasks as follows:

Task 1 - Project Management
Task 2 - Process Design
  Subtask 2.1 - Host Site Characterization
  Subtask 2.2 - Process Specification
Task 3 - Project Engineering
Task 4 - Environmental Reports, Permitting, Plans and Design
Task 5 - Technology Transfer

During the period between May 15 and August 15, 1989, Phase AII-A overlap work was carried out for Hennepin Unit No. 1, the tangentially fired boiler, to pre-engineer and procure long lead time items in preparation for the beginning of Phase II proper, Construction and Startup, so that the Spring

1990 outage schedule of this unit could be met. Because of delays in finalizing negotiations with the utility, Phase AII-B, the balance of Phase II work for Hennepin could not be started on August 15, as planned. A Host Agreement Modification was signed on January 19, 1990 by the utility, Illinois Power Company, and EER. Work on Phase AII-B for the tangentially fired site was resumed immediately.

In Task 1, Project Management, the emphasis was on initiating the construction and startup phase of the project for the tangentially fired site (Hennepin Unit No. 1) while pursuing negotiations with the owner of the cyclone fired unit (City of Springfield, Department of Water, Light and Power, Lakeside Unit No. 7) to enter into Phase II of the this project. Related to the Hennepin project, EER personnel and subcontractors were mobilized and deployed at the construction site. Monthly review meetings have been held with Illinois Power at Hennepin, and the project co-funders--the Department of Energy (DOE), the Gas Research Institute (GRI) and the State of Illinois Department of Energy and Natural Resources (ENR)--have been kept apprised of progress through written and verbal communications.

In Task 2, Construction and Startup, details of the contracts have been negotiated with various subcontractors. A significant item, the construction of a new ash pond at Hennepin, has been eliminated because of the decision to utilize the existing ash pond. On the other hand, a new item, realignment of superheater tubes, has been added to the workscope to protect the superheater from potential damage that could be caused by sorbent injection. Critical path construction CPM scheduling has been established, and work on design drawings has continued during this period. In addition to negotiating this subcontract, all material to be supplied by EER has been ordered. The beginning of the two-month outage at Hennepin is scheduled for April 14. Installation of the GR-SI and auxiliary equipment will proceed during this period.

Only long range planning has taken place relative to Task 3, Technology Transfer. Tentatively, the next meeting of the Industry Panel has been scheduled for October 1990, including a site visit to the GR-SI installation at Hennepin. The objective of this meeting is to acquaint the Industry Panel with the installation and present, if possible, preliminary data to be obtained during equipment startup.

Key Words

SO_x	Ash	Emission
SO_2	Coal	Control
NO_x	Gas	Boiler
NO	Sorbent	Precipitator
Pond	Construction	Flue Gas
Startup	Instrumentation	Contracts

2.0 INTRODUCTION

Clean Coal Technology implies the use of coal in an environmentally acceptable manner. Coal combustion results in the emission of two acid rain precursors: oxides of sulfur (SO_x) and oxides of nitrogen (NO_x). This clean coal technology project will demonstrate a combination of two developed technologies to reduce both NO_x and SO_x emissions: gas reburning and calcium based dry sorbent injection. The demonstrations will be conducted on two pre-NSPS utility boilers representative of the U.S. boilers which contribute significantly to the inventory of acid rain precursor emissions: tangentially fired and cyclone fired units. (A demonstration on another representative boiler type, wall fired, is "on hold" because of funding limitations.)

Gas reburning is a combustion modification technique that consists of firing 80-85 percent of the fuel corresponding to the total heat release in the lower furnace. Reduction of NO_x to molecular nitrogen (N_2) is accomplished via the downstream injection of the remaining fuel requirement in the form of natural gas (which also reduces the total SO_x emissions). In a third stage, burnout air is injected at lower temperatures in the upper furnace to complete the combustion process without generating significant additional NO_x.

Dry sorbent injection consists of injecting calcium based sorbents (such as limestone, dolomite, or hydrated lime) into the combustion products. For sulfation of the sorbent to $CaSO_4$, an injection temperature of about 1230°C is optimum, but calcium-sulfur reactions can also take place at lower temperatures. Thus, the sorbent may be injected at different locations, such as with the burnout air, at the exit from the superheater, or into the ducting downstream of the boiler with H_2O added for humidification. The calcium sulfate or sulfite products are collected together with unreacted sorbent by the particulate collection device, usually an electrostatic precipitator or bag filter.

The specific goal of this project is to demonstrate NO_x and SO_x emission reductions of 60 percent and 50 percent, respectively, on two coal fired utility boilers having the design characteristics mentioned above. Host Site Agreements have been signed by EER and three utility companies in the State of Illinois: Illinois Power Company (Test Site A, Hennepin Unit 1, 71 MW_{net}

tangentially fired boiler in Hennepin), Central Illinois Light Company (Test Site B, Edwards Unit 1, 117 MW_{net} front wall fired boiler in Bartonville), and City Water Light and Power (Test Site C, Lakeside Unit 7, 33 MW_{net} cyclone fired boiler in Springfield). (As discussed above, GR-SI demonstrations are now planned only at site A and C.)

Co-funding for this project is provided by the Gas Research Institute (GRI) and the State of Illinois Department of Energy and Natural Resources (ENR)--the other Funding Participants. GRI and ENR are responsible for funding approximately one-third and one-sixth, respectively, of the total project costs.

To achieve the objectives of the project, it will be conducted in the following three phases at each host site.

Phase I: Design and Permitting
Phase II: Construction and Startup
Phase III: Operation, Data Collection, Reporting and Disposition

Phase I of the project was conducted in parallel for test sites A, B, and C over a period of 22 months. For this reason, quarterly reports were issued during Phase I, combining the work done related to all three sites. Starting with Phase II, which will consist of a staggered schedule of eight months duration for each Test Site, separate reporting will be instituted to cover the work done at each site. This practice will be continued for the remainder of the total project schedule that includes the Phase III work at each site.

During the last quarter between May 15 and August 15, 1989, Phase AII-A overlap with Phase I for the Hennepin tangentially fired Unit No. 1 was performed. The purpose of this overlap was to perform engineering work related to the procurement of long lead time items and negotiating with subcontractors, so that Phase II work could be started on a timely basis. However, because of negotiation delays with EER's host utilities, Phase II work at Hennepin was initiated only on January 19, 1990. This schedule should still allow the installation of the GR-SI equipment during the annual maintenance outage of the unit in April-May 1990.

The principal objectives of the work performed during this quarter were as follows:

- Negotiate construction details with subcontractors.
- Order all necessary construction material.
- Continue production of design drawings.
- Establish critical path construction schedule.
- Resolve outstanding issues with Illinois Power--superheater realignment, ash line, sootblower compressor, etc.
- Review progress and issues with Illinois Power at monthly meetings held in Hennepin.
- Apprise DOE, GRI and ENR of progress and new developments.
- Continue dialogue with CWLP regarding agreement to start Phase II of the project on the cyclone fired Lakeside No. 7 unit.

3.0 PROJECT DESCRIPTION

Within the three phases of the project, the following tasks will be performed to demonstrate the cost effective control of NO_x and SO_x emissions from pre-NSPS coal fired utility boilers:

Phase I: DESIGN AND PERMITTING

Task 1 - Project Management

- Coordination of all Participant and subcontractor efforts
- Coordination with the host sites
- Planning and scheduling all tasks
- Monitoring all technical efforts
- Keeping DOE, GRI, and ENR fully informed of project status
- Continual review of relevant ongoing technical developments

Task 2 - Process Design

Subtask 2.1 - Host Site Characterization

- Establishment of the condition of each host site, including field evaluations.

Subtask 2.2 - Process Specification

- Preparation of GR-SI process designs, aiming at 60% and 50% reduction in NO_x and SO_x, respectively.
- Continuing bench scale tests to define key process parameters.

Task 3 - Project Engineering

- Preparation of site specific detailed engineering designs, construction plans and schedules, cost estimates, startup plans and Phase III test plans.

Task 4 - Environmental Reporting, Permitting, Plans and Design

- Preparation of relevant environmental data for obtaining NEPA approval.
- Preparation of Environmental Monitoring Plan.
- Assistance to host sites in obtaining environmental permits.

Task 5 - Technology Transfer

- Formation of an Industry Panel for technology transfer.
- Arrangement of Panel meetings on (1) process design and (2) detailed engineering design and plans for Phases II and III.

Phase II: CONSTRUCTION AND STARTUP

Task 1 - Project Management

- Continuation of Phase I project management activities.
- Arrangement of project review meetings at approximately the 40 and 90 percent completion points for each site.

Task 2 - Installation and Checkout

- Installation of the emission control and auxiliary equipment.
- Checkout of functional operation of all components.

Task 3 - Technology Transfer

- Continuation of technology transfer activities initiated in Phase I.
- Meetings with Industry Panel to review installations and plans.

Task 4 - Restoration

- Decision on disposition of test equipment if project is discontinued: to be retained by host sites or removal and restoration work.

Phase III: OPERATION, DATA COLLECTION, REPORTING AND DISPOSITION

Task 1 - Project Management

- Continuation of Phases 1 and 2 project management activities.
- Conducting final project review at conclusion of project.

Task 2 - Technology Demonstration

Subtask 2.1 - Optimization Testing

- Evaluation of effects of process variables on emission control performance.
- Determination of operating conditions for optimum overall performance.

Subtask 2.2 - Evaluation of Alternative Coals and Sorbents

- Evaluation of performance of alternative coals and sorbents:
  - High and medium sulfur coals, with consideration of cleaned and run-of-mine coals.
  - Selection of sorbents from high calcium and dolomite limestones, hydrated limestones and limes.

Subtask 2.3 - Long-Term Testing

- Operation of GR-SI equipment under optimized conditions for approximately one-year duration at each host site.
- Measurement of emission control system performance.
- Determination of boiler impacts.

Task 3 - Evaluation of Demonstration Results

- Analysis of test data.
- Preparation of guideline manuals for application of GR-SI technology, including design recommendations, cost projection and comparisons with competing technologies.

Task 4 - Restoration

- Disposition of GR-SI equipment installation:
  - To be retained by host site or removal and restoration work.

Task 5 - Technology Transfer

- Continuation of technology transfer activities from Phases I and II.
- Meeting with Industry Panel at one host site to review results obtained there and plans for other two host sites.
- Meeting with Industry Panel at completion of project.

4.0 PROJECT STATUS

Work was initiated on January 19, 1990 on Phase II for Site A (Hennepin Unit No. 1).

4.1 Task 1 - Project Management

Monthly and other reporting activities were fulfilled according to the reporting requirements of the cooperative agreement. A Project Evaluation Plan (PEP) for Phase A-II is in preparation.

EER and subcontractor progress have been under continuous review. Coordination with IP took place at monthly meetings in Hennepin and by telephone.

Frequent telephone contacts with the project cofunders were implemented to keep them updated on progress and issues related to the project.

The Host Agreement Modification (Construction and Services Agreement) has been further negotiated with CWLP for the Lakeside No. 7 site. Progress to date suggests that an agreement to proceed with Phase II at Lakeside should be reached during the next quarter.

4.2 Task 2 - Installation and Startup

All engineering and construction and activity performed during this reporting period was for the IP Hennepin Station. This work has been designated as Phase AII-B Subtasks 1.2 and 2.2, respectively, for engineering and construction. The overlap phases, Subtasks 1.1 and 2.1, have been completed.

The IP Hennepin Unit No. 1 outage remains scheduled for April and May, with first quarter activities targeted toward preparation for the outage.

Orders for all-EER purchased major equipment and instrumentation have been placed. Acceptable deliveries have been negotiated.

4.2.1 Contracts

The decision to permit use of the existing ash pond for the GR-SI ash cancelled further work on the ash pond design by Hammontree & Associates. Similarly, the Provost Constructors (construction scheduling) contract was dropped in favor of doing construction scheduling by EER.

Due to the delayed project construction start, it was necessary to negotiate changes in the dollar value of the construction contracts. Since mobilization, there have been additional change orders to account for interferences and other minor changes. The major mechanical change order is for work in the superheater area where $100,000 to $200,000 must be expended to realign the sagging tubes. The ash line contract has been modified to eliminate the new line to the new ash pond, but to replace major sections of the existing ash line.

4.2.2 Construction CPM Scheduling

EER has generated critical path schedules encompassing the project management and mechanical construction activities. The electrical and ash line installations are to be added into the schedule. Despite the delayed project release, the subcontractors have been quickly mobilized and will be ready for the Unit 1 outage. Construction activities will continue through August.

4.2.3 Ash Pond Final Design

As noted above, a new ash pond will not be necessary and this project reporting section will be dropped.

4.2.4 Construction Drawings

Construction drawings have continued as a significant activity during the first quarter, 1990. Drawings left on "hold" in 1989 have been completed. Approvals of vendor and subcontractor fabrication drawings for steel and ductwork have involved considerable effort. Field interferences are also making it necessary to modify supports and routings.

4.2.5 Equipment Purchasing

Except for a few instruments, all equipment orders have been placed. Deliveries are acceptable for outage and non-outage installation activities. Expediting activities have been necessary for new wall openings, and for a 4160 v. circuit breaker.

4.2.6 Miscellaneous

Meetings between Illinois Power and EER were held at Hennepin in January, February, and March. A contractor kickoff meeting was held in January.

Unplanned equipment purchases include a sootblower air compressor and 4160 v. breaker and bus extension.

The deteriorated condition of the I.D. fans (housings and rotating elements) discovered after removal of insulation, will necessitate repairs. This will impact the job sequence, and possibly the job duration.

5.0 PLANNED ACTIVITIES

During the next quarter (April through June 1990) the following work is planned:

A. Hennepin Plant:

1. Complete the Unit 1 outage work.

2. Develop an operator training program outline and content details.

3. Complete the ash line pH control system design.

B. Springfield CWLP

1. Finalize Host Agreement Modification for Phase II and II at Lakeside.

2. Develop project schedule.

3. Update contracts following the project delay.

4. Initiate Phase II engineering activity for Lakeside.

6.0 REPORT DISTRIBUTION LIST

The number in parentheses () indicates the total number of copies submitted.

6.1 Funding Organization Distribution

6.1.1 U.S. Department of Energy

Mr. Harry J. Ritz (2)
PETC Technical Project Manager
Mail Stop 920-L
U.S. Department of Energy/PETC
P.O. Box 10940
Pittsburgh, PA 15236

Mr. John Augustine (1)
Contracting Specialist
AD-21, Mail Stop 921-165
U.S. Department of Energy/PETC
P.O. Box 10940
Pittsburgh, PA 15236

Mr. Douglas Uthus (1)
HQ Program Manager
FE-22, 3E-042, Forrestal
U.S. Department of Energy
Washington, DC 20545

Office of Patent Counsel (1)
U.S. Department of Energy
9800 South Cass Avenue
Argonne, IL 60439

Department of Energy (3)
Office of Technology Transfer
Mail Stop 58-105
U.S. Department of Energy/PETC
P.O. Box 10940
Pittsburgh, PA 15236

Dr. S.N. Roger Rao (1)
Burns and Roe Technical Group Manager
P.O. Box 18288
Pittsburgh, PA 15236

Mr. Charles Drummond (1)
Mail Stop 920-L
U.S. Department of Energy/PETC
P.O. Box 10940
Pittsburgh, PA 15236

Mr. George G. Weth (1)
Senior Program Manager
Office of Clean Coal Technology
FE-24, C-177
U.S. Department of Energy
Washington, DC 20545

Dr. C. Lowell Miller (1)
Associate Deputy for Clean Coal
Office of Clean Coal Technology
FE-24, C-178
U.S. Department of Energy
Washington, DC 20545

6.1.2 Gas Research Institute

Mr. John Pratapas (10)
Gas Research Institute
8600 West Bryn Mawr Avenue
Chicago, IL 60631

6.1.3 Illinois Department of Energy and Natural Resources

Mr. Donald J. Farrell (10)
Illinois Department of Energy and Natural Resources
325 West Adams Street
Springfield, IL 62706

6.2 Host Utility Distribution

6.2.1 City Water Light and Power

Mr. James Rechner (6)
Electric Division Manager
City Water Light and Power
Municipal Building
Springfield, IL 62757

6.2.2 Illinois Power Company

Mr. T. J. May (6)
Illinois Power Company
500 South 27th Street
Decatur, IL 62521

6.2.3 Central Illinois Light Company

Mr. James F. Wittmer (6)
Central Illinois Light Company
300 Liberty Street
Peoria, IL 61602

DATE
FILMED
8/31/92