DOE/PC/90542--T1

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DE92 005263

CLEAN COAL TECHNOLOGY III (CCT III)

10 MW DEMONSTRATION OF GAS SUSPENSION ABSORPTION

DOE Cooperative Agreement
DE-FC22-90PC90542

AirPol Job Number
RD-43

TECHNICAL PROGRESS REPORT

FIRST QUARTER, 1991 (10/01/90 - 12/31/90)

Cleared by Office of Patent Counsel
Chicago Operation Office
Department of Energy

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EXECUTIVE SUMMARY

The 10 MW Demonstration of Gas Suspension Absorption program is designed to demonstrate the performance of the Gas Suspension Absorption System in treating the flue gas from a boiler burning high sulfur coal.

The demonstration project is divided into three major phases:

Phase I - Engineering and Design

Phase II - Procurement and Construction

Phase III - Operation and Testing

During the reporting period (first quarter of 1991), Phase I of the project commenced (on November 1,1990) and significant progress was made in the following areas:

Task I - Project and Contract Management

Initial discussion on Subcontract Agreement was held between AirPol and TVA.

A schedule change was made to reflect the change in site availability.

Task II - Process and Technology Design

Basic process design has been prepared by FLS miljo, the inventor of the GSA process.

Task III - Environmental Analysis

The Environmental Information Volume (EIV) has been prepared and approved.

Task IV - Engineering Design

Field trips were made to collect data and information needed for the design of the GSA system. Preliminary general arrangement drawings were prepared.

It is anticipated that the work accomplished during the reporting quarter will ensure the successful completion of Phase I, Engineering and Design, during the second quarter of the 1991.

ACKNOWLEDGEMENT

The planning, execution, and reporting of this project were a combined effort of many people and organizations. We wish to acknowledge the following for their outstanding effort.

Department of Energy: Richard Santore, Sharon K. Marchant, Karen Troy

Tennessee Valley Authority: Dr. H.B. Flora, Thomas A. Burnett, Bruce A. Gold

FLS miljo: Jorgen Bigum, Jorn Touborg, Tom Rohrmann-Pedersen

AirPol: Willard L. Goss, Shyam K. Nadkarni, Richard A. Rubio, Stuart L. Turgel, Paul Sisler, Chuck S. Marchese

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INTRODUCTION

The Clean Coal Technology Demonstration Program (CCT Program) is a government and industry co-funded technology development effort to demonstrate a new generation of innovative coal utilization processes in a series of full-scale, "showcase" facilities built across the country. These demonstrations will be on a scale large enough to generate all the data, from design, construction, and operation, for technical/economic evaluation and future commercialization of the process.

The goal of the program is to furnish the U.S. Energy marketplace with a number of advanced, more efficient, and environmentally responsive coal-using technologies. These technologies will reduce and/or eliminate the economic and environmental impediments that limit the full consideration of coal as a viable future energy resource.

To achieve this goal, a multiphased effort consisting of five separate solicitation is administered by the Department of Energy. Projects selected through these solicitations will demonstrate technology options with the potential to meet the needs of energy markets and respond to relevant environmental considerations.

The third solicitation (CCT-III), issued in 1989, targeted those technologies capable of achieving significant reductions in the emission of SO_2 and/or NO_x from existing facilities to minimize environmental impacts, such as transboundary and interstate pollution, and/or provide for future energy needs in an environmentally acceptable manner.

In response to the third solicitation, AirPol Inc. submitted a proposal for the design, installation and testing of the Gas Suspension Absorption system at TVA's Shawnee Test facility. On July 25, 1990, a Cooperative Agreement was signed by AirPol for the project entitled "10 MW Demonstration of gas Suspension Absorption". The project was approved by congress in October of 1990.

This low-cost retrofit project will demonstrate the Gas Suspension Absorption which is expected to remove more than 90% of the SO_2 from coal-fired flue gas, while achieving a high utilization of reagent lime. The host site facility will be the Shawnee Test Facility (STF), located at the Tennessee Valley Authority's Shawnee Fossil Plant in West Paducah, Kentucky.

Over the past 15 years the Shawnee Test Facility has served as a testground for flue gas desulfurization (FGD) systems. At the present time a semi-dry process employing 10 MW capacity spray dryer is being tested at the facility. Upon completion of the current test the spray dryer will replaced with GSA system, which will be tested for a period of eleven (11) months.

The Gas Suspension Absorber was initially developed as a calciner for limestone used for cement production. It has been used successfully to clean the gases from a commercial waste to energy plant in Denmark where it has also captured chloride emissions. The GSA system brings coal combustion gases into contact with a suspended mixture of solids, including sulfur-absorbing lime. After the lime absorbs the sulfur pollutants, the solids are separated from the gases in a cyclone device and recirculated back into the system where they capture additional sulfur pollutant. The cleaned flue gases are sent through a dust collector before being released into the atmosphere. The key to the system's superior economic performance with high sulfur coals is the recirculation of solids. Typically, a solid particle will pass through the system over one hundred times before leaving the system. Another advantage of the GSA system is that a single spray nozzle is used to inject fresh lime slurry.

The GSA system is expected to be the answer to the need of the U.S. industry for a effective, economic and space efficient solution to the SO_2 pollution problem.

PROJECT DESCRIPTION

This project will be the first North American demonstration of the Gas Suspension Absorption (GSA) System in its application for flue gas desulfurization. The purpose of this project is to demonstrate the high sulfur dioxide (SO_2) removal efficiency as well as the cost effectiveness of the GSA system. GSA is a novel concept for flue gas desulfurization developed by F. L. Smidth miljo (FLS miljo). The GSA system is distinguished in the European market by its low capital cost, high SO_2 removal efficiency and low operating cost.

A 10 MW GSA demonstration system shall be installed and tested at the Tennessee Valley Authority (TVA) Shawnee Fossil Plant at West Paducah, Kentucky. The new GSA system will replace the existing Spray Dryer that was installed previously as a test unit. The experience gained in designing, manufacturing and constructing the GSA equipments through executing this project will be used for future commercialization of the GSA system. Results of the operation and experimental testing will be used to further improve the GSA design and operation.

The specific technical objectives of the GSA demonstration project are to:

- Effectively demonstrate SO_2 removal in excess of 90% using high sulfur U.S. coal.
- Optimize recycle and design parameters to increase efficiencies of lime reagent utilization and SO_2 removal.
- Compare removal efficiency and cost with existing Spray Dryer/Electrostatic Precipitator technology.

In order to accomplish these objectives, the demonstration project is divided into phases and tasks as shown in the Work Breakdown Structure (WBS) below:

Phase I - Engineering and Design

- Task I - Project and Contract Management
- Task II - Process and Technology Design
- Task III - Environmental Analysis
- Task IV - Engineering Design

Phase II - Procurement and Construction

- Task I - Project and Contract Management
- Task II - Procurement and Furnish Material
- Task III - Construction and Commissioning

Phase III - Operation and Testing

Task I - Project Management
Task II - Start-up and Training
Task III - Experimental Testing and Reporting

According to the revised project schedule the design phase will be complete in March of 1991, the construction phase will be complete by the end of November of 1991, and the testing phase will end in November of 1992.

PROJECT STATUS

A. Task I - Project and Contract Management

Project Management - AirPol has provided overall project management by interfacing with DOE on all aspects of the project, and coordinating the site-related activities with TVA.

AirPol has submitted project reports as specified in the Federal Assistance Reporting Checklist as attached to the Cooperative Agreement. A computerized spread sheet has been set up to establish the Cost Plan as well as to track the actual cost of the project.

Initial discussion was held between AirPol and TVA on the Subcontract Agreement.

Schedule Update - Due to a change of site availability, the Project Schedule was revised to reflect a two (2) month delay of the start of Phase III, Operation and Testing. The revised schedule as shown in Attachment 1 was submitted to DOE in December of 1990.

Preliminary Procurement - Preliminary quotations for reactor, cyclone and recirculation fan were obtained from steel fabricators for the purpose of confirming the cost estimate and entertaining opinion on fabrication details.

Preliminary quotations for the recirculation fan were obtained to confirm the cost estimate and technical design details.

B. Task II - Process and Technology Design

Process Engineering Design - AirPol Process Department obtained process calculation data from FLS miljo, the inventor of the GSA technology. The process information, as provided in the form of Process Design Sheet (PD-Sht.) includes the following details of the process:

- The amount of flow as well as flow characteristics at all elements of the GSA System;
- Sizing information for reactor, cyclone, feeder box, recirculation fan;
- Estimates of pressure drop through all components;
- Estimate of power consumption of all electrical equipment;
- Estimate of lime and water consumption;
- Estimate of by-products.

Note: Information on the Process Design Sheet has been classified as proprietary.

With assistance from FLS miljo, AirPol Process Department is developing the ability to perform the process calculation for the GSA process.

C. Task III - Environmental Analysis

An Environmental Information Volume (EIV) was prepared and submitted to DOE Headquarters in November of 1990. The study concluded that only favorable environmental impacts are expected to occur at the demonstration site as a result of the installation and operation of the GSA System.

The Shawnee Test Facility (STF) is presently used for a similar type of test of a Spray Drier/Electrostatic Precipitator (SD/ESP) FGD system. Because the materials used for both processes are identical, the complexion of the solid waste stream is not expected to change. However, due to the GSA's ability to recycle 99% of the solids in the system versus the existing system's 75%, less fresh lime will be consumed and lower quantities of solid wastes may be produced during flue gas scrubbing at the site.

It was determined that no modifications to the existing permits will be required beyond letters of notification to the State of Kentucky of TVA's intent to test the GSA technology. Construction permit for the new installation will be obtained from the State of Kentucky and local authorities by TVA.

The EIV was reviewed and approved by DOE Headquarters.

D. Task IV - Engineering Design

Site Investigation - Following site related information have been obtained:

a. Soil Information - A report of the Surface Investigation by Florence & Hutcheson, Inc., Consulting Engineer, Paducah, Kentucky, was furnished by TVA. The report was prepared in 1984 to develop recommendations for the design and construction of foundations for the SD/ESP facility that is now existing at STF. The soil information in the report is directly applicable to the design and construction of the GSA System.

b. Field check - Paul Sisler, AirPol Head of Field Service Dept., made a field inspection trip and accomplished the following:

   o Verified dimensions TVA arrangement drawings, and filled in missing dimensions.

- Identified and located existing equipment/objects, such as guy wires for the stack, test building on top of the ESP inlet ductwork, duct support columns, platform and catwalk, etc. which are relevant to the arrangement of the GSA System but not shown on the TVA arrangement drawings.

- Checked the preliminary layout of the GSA System against the existing structure/equipment to identify interference and propose alternate arrangement.

- Identified lay-down areas for future construction need.

- Identified access roadway for future construction traffic.

- Acquired an understanding of the local labor condition.

- Inquired into future office area for AirPol field personnel.

- Checked availability of facilities such as parking, vending machine, cafeteria and sanitary facility.

- Took photographs of the existing structure/equipment for office reference use.

c. Existing equipment to be reused - Tom Pedersen, Chief Electrical Engineer of FLS miljo's GSA Group, visited the plant in November of 1990 and accomplished the following:

- After investigating the feasibility of re-programming the existing Faxboro process control system for the control of new GSA System, Tom concluded that it is more economical and efficient to use a dedicated PLC with a standard GSA control program. The existing Faxboro system will still be used for collecting and recording test data from the various data sampling instruments. Tom recommended that communication links be set up between the new PLC and the existing Faxboro system.

- Confirmed that the existing lime preparation system and the existing ash handling system is suitable for the new GSA operation.

- Confirmed the re-usability and suitability of the following existing equipment/instruments:

Motor control center for power supply to the GSA System.
Air compressor
Slurry pump
I. D. fan
Inlet temperature sensor
outlet temperature sensor
Inlet pressure transmitter
Outlet pressure transmitter
Inlet gas flow meter
outlet gas flow meter
Water pressure gauge
Water flow meter
Slurry flow meter
Inlet SO_2 monitor
Outlet SO_2 monitor

General Arrangement - General arrangement drawing showing the existing structures and equipment was originally prepared based on TVA supplied plot plans.

A preliminary layout of the retrofitted GSA System was made to facilitate discussion of the arrangement and field interference check.

The arrangement drawings were subsequently revised based on information obtained from the site visit by Paul Sisler.

Process Equipment Design - As the design of the process equipment, instrumentation and control is governed by the overall approach to how the unit shall be controlled. Extensive discussions were carried out among the key members of the project design team and Tom Pedersen of FLS miljo on the general approach to controlling the GSA System. Following issues were discussed:

- Control of slurry feed - Whether the control system should be as sophisticated as the one used in the European market (for incinerator application whereby a PLC is used to analyze SO_2, O_2, and H_2O at both the inlet and outlet), or should it be simplified to use feed forward linear control system taking only the inlet SO_2 for input. The reason for considering the later is for future commercialization of the GSA.

- Control of feed rate of recycled material - Whether the control should be automatic or manual. The consideration for manual control is based on the fact that during any given test the inlet gas volume and sulfur concentration will not be changed.

Further discussion of these issues are planned for the near future.
Once these concepts are finalized design work for the process equipment and instrumentation/control can then proceed.

Mechanical Engineering - Based on sizing and detail engineering information provided by FLS miljo, AirPol Engineering Department has completed the preliminary fabrication detail drawings for both the reactor and cyclone.

Structural Design - AirPol Engineering Department completed the preliminary design of the support structure for the reactor and the cyclone.

PLAN FOR NEXT QUARTER

A. Task I - Project and Contract Management

Project Management - Continue monitoring project cost and produce reports according to the Federal Assistance Reporting Checklist.

Continue monitoring the progress of the project and update the project schedule accordingly.

Proceed with the negotiation with TVA on the Subcontract Agreement.

Execute a Technology Transfer Agreement with FLS miljo.

Preliminary Procurement - Issue preliminary inquiries for material and equipment pricing. Issue preliminary inquiry for the construction contract.

B. Task II - Process and Technology Design

Technology Development - AirPol Process Department will acquire from FLS miljo the GSA technology and establish the capability of performing the GSA process design and equipment sizing.

Process Engineering Design - Based on the development of the GSA technology acquired from FLS miljo, AirPol Process Engineering Department will independently prepare detailed heat and material balance calculation for the GSA process and accomplish the following major items:

- Prepare process flow diagram
- Identify effluent yield and quantity
- Identify by-product yield and quantity
- Determine requirements for raw materials and utilities during the Operation and Testing Phase.

C. Task III - Environmental Analysis

Environmental Monitoring Plan - An Environmental Monitoring Plan (EMP) will be prepared to describe the collection and dissemination of significant technology, project, and site-specific environmental data.

D. Task IV - Engineering Design

General Arrangement - AirPol Engineering Department will complete the preliminary general arrangement drawings and release the arrangement drawings to both TVA and FLS miljo for

review and comment.

Process Equipment Design - Instrumentation and control concept will be finalized. Piping and instrumentation drawings will be prepared to depict in detail the process equipment arrangement, instrumentations and the control loops. Specification for pumps, valves, flow meters, pressure sensors, temperature sensors, level detectors, etc. will be prepared.

Mechanical Design - Fabrication drawings and specifications for the following mechanical equipment will be prepared and finalized:

- Reactor and cyclone
- Recycle feeder box
- Recirculation fan
- Ash handling equipment

Detail Design of Auxiliary Equipment - Fabrication drawings and specifications will be prepared for the following auxiliary equipment:

- Support structure
- Stairs and platforms
- Connecting ductwork
- Expansion Joints

Detail Design of Field Installed Materials - Fabrication drawings and specifications will be prepared for the following field installed material:

- Interconnecting piping
- Interconnecting electrical wiring and conduits
- Insulation and lagging for reactor, cyclone and ductwork
- Roofing and siding for the enclosure
- Enclosure indoor lighting
- Foundation and footing

Process Control - Preparation of specification of the control system and the operating program.

It is expected that all design work will be completed at the end of the second quarter of 1991.

Attachment 1

Revised Project Schedule

10 MW DEMONSTRATION OF GAS SUSPENSION ABSORPTION, FINAL PROJECT SCHEDULE

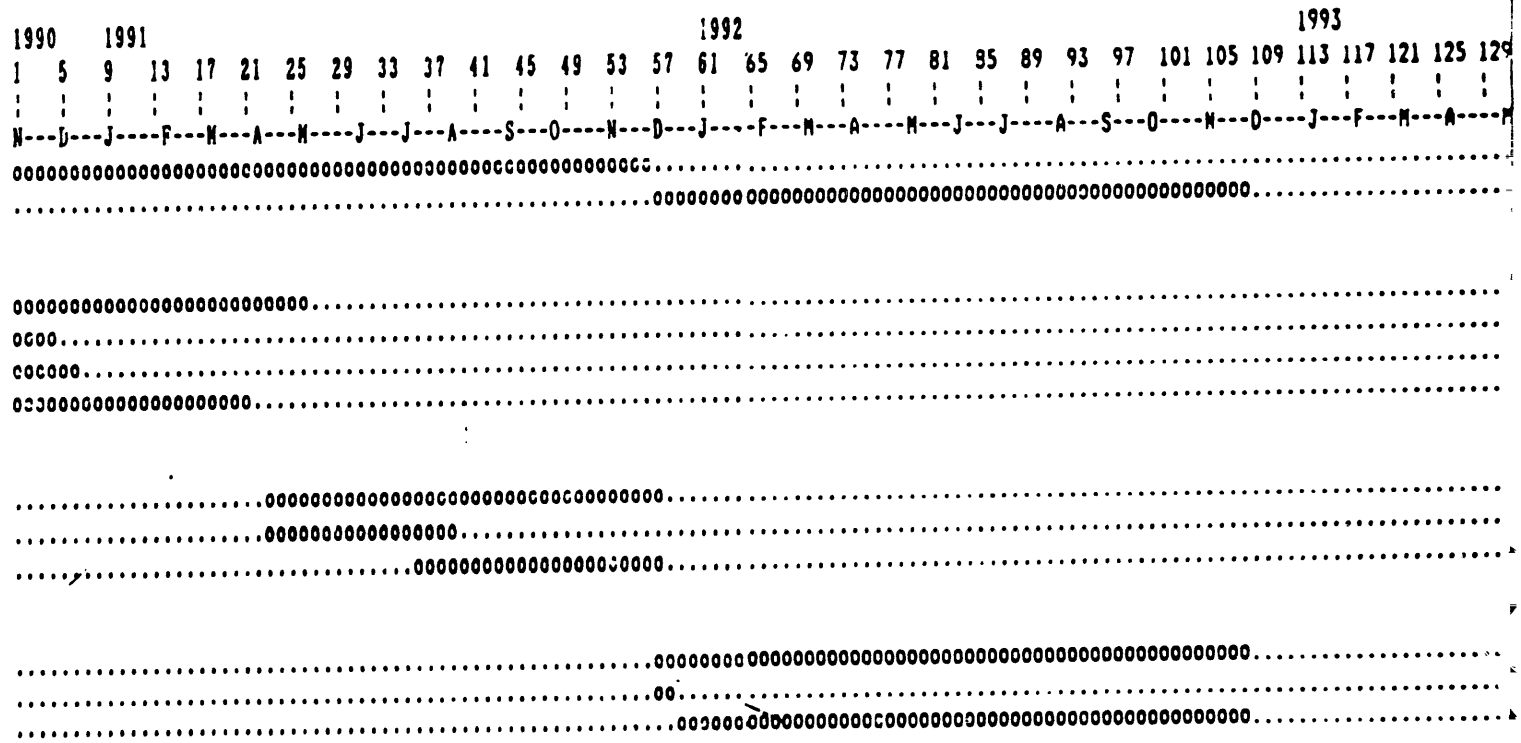
AirPol Inc. Printed 01/03/91 Maximum 136 Weeks

Schedule 16:26:18 109 Weeks

Job: DOE/TVA 11/01/90 Start Date

Ref: Job # RD-43 11/30/92 End Date

Item	Description	Start Date	End Date
100	Budget Period 1	11/01/90	11/30/91
200	Budget Period 2	12/01/91	11/30/92
Phase I Tasks		11/01/90	03/31/91
1.1	Proj. & Contr. Mgt.	11/01/90	04/30/91
1.2	Proc. & Tech. Design	11/01/90	11/30/90
1.3	Environ. Analysis	11/01/90	12/14/90
1.4	Engineering Design	11/01/90	03/31/91
Phase II Tasks		04/01/91	11/30/91
2.1	Proj. & Contr. Mgt.	04/01/91	11/30/91
2.2	Proc. & Furn. Mat'l	04/01/91	07/31/91
2.3	Constr. & Commiss.	07/01/91	11/30/91
Phase III Tasks		12/01/91	11/30/92
3.1	Project Management	12/01/91	11/30/92
3.2	Start-up & Training	12/01/91	12/14/91
3.3	Testing & Reporting	12/15/91	11/30/92



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