Project: " DEVELOPMENT & TESTING OF INDUSTRIAL SCALE , COAL FIRED COMBUSTION SYSTEM,PHASE 3"

Contract: DE-AC22-91PC91162

Contract Period of Performance: 9/30/91 to 9/30/95

First Quarterly Technical Progress Report

PART 1

Period Covered by Report: October 1,1991 to Decmber 31,1991

Contractor: Coal Tech Corp.
P.O.Box 154, Merion Station, PA 19066

Principal Investigator: Dr.Bert Zauderer, Phone No.(215)667-0442

Date Submitted: May 9,1992

Prepared for

PETC Project Manager: Clifford A.Smith

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1. SUMMARY- Part 1, Period10/1/91 TO 12/31/91

No work was performed on this project during this quarter. The only activity consisted of ordering several components, inclduing part of an SO2 gas meter and several computer components, that had been specially approved by DOE for later use on this project.

2. PROJECT DESCRIPTION

2.1. Objectives

The primary objective of the present Phase 3 effort is to perform the final testing at a 20 MMBtu/hr commercial scale of an air cooled, slagging coal combustor for application to industrial steam boilers and power plants. The focus of the test effort will be on combustor durability, automatic control of the combustor's operation, and optimum environmental control of emissions inside the combustor. In connection with the latter, the goal is to achieve 0.4 lb/ MMBtu of SO2 emissions, 0.2 lb/MMBtu of NOx emissions, and 0.02 lb particulates/MMBtu. Meeting the particulate goal will require the use of a baghouse or electrostatic precipitator to augment the nominal 80% ash retention in the combustor. The NOx emission goal will require a modest improvement over reductions achieved to date in the combustor of 0.26 lb/MMBtu. To reach the SO2 emissions goal inside the combustor may require a combination of reduction inside the combustor and inside the boiler by injection of suitable sorbents. To date, SO2 levels as low as 0.6 lb/MMBtu, equal to 81% reduction in 2% sulfur coals, have been measured with boiler injection of sorbents.

The project objectives will be met by a series of tests of increasingly longer duration, and totaling about 800 hours of total testing.

The final objective is to define suitable commercial power or steam generating systems to which the use of the air cooled combustor offers significant technical and economic benefits. In implementing this objective both simple steam generation and combined gas turbine-steam generation systems will be considered.

2.2. Technical Approach

2.2.1. Overview

The work of this Phase 3 project will be implemented on Coal Tech's patented, 20 MMBtu/hr, air cooled cyclone coal combustor that is installed on an oil designed, package boiler at the Tampella plant in Williamsport, PA. This combustor was installed in 1987 an it has undergone development and demonstration testing since that time. The primary fuel has been coal. Other tests, includingcombustion of refuse derived fuels and vitrification of fly ash, have been successfully performed.

The combustor's novel features are air cooling and internal control of SO2, NOx, and particulates. Air cooling, which regenerates the heat losses in the combustor, results in a higher efficiency and more compact combustor than similar water cooled combustors. Internal control of pollutants is accomplished by creating a high swirl in the combustor which traps most of the mineral matter injected in the combustor and converts it to a liquid slag that is removed from the floor of the combustor. SO2 is controlled by injected calcium oxide based sorbents into the combustor to react with sulfur emitted during combustion. The spent sorbent is dissolved in the slag and removed with it, thereby encapsulating the sulfur in slag. NOx is controlled by staged, fuel rich combustion inside the combustor.

As described in Section 2.1. excellent progress has been made in the past several years in meeting these combustor performance objectives. One of the most important objectives of this technology development effort is to demonstrate very high SO2 reduction in the combustor. Prior to the start of the present Phase 3 project, the peak SO2 reduction achieved with sorbent injection in the combustor has been 56%, (+/-) 5%. Of this amount a maximum of 11% of the total coal sulfur was trapped in the slag. On the other hand, up to 81% SO2 reduction has been measured with sorbent injection in the boiler immediately downstream of the combustor. Tests in the past several years have revealed the critical role played by optimum operating conditions in the SO2 reduction process. Specifically, combustor operation must be automatically controlled, and solids feed and air-solids mixing in the combustor must be optimized. Progress in both areas has been accomplished in the past 2 years by using a microcomputer to control the combustion process and by testing various methods of feeding and mixing the coal and sorbents. As a result of very recent work it is now believed that in excess of 90% SO2 reduction could be achieved by sorbent injection in the combustor, and that a very high fraction of the captured sulfur can be retained in the slag. The validation of this conclusion is one of the key objectives of the present project.

Combustor durability is an essential requirement for commercial utility of the combustor. Due to the aggressive nature of the combustion process and the need to utilize refractory materials inside the combustor to withstand the 3000F gas temperatures, durability has been one of the key challenges in the development process. Here also the use of computer control has been the means whereby this problem is being solved. Since introduction of computer control two years ago, the need for frequent refractory liner patching inside the combustor has been eliminated. The project objective of combustor durability will be implemented by operating the combustor for increasingly longer continuous periods on coal. To date, the longest continuous operation on coal has been 8 to 10 hours. It is planned by the end of the present project to achieve continuous round-the-clock coal fired operation for up to 100 hours. The combustor internals and auxiliary components will be modified, and the automated computer control will be extended to accomplish the durability objective.

The final project objective of placing the combustor in a viable industrial steam or power generating system will be accomplished by detailed engineering analysis on the use of the combustor in one or more steam generating cycles. This effort will also include an assessment of the requirements for commercializing the combustor for an industrial application.

2.2.2. Task Description

Task 1: Design, Fabricate, and Integrate Components

This task consists of three sub-tasks. Components design, component fabrications, and components integration. The 20 MMBtu/hr combustor will be modified to allow safe and environmentally compliant operation for periods of up to 100 hours.

Task 2: Preliminary Systems Tests

The modified combustor system will undergo a series of one day parametric tests of total duration of 100 hours to validate the design changes introduced in task 1, and to accomplish the project objectives and goals.

Task 3. Proof of Concept Tests

The durability of the combustor will be determined in a series of tests of between 50 and 100 hours of continuous operation. The total test period will be 200 hours.

Task 4. Economic Evaluation & Commercialization Plan

The economics of one or at most two different industrial scale steam based cycles using the combustor will be evaluated. A commercialization plan will be developed for marketing the combustor in an industrial environment both in the US and overseas.

Task 5. Conduct Site Demonstration

This task will be the final test activity in the project. Its objective will be to demonstrate the durability and hence the commercial readiness of the combustor for its intended industrial application(s). The effort will consist of two sub-tasks. In the first one any changes required as a result of prior tests will be made to the combustor. In the second one a series of tests, each of up to 100 hours of continuous coal fired operation will be performed, with a total test time of 500 hours.

Task 6. Decommissioning Test Facility

The test facility will be removed from the boiler installation and disposed in accordance with required regulations.

3. PROJECT STATUS.- Part 1, Period10/1/91 TO 12/31/91

No work was performed on this project during this quarter. The only activity consisted of ordering several components, incldуing part of an SO2 gas meter and several computer components, that had been specially approved by DOE for later use on this project.

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First Quarterly Technical Progress Report

PART 2

Period Covered by Report: January 1,1992 to March 31,1992

Contractor: Coal Tech Corp.
P.O.Box 154, Merion Station, PA 19066

Principal Investigator: Dr.Bert Zauderer, Phone No.(215)667-0442

Date Submitted: May 9,1992

Prepared for

PETC Project Manager: Clifford A.Smith

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1. SUMMARY

Although the contract start date was 10/1/91, the project plan called for work to begin on 1/1/92. The only effort performed prior to that date was to specify and order several pieces of equipment which were required on an presently ongoing DOE project as well as the present Phase 3 project. The cost of these items was shared by both projects.

In the first quarter of calendar year 1992, work began on Task 1.1."DESIGN MODIFICATIONS TO THE 20 MMBTU/HR AIR COOLED COMBUSTOR AND BOILER COMPONENTS". As implied by its name, this effort consisted of specifying and designing the changes needed to prepare the 20 MMBtu/hr air cooled combustor at the Tampella boiler house site in Williamsport, PA for implementing the work scope of the present Phase 3 project. This work scope was originally defined in the proposal to this project which was prepared in the summer of 1990. Since that time significant progress has been made in improving the combustor and its auxiliary components performance. Therefore, several important changes planned for the task 1.1 are not required anymore. To present a complete picture of the present technical status of the combustor as well as the planned design changes to be implemented in task 1 of the present project, a report of the required work in task 1 was prepared during this quarter. This report was submitted in draft form to DOE in early March. At the same time, a presentation was made of its contents. This report's contents are enclosed as an Appendix to this quarterly report. It describes the bulk of the technical effort during this quarter.

The only other significant item in the present reporting period, is that the National Environmental Policy Act (NEPA) approval process for the present project was not completed during this period. As a result, work on task 1.2 , whose scope is to implement the design changes to the combustor, and which was to begin on 3/1/92, was not implemented.

2. PROJECT DESCRIPTION

2.1. Objectives

The primary objective of the present Phase 3 effort is to perform the final testing at a 20 MMBtu/hr commercial scale of an air cooled, slagging coal combustor for application to industrial steam boilers and power plants. The focus of the test effort will be on combustor durability, automatic control of the combustor's operation, and optimum environmental control of emissions inside the combustor. In connection with the latter, the goal is to achieve 0.4 lb/ MMBtu of SO2 emissions, 0.2 lb/MMBtu of NOx emissions, and 0.02 lb particulates/MMBtu. Meeting the particulate goal will require the use of a baghouse or electrostatic precipitator to augment the nominal 80% ash retention in the combustor. The NOx emission goal will require a modest improvement over reductions achieved to date in the combustor of 0.26 lb/MMBtu. To reach the SO2 emissions goal inside the combustor may require a combination of reduction inside the combustor and inside the boiler by injection of suitable sorbents. To date, SO2 levels as low as 0.6 lb/MMBtu, equal to 81% reduction in 2% sulfur coals, have been measured with boiler injection of sorbents.

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As described in Section 2.1. excellent progress has been made in the past several years in meeting these combustor performance objectives. One of the most important objectives of this technology development effort is to demonstrate very high SO2 reduction in the combustor. Prior to the start of the present Phase 3 project, the peak SO2 reduction achieved with sorbent injection in the combustor has been 56%, (+/-) 5%. Of this amount a maximum of 11% of the total coal sulfur was trapped in the slag. On the other hand, up to 81% SO2 reduction has been measured with sorbent injection in the boiler immediately downstream of the combustor. Tests in the past several years have revealed the critical role played by optimum operating conditions in the SO2 reduction process. Specifically, combustor operation must be automatically controlled, and solids feed and air-solids mixing in the combustor must be optimized. Progress in both areas has been accomplished in the past 2 years by using a microcomputer to control the combustion process and by testing various methods of feeding and mixing the coal and sorbents. As a result of very recent work it is now believed that in excess of 90% SO2 reduction could be achieved by sorbent injection in the combustor, and that a very high fraction of the captured sulfur can be retained in the slag. The validation of this conclusion is one of the key objectives of the present project.

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Task 6. Decommissioning Test Facility

The test facility will be removed from the boiler installation and disposed in accordance with required regulations.

3. PROJECT STATUS.- Part 2, Period1/1/92 TO 3/31/92

The effort of this quarter was devoted to task 1.1, the design of the modifications to the combustor to implement the project objectives. A preliminary report of the combustor's technical status and the work to be implemented was prepared and submitted to DOE in March 1992. This report was submitted as a Topical Report for the present project.. It describes the bulk of the effort that was performed in the present project.

During the next quarter, work will begin to implement the activities described in this document. In addition, planning documents for the task 2 and task 3 effort will be prepared. Finally, if the NEPA approval process is complete work on implementing the design changes on the combustor will begin.

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8/26/93