TECHNICAL PROGRESS REPORT

April 1992 - June 1992

For:
U.S. Department of Energy
Morgantown Energy Technology Center

Under:
DOE Contract No. DE-AC21-89MC26288
Sonic Enhanced Ash Agglomeration
and Sulfur Capture

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This 12th Quarterly Technical Progress Report presents the results of work accomplished during the period March 30, 1992 through June 28, 1992, under Contract No. DE-AC21-88MC26288 entitled "Sonic Enhanced Ash Agglomeration and Sulfur Capture."

During this period, fabrication of all system components has been completed. They have also been installed on the support structure. The outdoor site for the solids feeder has been completed and installation completed. The storage bin will accommodate an 8-hour supply for the test. It is anticipated that a form and fit checkout will be completed next period and that shakedown testing may be initiated during the latter part of September.
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SECTION 1.0
INTRODUCTION

1.1 PROJECT DESCRIPTION AND WORK STATUS

A major concern with the utilization of coal in directly fired gas turbines is the control of particulate emissions and reduction of sulfur dioxide, and alkali vapor from combustion of coal, upstream of the gas turbine. Much research and development has been sponsored on methods for particulate emissions control and the direct injection of calcium-based sorbents to reduce SO₂ emission levels. The results of this research and development indicate that both acoustic agglomeration of particulates and direct injection of sorbents have the potential to become a significant emissions control strategy.

The Sonic Enhanced Ash Agglomeration and Sulfur Capture program focuses upon the application of an MTCI proprietary invention (Invention Disclosure filed) for simultaneously enhancing sulfur capture and particulate agglomeration of the combustor effluent. This application can be adapted as either a "hot flue gas cleanup" subsystem for the current concepts for combustor islands or as an alternative primary pulse combustor island in which slagging, sulfur capture, particulate agglomeration and control, and alkali gettering as well as NOₓ control processes become an integral part of the pulse combustion process.

The goal of the program is to support the DOE mission in developing coal-fired combustion gas turbines. In particular, the MTCI proprietary process for bimodal ash agglomeration and simultaneous sulfur capture will be evaluated and developed. The technology embodiment of the invention provides for the use of standard grind, moderately beneficiated coal and WEM for firing the gas turbine with efficient sulfur capture and particulate emission control upstream of the turbine. The process also accommodates injection of alkali gettering material if necessary. This is aimed at utilization of relatively inexpensive coal fuels, thus realizing the primary benefit being sought by direct firing of coal in such gas turbine systems. The proposed technology
provides for practical, reliable, and capital (and O&M) cost-effective means of protection for the gas turbine from impurities in the coal combustor effluent.

1.2 PROGRAM OBJECTIVES

The major objective of the Phase I test program is to confirm the feasibility of the MTCI bimodal particle size approach to enhance particulate control by acoustic ash agglomeration. An ancillary objective of the Phase I effort is to demonstrate and confirm the feasibility of an acoustic field to enhance sulfur capture by increasing sorbent reactivity. Phase I tests are designed to cover the frequency range between 50 and 1400 Hz, establish monomodal baseline performance as a benchmark from which to measure the degree of enhancement expected from the bimodal approach, and, finally, to confirm the effectiveness of low-frequency fields over high-frequency fields for realistic particulate streams.

The program will demonstrate the effectiveness of a unique approach which uses a bimodal distribution composed of large sorbent particles and fine fly ash particles to enhance ash agglomeration and sulfur capture at conditions found in direct coal-fired turbines. Under the impact of high-intensity sound waves, sorbent reactivity and utilization, it is theorized, will increase while agglomerates of fly ash and sorbents are formed which are readily collected in commercial cyclones. The work will extend the concept from the demonstration of feasibility (Phase I), through proof-of-concept (Phase II) to the construction (Phase III) of a coal-fired pulsed combustor with in-furnace sorbent injection. For Phase I, Pennsylvania State University will conduct studies for enhanced sulfur capture in The Combustion Laboratory and agglomeration tests in the High Intensity Acoustic Laboratory.
1.3 SUMMARY STATUS FOR THE PERIOD

During this period, fabrication of all system components has been completed. They have also been installed on the support structure. The outdoor site for the solids feeder has been completed and installation completed. The storage bin will accommodate an 8-hour supply for the test. A batch rotary mixer for coal and sorbent was substituted for the hopper/screw feeder to maintain a steady supply of materials during the test. It is anticipated that a form and fit checkout will be completed next period and that shakedown testing may be initiated during the latter part of September.
The remaining system components have all been fabricated. These included:

- Agglomeration chamber catch pot
- Cyclone catch pot
- Heat exchanger for flue gas cooling
- Coal preconditioner
- Coal and sorbent feeder supply subsystem.

All the system components have been assembled and installed on the support structure. The solids (coal and sorbent) feeder has been received from the vendor (Macawber Company) and has been installed outdoors after site preparation. A few changes have been made in the piping and instrumentation diagram (P&ID) included in the previous (11th) quarterly report. The revised P&ID of the bimodal test facility is shown in Figure 1. The modifications include:

- Substitution of coal and sorbent hopper/screw feeder with a coal and sorbent supply subsystem comprising a batch rotary mixer, storage bin, rotary valve, eductor, cyclone and baghouse. A level switch in the solids feeder hopper controls the rotary valve and regulates solids flow into the hopper. The storage bin can accommodate about an 8-hour supply of coal and sorbent and therefore will not require frequent changing as in the previous configuration incorporating hopper (screw feeder subsystem).

- Convection of the cooling water circuits to the space heating unit or the air rotation unit (ARU) of the commercial-scale boiler instead of the industrial boiler. This facilitated the use of existing
FIGURE 1: P&ID OF THE BIMODAL TEST FACILITY
equipment and eliminated the need to purchase a pump with elevated temperature (250°F) seal.

- Addition of a water jacket enclosure around the top part of the agglomeration chamber. This was done as a safety measure to keep the metal temperature relatively cool and prevent failure under pressure in the unlikely event of a loss of insulation in that section due to settling of the kaowool insulation.

- Incorporation of tangential solids injection and coaxial gas injection into the pulse combustor in lieu of coaxial solids injection and transverse gas injection via a manifold. This change was made based on the PAFBC pulse combustor tests as discussed in the previous (11th) quarterly report.

Photographs of some of the components as installed are shown in Figures 2 through 6. Figure 6 shows the system backpressure controller, steam drum pressure controller, thermocouple and static pressure LCDs, flow meters, flow indicators/status displays and static pressure gauges.

The plumbing and instrumentation connections are about 80 percent complete. It is proposed to complete these and the instrument calibration by the end of next month.
FIGURE 2: AGGLOMERATION CHAMBER - BOTTOM SECTION AND CATCH POT
FIGURE 4: HEAT EXCHANGER AND FUEL PRECONDITIONER
FIGURE 6: ONE SECTION OF INSTRUMENTATION AND CONTROL PANEL
SECTION 3.0
PLANS FOR NEXT PERIOD

- Complete the plumbing and instrumentation connections.
- Pressure test the water side and flue gas side for leaks and fix, if any.
- Perform instrument calibration and check out the control system.
- Conduct shakedown tests.