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Sonic-Enhanced Ash Agglomeration and Sulfur Capture

Technical Progress Report
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For
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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 SO_2 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 (Patent No. 5,197,399) 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 NO_x 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 reporting period, additional fabrication work was carried out and final report preparation was started.

SECTION 2.0

TECHNICAL DISCUSSION OF THE WORK ACCOMPLISHED DURING THE REPORTING PERIOD

2.1 TASK 2: ADDITIONAL TEST FACILITY MODIFICATIONS AND SHAKEDOWN TESTING

Additional fabrication was carried out on pulse combustor water jacket, slag handling section and ash drain section. The leftover refractory work was also completed. *Table 1* provides a summary of fabrication status.

2.2. TASK 5: COMMERCIALIZATION PLAN

No activity during this reporting period.

Final Report

An outline was prepared, material were assembled from the quarterly reports and log books and the write-up was begun.

TABLE 1:
DESIGN AND FABRICATION STATUS OF BIMODAL PDU

Item No.	Description of Components	Design Accomplished, %	Fabrication Accomplished, %
1	Air plenum	100	100
2	Coal injector	100	100
3	Pilot burner	100	100
4	Aerovalve	100	100
5	Water jacket of pulse combustor	100	100
6	U-bend water jacket	100	100
7	Agglomeration chamber (60" dia.)	100	100
8	Slag-handling section	100	60
9	Ash drain section	100	60
10	Reburning coal injector	100	100
11	Primary cyclone	100	100
12	Secondary cyclone	*	*
14	Dipleg and ash recycle section	100	100
15	Refractory and insulation	100	100
16	Splitter of coal and air mixture	0	0
17	Flue gas heat exchanger	50	0
18	Steam drum	0	0
19	Air preheater in the flare	0	0
20	Structure	100	25
21	Instrumentation and control	70	0
22	Modification for pressure test	100	100
23	Concrete pad	100	100
24	Flanges for hydro testing	100	100
25	Hydrostatic test	-	100

* Primary cyclone of the previous configuration to be refurbished.

SECTION 3.0

PLANS FOR NEXT PERIOD

- Prepare the Draft Final Report and submit the Report.

- Prepare the Final Property Management Report and submit the Report.