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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 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 (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 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 reporting period, commercialization activity was continued.

SECTION 2.0

TECHNICAL DISCUSSION OF THE WORK ACCOMPLISHED DURING THE REPORTING PERIOD

2.1 TASK 2: ADDITIONAL TEST FACILITY MODIFICATIONS AND SHAKEDOWN TESTING

No activity during this reporting period.

2.2. TASK 5: COMMERCIALIZATION PLAN

A presentation was made at the Federal Energy Technology Center (FETC), Morgantown, West Virginia to facilitate a strategic partnership for advanced conversion of energy. It included a review of the concept, advantages and status of the pulsed gasification combined-cycle (PGCC). The advantages of the PGCC in comparison with competing advanced power generation technologies are listed in ***Table 1***, based on a preliminary evaluation. The PGCC offers comparable performance with fewer components and shows potential for significant capital cost saving. FETC support was sought to carry out performance and cost studies on PGCC to aid commercialization.

TABLE 1:

PGCC ADVANTAGES

	IGCC		SECOND-GENERATION		
	OXYGEN	AIR	PFBC	TRANSPORT	PGCC
BARRIER FILTER	Yes	Yes	Yes	Yes	No
SYNGAS COOLER	Yes	Yes	No	Yes	No
AIR SEPARATION UNIT	Yes	No	No	No	No
HOT GAS CLEANUP	Yes	Yes	No	Yes	No
SULFUR RECOVERY	Yes	No	No	No	No
EFFICIENCY, %	37-42	40-44	44-46	~ 45	~ 45
SONIC-ENHANCED SULFUR CAPTURE	No	No	No	No	Yes
CAPITAL COST SAVING FOR PGCC, $/kW	300-400	100-200	50-150	50-100	-

SECTION 3.0

PLANS FOR NEXT PERIOD

- Complete the fabrication of the slag handling section, ash drain section and the second-level structural support.

- Pursue commercialization activities.

- Prepare a Final Report.