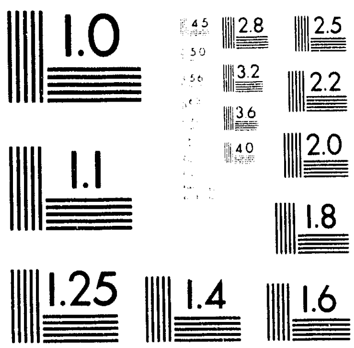
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Particle Collection Enhancement by Acoustics

Authors:
M.N. Mansour
R.R. Chandran
J.N. Duqum
A.W. Scaroni
G.H. Koopman
J.L. Loth

Contractor:
Manufacturing and Technology Conversion International, Inc.
P.O. Box 21
Columbia, MD 21045

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DISCLAIMER

5.8 Particle Collection Enhancement By Acoustics

CONTRACT INFORMATION

Contract Number	DE-AC21-89MC26288
Contractor	Manufacturing and Technology Conversion International, Inc. P.O. Box 21 Columbia, MD 21045 (301) 982-1292
Contractor Project Manager	Momtaz N. Mansour
Principal Investigators	Momtaz N. Mansour Ravi R. Chandran Jamal N. Duqum Alan W. Scaroni (Penn State U.) Gary H. Koopman (Penn State U.) John L. Loth (West Virginia U.)
METC Project Managers	Daniel C. Cicero and Darren J. Mollott
Period of Performance	June 1989 to July 1994

ABSTRACT

The overall objective of this project is to demonstrate pulse combustion induced acoustic enhancement of coal ash agglomeration and sulfur capture efficiency at conditions typical of proposed direct coal-fired turbines. The MTCI proprietary approach results in agglomerates that allow the use of conventional cyclones to achieve very high particulate collection efficiency and eliminates the need for barrier filters which pose concerns regarding durability and economics. The goal of the program is to support the mission of the Department of Energy (DOE) for developing coal-fired combustion gas turbines. The MTCI concept can be packaged either as a hot flue gas clean-up subsystem for the existing combustor island configurations or as an alternative primary pulse combustor island with integrated sulfur capture, particulate agglomeration and capture, alkali gettering and NO_x emissions control.

Phases I, II and III of the sonic-enhanced ash agglomeration and sulfur capture (SEAASC) program have established the technical merit and the engineering feasibility of the MTCI bimodal concept. To demonstrate proof-of-concept, a laboratory-scale bimodal test facility has been designed, fabricated, and integrated for elevated pressure (4 atm.) operation.

It incorporates a new tailpipe-agglomeration chamber interface configuration, a coal preheating arrangement, a refractory-lined cyclone to simulate hot gas cleanup, and elaborate instrumentation and controls to enable complete process characterization and safe operation. The test facility comprises the following components/subsystems:

- Coal and sorbent feed system.
- Air and natural gas supply system.
- Pulse combustor.
- Acoustic agglomeration and sulfur capture chamber.
- Refractory-lined cyclone.
- Fuel preconditioner.
- Heat exchanger.
- Pressure letdown valve.
- Baghouse.
- ID fan.
- Steam circuit.
- Cooling water circuit.
- Instrumentation and controls.

Work is underway to experimentally characterize the laboratory-scale MTCI coal-fired pulse combustor island for gas turbine application and develop the design framework for scale-up of this advanced combustion technology. A team has been formed with MTCI as the prime contractor and Penn State University (PSU) and West Virginia University (WVU) as subcontractors to MTCI. MTCI is focusing on hardware development and system demonstration, PSU is investigating and modeling acoustic agglomeration and sulfur capture, and WVU is studying aerovalve fluid dynamics.

At MTCI, system shakedown tests were initially conducted at pressures of 2 and 3 atm. with natural gas and pulverized coal (SeaCoal - Pittsburgh No. 8). After verification of satisfactory system operation, screening tests have been performed with the injection of either coal or coal plus pulverized dolomite (Dolofil - Pfizer) mixture into the pulse combustion chamber. The test results indicate combustion efficiency exceeding 99.5 percent and sulfur capture efficiency ranging from 75 to 99 percent for a variation in Ca/S molar feed ratio from 1.5 to 2.5. Due to contamination of baghouse catch by fly ash from another combustion unit, particulate carryover in the flue gas stream downstream of the hot cyclone are not quantified here. A preliminary evaluation of test data shows potential for meeting gas turbine particulate tolerance criteria. A dedicated baghouse has been installed and connected to the bimodal test facility. Tests with coal and coal-lime mixture are scheduled.

PSU is performing fundamental studies of bimodal acoustic agglomeration and sorbent behavior under pulse combustion conditions. Experiments have been conducted in a particle observation facility to visualize particle motion and collisions. PSU is also upgrading a pulverized coal combustion code (PCGC-2) to model sulfur capture and bimodal acoustic agglomeration under pulse combustion conditions. WVU has performed steady and unsteady tests on aerovalves and determined aerovalve diodicity. A quasi-steady compressible flow analysis is being carried out to characterize aerovalve performance.

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