Dφε/Pc/90297-T4

DOE/PC/90297--T4

RECEIVED USDOE/PETC

DE92 015533

92 FEB 19

QUARTERLY REPORT FIFTH QUARTER, COVERING 10/1/91 TO 12/30/91

FUNDING AGENCY: U.S. Department of Energy P.E.T.C.

GRANT NO: DE-FG22-90PC90297

PROJECT TITLE: Impact of Nonequilibrium ParticleTemperature Considerations on Seeded Coal Combustion Plasma Properties

PRINCIPAL INVESTIGATOR: Dr. A.A. Oni
INSTITUTION: School of Engineering Morgan State University, Baltimore, MD. 21239
CONTRACT SPECIALIST: Ms. Rhonda Dupree
PETC; MS 921-165
TECHNICAL OFFICER: Dr. Harold Chambers
PETC; MS 922

THE RESEARCH TEAM:

1. Dr. Adeboyejo A. Oni, Principal Investigator
Assistant Professor of Engineering and Applied Science
Morgan State University, Baltimore, Maryland.

2. Mr. Feng Lin, Graduate Research Assistant
Ph.D Student in Mechanical Engineering (Thermofluids)
University of Maryland Baltimore County Campus
Catonsville, Maryland.

3. Ms. Kimberly Myles, Undergraduate Research Assistant
Senior Industrial Engineering student
Morgan State University, Baltimore, Maryland.

4. Dr. Robin Khosah, Consultant on Chemical Equilibrium
Combustion Diversified Technologies Inc.
551 Larimar Ave
P.O. Box 5297
Pittsburgh, PA. 15206

ABSTRACT

The main purpose of this research is to investigate the impact of nonequilibrium temperatures of the post-combustion entrained particles on the generator-bound combustion plasma properties and consequently on the overall performance of the MHD channels for both Linear and Disk configurations in the typical coal-fired MHD environment.

Aiming at this purpose, three major tasks should be completed within the 2-year period of grant. The first task is to establish a simulation model to present the steady

state, non-equilibrium interactions between the post-combustion entrained particles and their carrier gases. The second task is to predict the overall performance of the MHD channels for both Linear and Disk configurations with the available fully-developed non-equilibrium simulation model. The third task is to evaluate the relative impact of gas-particle temperature difference on generator slag phenomena as well as MHD overall performance.

This past quarter ending 12/30/91, the linear MHD channel simulation model has not only been completely specified but also fully modified to incorporate considerations for nonequilibrium particle temperatures. Testing of the modified model with the initial values from the first submodel (Richter's combustion zone model) and evaluation of the non-equilibrium particle temperature effect on the overall MHD performance is being held up. Reasons for the holdup is the lack of adequate response from Dr. Richter on questions about his nonequilibrium particle temperature model. These questions relate to our insistence to know precisely how the model works and also some review of the source code to ascertain that it is in synchronization with our overall analytical development.

In the meantime, we have decided to generate initial generator inlet particle parameter values by modifying the CEC code to provide particle parameter values.

INTRODUCTION:

In order to incorporate temperature differences between particles and gases into the existing MHD simulation models, two submodels under the first task should be developed. The first submodel, originally planned to be the modified Richter's Combustion Zone model, will be a modified CEC code that accomodates the generation of properties for particles produced during combustion. In other words, the CEC will be modified to simulate equilibrium particle properties. The second submodel is a modification of the current Burns and Roe/SAIC linear channel and disk generator simulation models. The modification of the Burns and Roe Linear Channel model to accept gas and particle property values has been completed, and works very efficiently with dummy particle parameter values.

During the last four months, we concentrated our efforts to very limited editing of the CEC code in order to have it generate particle information. The code already acounts for particle production, but suppresses calculations of the properties for those particles. Once Richter's model becomes available, it will be evaluated alongside this current development. At the conclusion of this effort, we plan to have a fully-developed, steady state, nonequilibrium simulation model that links the modified Linear Channel code with either a fully specified Richter's model or a modified CEC particle property model.

QUARTER RESEARCH ACTIVITIES:

On the basis of previous work, the major activities during the fifth quarter are as follows:

1. In the absence of Dr. Richter's particle model, the PC version of the CEC code was recompiled, so that future editions may also be compilable after editing sessions. The objective is to allow the CEC code to simulate the production of particles, and thus provide initial value particle properties for the Linear Code. A table similar to the current one for gas properties will be the output of the current ongoing effort. This table will provide combustor outlet values for gas temperature, particle temperature, particle sizes, particles densities, particle concentration, CO/CO2 concentration, outlet pressure, particle molecular weight and particle constant pressure specific heat over the gas temperature range of 1000K-3000K, gas pressure range of 0.5-10 atm, particle size range of 1um-100um, particle concentration range of 0.1-5% and CO/CO2 concentration range of 100%/0 - 0/100%.

The three class of equations written out for the nonequilibrium simulation model have completely been incorporated into the modified CEC code. These are:

a) the governing equations for the gaseous phase;

b) governing equations for the particulate phase and

c) governing equations for the gas-particle continuum.

These equations were introduced to the Burns and Roe/SAIC linear channel program, to obtain the second submodel which will then be used to evaluate the nonequilibrium particle temperature effect on the thermo-fluid dynamic and electrical properties of the plasma.

As mentioned earlier, inlet gas-particle parameter values for the MHD channel will be obtained from the currently ongoing modificatios to the CEC code for the particulate phase. Richter's combustion zone model will be investigated alongside this effort, if it becomes available, and if it can be verified as being analytically appropriate

PREVIEW OF SIXTH QUARTER ACTIVITIES:

This quarter, we will attempt to do the following:

1. Complete the modification of the CEC code for generation of particle parameters. Run the modified linear channel code (the second sub-model) with input parameters as generated by the modified CEC code. Continue to work with Dr. Richter for a resolution of the availability of the Richter code. Test the results given by particle parameter output from the Richter code, if it becomes available. Output channel performance data using these particle parameter codes will then be compared with previous predictions.

2. Begin the modification of the disk code. Next will be a similar development with the disk channel. Both modeling systems will be thoroughly tested for their robustness, i.e. their sensitivities to input parameter changes, and their conformance to experimental estimations, as discussed in the proposal for this study.

END

DATE FILMED

8/19/92