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TURBULENT SWIRLING COMBUSTION*

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EXPERIMENTAL EFFORT

Turbine Combustion Facility

An experimental facility constructed to simulate swirling gas turbine combustion has been subjected to extensive redesign and modification. The program undertaken over the course of the past year consisted essentially of two phases: (1) an assessment of the existing test facility, and (2) a major redesign and reconstruction of those components deemed in need of alteration. As a result of this extensive effort, the test facility at Carnegie-Mellon University has achieved a higher degree of precision and reproducibility. Furthermore, it is believed that those undesirable extraneous effects which plague any fluid mechanics experiment have been substantially reduced. Hence, it is at this time that accurate and reproducible flow measurements can begin.

Measurements and Results

Measurements of the non-reacting turbulent flow produced by two confined, co- and/or counter-swirling jets have been obtained by means of a two-color laser Doppler velocimeter. These results are compared with earlier experiments by Vu and Gouldin (ref. 1), and the numerical predictions of Ramos (refs. 2 and 3). It is shown that under both swirl conditions, a closed recirculation zone is created at the combustor center line. This zone is characterized by the presence of a one-cell toroidal vortex, low tangential velocities, high turbulent intensity, and large dissipation rates of the kinetic energy of turbulence.

THEORETICAL EFFORT

Numerical Modeling of Turbulent Swirling Flows

The major thrust of the theoretical effort has been the adaptation of previously developed computer codes by Lilley (ref. 4) and Ramos (ref. 5) to the above described experiment. Both codes are based on the k-ϵ turbulence model, while Ramos additionally utilizes a k-ℓ turbulence model.

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In his numerical solution, Ramos (ref. 2) includes streamline curvature effects. The streamline curvature effect is being improved and a correction factor for the k-ε model will be developed during the remaining funding period. Because the codes utilize different numerical solution techniques to solve the finite difference equations, comparison between numerical results and measurements will be used to evaluate the quality of both techniques.

Special care will be taken to model the recirculation zone casued by the presence of co- and counter-swirling flows. It will be possible, due to clearly defined experimental boundary and initial conditions, to investigate the influence of turbulence models on complex reacting flows. These conditions have been found to be critical in numerical studies.

REFERENCES

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