NASA SBIR/STTR Technologies

Advanced Nongray Radiation Module in the LOCI Framework For Combustion CFD

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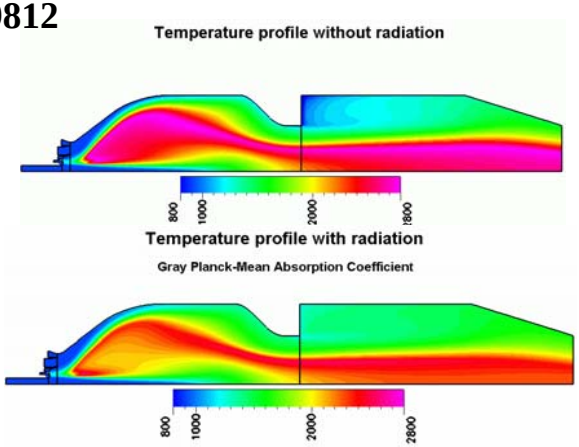
Identification and Significance of Innovation

- Radiative heat transfer modeling will become increasingly important in the design and analysis of advanced rocket motors.
- Hydrocarbon fuels (in-situ propellants, nontoxic control thruster fuel) produce soot – increased radiative heat transfer, wall temperatures.
- The LOCI framework and the combustion modeling code CHEM, in use at NASA, do not have any radiation modeling capabilities.
- CFDRC-Mississippi State University team will develop an innovative, robust and computationally efficient radiation module in LOCI.
- Completion of effort will provide NASA with state-of-the-art radiation simulation capabilities.



Temperature Profiles for 2-D axisymmetric Propane-Air Combustion Without Radiation (Top), with Gray Gas Assumption (Bottom)

Technical Objectives

- Develop an advanced radiation modeling capability within the LOCI framework.
- Phase I - demonstrate feasibility by implementing and validating widely accepted radiation models in the LOCI framework.
- Phase II - implement innovative and higher accuracy nongray models such as the Full Spectrum Correlated k-distribution (FSCK).

Work Plan

- Develop a LOCI-based module to solve the radiative transfer equation using the proven Control-Angle Discrete Ordinates Method.
- Implement the widely accepted Edwards wide band nongray gas radiative properties model.
- Couple the LOCI module to the combustion code LOCI-CHEM and validate it.

NASA Applications

- The LOCI radiation module will enable NASA and government contractors to better design and analyze rocket engine combustion systems.
- Help improve the design of future motors using in-situ and other hydrocarbon-based fuels.
- The LOCI module can also be used with other LOCI-based codes, such as LOCI-Stream.

Non-NASA Applications

- Better prediction of pollutant emissions in the design of industrial combustion systems.
- Will also be applicable in the furnace, heater and boiler industry.

Subcontractors: Mississippi State University (Dr. Edward Luke)

NON-PROPRIETARY DATA