NASA SBIR/STTR Technologies

Proposal No. T8.02-9982 - Fuel/Oxidizer Injector Modeling in Sub- and Super-Critical Regimes for Deep Throttling Cryogenic Engines

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Identification and Significance of Innovation

- Accurate CFD modeling of fuel/oxidizer injection and combustion is needed to design and analyze liquid rocket engines.
- Currently, there is no mature modeling capability for liquid fuel/oxidizer injectors in LOCI-Chem, used by NASA and its contractors to analyze rocket engines.
- In this STTR, CFDRC-Mississippi State University team will develop in LOCI-Chem an innovative, robust and computationally efficient module that will have the capability to model subcritical, transcritical and supercritical injection regimes, as well as transient and steady operating conditions in a cryogenic engine combustion chamber.

Pratt & Whitney-Rocketdyne Liquid Oxygen-liquid Hydrogen Deep Throttling Engine

Technical Objectives

- Phase I - Develop and implement into LOCI-Chem a Level Set-based module to capture phase interface as well as primary atomization under subcritical injection conditions.
- Phase I - Show the feasibility of the proposed approach by comparing numerical results obtained from LOCI-Chem with shear coaxial, non-reacting flow experimental data of AFRL (Edwards AFB) for LN_2/GN_2 jets.
- Phase II - Develop an accurate and comprehensive suite of models for subcritical, transcritical and supercritical flow processes in a liquid rocket engine.

Work Plan

- Develop a LOCI-based module to solve the Level Set equation.
- Couple the LOCI Level Set module to the combustion code LOCI-Chem and validate it.

NASA Applications

- The proposed module in LOCI-Chem will enable NASA and government contractors to better analyze and design liquid rocket engines, such as the CECE engine as part of NASA's Vision for Space Exploration.
- It will also be beneficial to the J-2X cryogenic engine program as part of Project Constellation to replace the space shuttle in 2010.
- The models will help predict liner temperatures and combustion-driven instabilities, and improve the overall efficiency of rocket engines.

Non-NASA Applications

- The module will be beneficial to gas turbine engine and diesel engine manufacturers, and has applications in fuel injector design for power plants and in industrial boilers/burners.

Subcontractors: Mississippi State University (Dr. Edward Luke)

NON-PROPRIETARY DATA