Paper ID: 22169
student

SPACE PROPULSION SYMPOSIUM (C4)
Hypersonic and Combined Cycle Propulsion (9)

Author: Mr. zhang yan
Beihang University, China, rechard_1982@sina.com

Prof. Lin Yuzhen
China, 18600369549@163.com
Mr. Liu Wei
China, 1468969367@qq.com
Mr. Wang Jianchen
Beihang University, China, rechard_1982@sina.com

FLAMELET MODELING OF TWO-PHASE N-DECANE SUPERSONIC COMBUSTION USING A SKELETAL CHEMICAL REACTION MECHANISM

Abstract

The steady combustion of liquid decane at varied fuel equivalence ratios in a Mach 2.03 scramjet combustor was numerically investigated. The reacting turbulent flow was solved using the shear stress transport (SST) k-ω turbulence model, particles stochastic trajectory model, steady-flamelet model and a skeletal chemical reaction mechanism with 46 species and 169 reactions. The flamelet approach has the advantages of high efficiency and allowing complex chemical mechanisms. In the proposed formulation, the temperature is computed from the transported total energy and tabulated species mass fractions. Consequently, the combustion is modeled by three additional scalar equations and a chemistry table calculated in a pre-processing step. In present paper, the reduced kinetic mechanism of liquid decane was firstly validated against the detailed mechanism on the ignition delay. The accuracy of flamelet modeling of the liquid decane supersonic combustion employing the skeletal reaction mechanism was validated by comparing the predicted static pressure profile along the combustor side wall with the experimental data. The experimental data was obtained from the Dual-Mode Scramjet Combustor in the Beihang University. The integrated transverse injector and series dual-cavity was tested in a M= 2.03, clean, heated flow facility as a combustion system. The facility operated at a total temperature of 1000K and total pressure of 0.80Mpa. Cold n-decane was used as fuel and a wide range of global equivalence ratios were tested. High speed photographs and PLIF are also being obtained to compare with the numerical OH fraction contours. The numerical results showed that the predicted combustor peak pressure agreed well with the experimental data. However, the predicted pre-combustion shock train was relatively longer, and the possible reason was discussed. Furthermore, the reacting flow calculations with a single-step chemistry model were also performed. Some obvious differences between two models were observed on the wall pressure distributions and combustor performance. The combustion efficiency and exit total temperature of the single-step chemistry model were higher than those of the flamelet model coupled with the skeletal chemical reaction mechanism.