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SPACE PROPULSION SYMPOSIUM (C4)
Hypersonic and Combined Cycle Propulsion (5)

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DESIGN AND OPTIMIZATION OF HYDROCARBON-FUELED DUAL-MODE SCRAMJET WITH EXERGY ANALYSIS

Abstract

The exergy analysis method has been used increasingly to research the design and optimization of component or process of hypersonic airbreathing vehicle, with the advantage of supplying a common structure for all of the subsystem and quantifying the effect of irreversible process on exergy destruction. Firstly, an exergy analysis model was established based on traditional thermal process efficiencies, real gas characteristics and fuel addition,and then used in a quasi 1-D procedure with consideration of skin friction, heat transfer, fuel-air mixing and finite-rate chemistry kinetics models. Secondly, optimization of thermal cycle parameters of dual-mode scramjet is implemented with the goal of minimum exergy destruction during the process. Thirdly, the baseline configuration of scramjet with 2D inlet, multi-staged diverging combustor and single-expansion nozzle is designed based on optimal cycle parameters, and then optimization of scramjet flowpath scheme is performed respectively with the goal of minimum exergy destruction on design-point Mach 6.0 and working Mach 4.0-7.0 during the flight. The preliminary results show that it is the combustion process that causes the majority (about 80 percent) of the total exergy construction in the scramjet flowpath, and the thrust is sensitive to the variety of the inlet efficiency while the percentage of exergy construction in inlet is relatively low.