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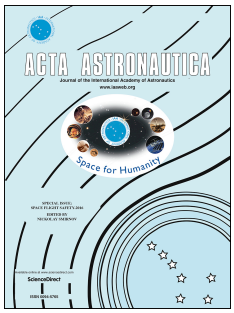

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Numerical and Experimental Investigation on the Influence of Inlet Contraction Ratio for a Rocket-based Combined Cycle Engine

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Abstract:

The influences of inlet contraction ratio on both the inlet and combustor of the rocket-based combined cycle engine are investigated in this paper by experimental and numerical approaches. A translating spike was employed to simulate the inlet counter pressure in the wind tunnel experiment. Steady-state pressure distributions were recorded and schlieren photos were obtained simultaneously. The combined numerical-experimental results show that the increased inlet contraction ratio always results in the increasing of the compression ratio and capability of anti-counter pressure, while its impact on the mass flow coefficient is negligible. Besides, the reactive numerical results show that the coefficients of inlet drag and combustor thrust increase with the increasing of the inlet contraction ratio, while the nozzle thrust coefficient demonstrates an opposite trend. These suggest that the selection of an appropriate inlet contraction ratio can effectively improve the total thrust coefficient of the engine, while the appropriate inlet contraction ratio is to be set to the minimum that satisfies the robust combustion requirement.

Key words:

Rocket-Based Combined Cycle (RBCC), Inlet, Contraction Ratio, Wind Tunnel Test, Numerical Simulation

1. Introduction

The Rocket-based Combined Cycle (RBCC) engine concept was proposed in the 1960s along with thirty-one other combined cycle propulsion systems. Further studies indicated that the RBCC takes advantage of the synergistic interactions between rocket engines and air-breathing engines, and therefore providing a high thrust-to-weight ratio with a high specific impulse within a wide flight envelope. This highly integrated propulsion system is one of the most promising prospective approaches for reusable space access and hypersonic cruise capabilities [1-5]. Recently, plenty of researches have been put on the air-breathing engine, including the operation characteristics [6-8]