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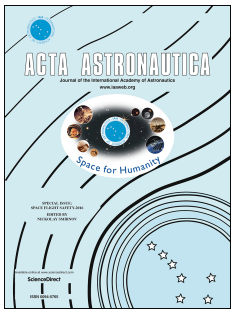

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Numerical Investigation of a Combined Solid Fuel Scramjet Combustor

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Abstract: A new scramjet configuration using solid fuel as propellant is proposed, namely, the combined solid fuel scramjet. The combined solid fuel scramjet combustor has been investigated numerically to predict its characteristics. Two-dimensional axisymmetric Reynolds-averaged Navier–Stokes equations and species transport equations are solved numerically. Turbulence closure is achieved using the shear stress transport k-ω model. Three global one-step reaction mechanisms are used in this study. The experimental data in the published literature has been used to validate the accuracy of numerical model. The results of the numerical analysis show that secondary combustion occurs in the supersonic combustor. At the combustor outlet, the total pressure loss is about 0.65 and the combustion efficiency is about 48%. A subsonic recirculation zone is formed near the wall between the air inlet and the fuel-rich gas inlet, which is beneficial to mixing and flame holding. A normal shock wave is generated at the end of the expansion zone after the fuel-rich gas is injected into the combustor, and this is due to the strong pressure downstream induced by secondary combustion.

Keywords: Combined solid fuel scramjet, Secondary combustion, Regression rate, Supersonic combustion

1 Introduction

Solid fuel scramjet(SFSCRJ) is a ramjet which pours or glues the solid fuel into the combustor to make a direct combustion with the supersonic airflow. With the advantages of simplicity, safety, rapid response, high energy density level, easy storage for a long duration, the SFSCRJ is a promising propulsion system for hypersonic flight[1].

Theoretical and experimental studies on SFSCRJ have been conducted actively in recent decades. Witt[2] made a preliminary experimental study on the concept of SFSCRJ for the first time. Polymethylmethacrylate (PMMA) and hydroxyl-terminated-polybutadiene (HTPB) were used as the solid fuel. Ignition and sustained combustion were established by adding a bit of