Experimental and numerical simulating studies on a solid-fuel rocket scramjet

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Abstract

Scramjet technology has got an increasing attention now. With the research of liquid-fuel scramjet engine, the study of solid-fuel scramjet engine has been rising quietly. At present, the configuration of solid-fuel scramjet engine is still the same as the configuration of inner-hole combustion for the subsonic solid-fuel ramjet engine. However, there are certain deficiencies for this boundary diffusion combustion method, such as unsteady flame, unpredictable and uncontrolled burning rate and inefficient fuel burning. This paper proposes and designs a configuration of solid-fuel rocket scramjet engine. In this project, solid-propellant gas generator is used. And high metal-based solid-fuel is utilized as solid propellant, and which can self-sustained combustion in solid gas generator. Then the high-temperature gas jet from solid-propellant gas generator will mix and burn with supersonic flow in second combustion. This configuration can avoid most deficiencies of the configuration of inner-hole ramjet engine that mentioned above. In order to confirm the feasibility of the project, the experiment and numerical simulation were conducted. A combustor model of a solid-fuel rocket scramjet engine was tested in simulating flight Mach number 6 at high altitude. The appropriate inlet conditions (stagnation temperature and pressure and in excess of 1560K and 18.8atm, respectively. and the mean Mach number of 3) were provided by a vitiated air heater. The model had one generator which is assembled in the center of inlet, and Magnesium-based solid-fuel was utilized as propellant for the engine. The experimental pressure data along the wall of the second combustor and the force of the model engine were tested. The experimental pressure data was used to value the accuracy of CFD. In numerical simulation, the flow-field construction in the chamber was demonstrated. The analysis of the experimental date and the result of the numerical simulation indicate that the high-temperature gas jet from solid-propellant gas generator can mix and burn with supersonic

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flow in second combustion, and the project of rocket scramjet engine is feasible.

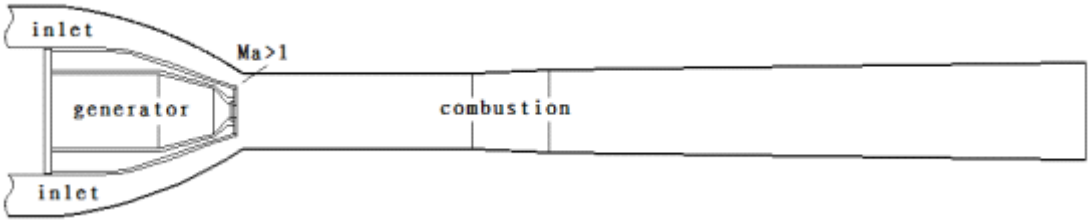

Fig1. the configuration of experimental rocket scramjet engine.