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EFFECT OF PLASMA SYNTHETIC JET ACTUATOR ON MIXING ENHANCEMENT IN A SOLID-PROPELLANT DUCTED ROCKET

Abstract

With the growing use of solid-propellant ducted rockets in high-speed cruise weapons, improving their operational performance has become a critical area of research. The secondary combustion chamber is a crucial element of solid-propellant ducted rockets. The combustion efficiency in the secondary combustion chamber plays a decisive role in the overall performance of solid-propellant ducted rockets. Mixing enhancement is an effective means of improving combustion efficiency. To date, there have been few studies on the active flow control mode of mixing enhancement, most of which have been applied to scramjet. This paper examines the impact of a plasma synthetic jet (PSJ) actuator on mixing enhancement in a solid-propellant ducted rocket. PSJ actuators have the advantages of a simple structure, fast response speed, and easy parameter adjustment. In this paper, a Discrete Phase Model (DPM) is used to describe the particle phase and the interactions between the gas and particle phases for numerical simulation of gas-solid two-phase combustion in the secondary combustion chamber of a solid-propellant ducted rocket. Through a series of parametric studies, the effects of jet position, array jet, and discharge parameters of the PSJ actuator on the flow field structure and combustion efficiency in the secondary combustion chamber are investigated. The results show that the arrangement of the PSJ actuator at the dome region of the secondary combustion chamber has a significant influence on the control effect of the flow field structure, and the changes of array jet and discharge parameters have a significant influence on the flow field in a specific range. The established two-phase flow combustion model and the study on the PSJ actuator provide methods and ideas for the study of mixing enhancement in the secondary combustion chamber of the solid-propellant ducted rocket. Based on this study, more refined models will be considered further to study the optimization methods of gas-solid two-phase mixing and combustion.