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NUMERICAL SIMULATION OF COMBUSTION STABILITY OF COAXIAL SWIRL INJECTOR

Abstract

Combustion instability is a critical issue in the development of rocket engine because of its complicated mechanism and tremendous destruction. Research of single injector combustion stability characteristic is one of the most important starting points. Single injector combustion experiment had been done in the National Key LAB of Science and Technology on LRE (KLSTND) of China. To save the cost, it is necessary to carry out numerical research, which can also get more details of the combustion process. In this paper, research on the response of combustion process to acoustic perturbation by Computational Fluid Dynamics (CFD) method is presented. Firstly, reactive-flow field of injector and combustion chamber (CC) is obtained via large eddy simulation (LES) method. Finite-rate/Eddy-Dissipation model with 9 species 10-step reaction is employed to describe the combustion mechanism. Comparison of the main microscopic parameters (such as chamber pressure and temperature etc.) of CC is carried out between test data and the simulated results. The accuracy of the numerical method is validated. Secondly, acoustic perturbations are simulated by the periodic opening and closing the assistant exhaust nozzle in the numerical method. The phenomenon of combustion process response is successfully detected by the simulation. Results show that standing wave type tangential characteristic oscillations are excited in CC when the perturbation frequency equals to the eigen frequency, which is also validated by the experiment data. The frequency value of numerical result and measure data agrees well. Furthermore, influence of turbulence intensity and reactive heat release rate nearby the injector outlet mix area by different locations of perturbation are analyzed as well as other detail information of the reactive-flow field. Through the research, the driving mechanism of single injector combustion instability is further recognized.