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COMBUSTION INSTABILITY SIMULATION AND ANALYSIS OF A SOLID ROCKET MOTOR TESTING DEVICE BASED ON LES METHOD

Abstract

Combustion Instability (CI) is a challengeable problem people encountered while developing the Solid Rocket Motor (SRM). Recently, the complex coupling between vortex shedding which exists in internal flow field of SRM and acoustic oscillating in SRM combustor becomes a hot issue in CI. Space Shuttle RSRM, Titan IV SRMU and Ariane 5'P230 motor were plagued by this problem since its inception. With the development of Fluid Dynamics and Computer Science, numerical simulation on the coupling between vortex and acoustic in the SRM become more and more feasible and important in developing the Solid Rocket Motor. For the turbulence simulation there are mainly three methods: Reynolds Averaged Navier-Stokes Simulation (RANS), Direct Numerical Simulation (DNS) and Large Eddy Simulation (LES). From the point of computation efficiency, the LES is between RANS and DNS. Moreover, by means of directly simulating the large scale eddy and giving a special treatment for the small scale eddy, LES method can accurately catch the motion behaviors of the main vortex within the SRM internal flow. As one of LES models, Wall-Adapting Local Eddy-Viscosity (WALE) subgrid-scale Turbulence Model is recognized for outstanding performance on simulation of wall friction flow, therefore, it is often selected to simulate the phenomenon of eddies shedding due to wall affecting in SRM. In this paper, a finite volume model under the request of grid scale for a SRM testing device was established. The numerical simulation on the internal flow of the device by using WALE method was performed. In addition, the flowing parameters for given points in the device after the unsteady turbulence flow reaching statistical equilibrium have been monitored. Through out date processing, the distribution of eddy intensity, the period property of eddy generating and disappearing in the testing device have been analyzed. Meanwhile, the influence of inner shape, acceleration and particles on the eddy property in the device has been researched, which will help us making a special attention on the CI when developing a similar SRM.