SPACE PROPULSION SYMPOSIUM (C4)
Hypersonic and Combined Cycle Propulsion (5)

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AERODYNAMIC CHARACTERISTICS RESEARCH ON THE WAVERIDER-BASED HYPERSONIC VEHICLE WITH THE GRID FIN

Abstract

   The scramjet engine of the air-breathing hypersonic vehicle must have an initial velocity to operate and it relies on the booster to accelerate to a special Mach number. Then, the booster separates from the vehicle, and the vehicle begins its autonomous flight after the engine ignites. In the flying process, the Mach number and flow field varies greatly. The normal force coefficient reduces quickly and couldn't keep steady. The aerodynamic static stability and the control ability are bad. All of these limit the development of the waverider-based hypersonic vehicle. Grid fin is a kind of unconventional aerodynamic lifting surfaces, which differs from the planar fin in many aspects. The oblique honeycombed grid fin, which consists of grid elements with an angle of 45 and the horizontal frame has been employed in the current study, and this is because of its advantage over the conventional planar fin at high angles of attack and wide range of Mach numbers, good lift characteristics at high angles of attack, and near-zero hinge moments. Grid fin now is faced up with potentially extensive application. This work describes the application of the grid fin to the booster of a waverider-based hypersonic vehicle which is in use of numerical simulation to investigate its aerodynamic characteristics. First of all, the grid fin model is built according to the design parameters, which consist of chord-to-width ratio, section plane geometry, oblique angle, and so on. In view of both efficiency and calculation precision, the unstructured Cartesian grid is used to describe the complex three-dimensional aircraft configurations, and an Euler Equation Solver is employed to analyze the aerodynamic characteristic of grid fins. Then, the superiority of the waverider-based hypersonic vehicle with grid fin over traditional planar fin is discussed as well. The obtained results show that there are a lot of specific features of grid fin aerodynamic characteristics and the combination changes the aerodynamic characteristics a lot. The normal force coefficient improves a lot, so as the aerodynamic stabilization characteristics and the control ability. The application of grid fin in the booster stage of the waverider-based hypersonic vehicle can bring obvious advancement to the aerodynamic characteristics, which seems much better than the planar fin.
   Keywords: Waverider-based Hypersonic Vehicle, Grid Fin, Aerodynamic Characteristics