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AEROTHERMAL ANALYSIS AND THERMAL PROTECTION OF GRID FINS FOR REENTRY ROCKETS

Abstract

Grid fins are effective control surfaces for re-entry rockets. The grid fin which is a combination of thin metal sheets sustains severe aerodynamic loads and heating during the re-entry flight. The critical aerothermal environment at the leading edge causes a high temperature and high thermal stress. Aerodynamic thermal analysis has been conducted for the thermal protection design of the grid fins on a suborbital solid rocket, SQX-1Z, which is developed for verifying the reentry control technology of the reusable launch vehicles. The aerodynamic loads and heat flux distribution of the grid fin are obtained by fluid-thermal couple numerical calculation based on SST turbulence model and structural mesh grids. And the thermal analysis using the finite element method indicates that the maximum temperature of the grid fins exceeds the operating temperature of the structural material, titanium alloy, during the re-entry flight. So a heat-resistant coating is adopted as an ablative protection solution. In the suborbital flight test in September 2018, the practical temperature response of a grid fin was measured by sensors and acquired through the telemetry system. The deviation between the calculated result and the flight measurement result is less than 16