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# COOLING CHANNEL AT THE LEADING EDGE OF SUPERSONIC VEHICLE DESIGN BASED ON WORKING FLUID CONVECTION

**Abstract**

Hypersonic vehicle is an important development direction of the future space technology. Due to the high requirements of engine intake performance and the purpose of drag reduction and lift increase, such type of vehicle always adopt relatively sharp configuration, and thus leads to very severe thermal environment, especially for the leading edge, inlet and other key components. The thermal protection technology for these components need to be developed. Although the structure of the passive thermal protection system is simple, the thermal insulation efficiency is low, and limited by the temperature limit of the material. Thus, the design of active thermal protection system is necessary.

The study takes a typical suction type hypersonic vehicle as the background, the aerodynamic thermal environment and the active thermal protection demand is analyzed, the cooling performance evaluation and the structure optimization for the leading edge is carried out bases on convection of working fluid.

From the simulation results, it can be seen that when the flow rate is m = 0.1kg / s and above, the temperature of the working medium in the entire flow field is not significantly changed in the active cooling channel of any structure, almost 300k, which indicates that the heat exchange efficiency of the active cooling channel needs to be improved.

Due to the limitation of the leading edge structure, it is considered to add a vortex generators at the bend of the cooling channel to strengthen the heat exchange. The main principle is that the sudden change in the structure of the vortex generator causes the flow in the original flow field to change, and gradually forms a secondary flow (circulation, reflow) to impact the fluid near the wall and the fluid in the mainstream area, thereby destroying the original stability in the boundary layer, a strong disturbance between fluids is formed with a small flow loss, thereby achieving higher heat exchange efficiency.

In this paper, the effect of inserting the vortex generator on the heat transfer efficiency of the active cooling channel is analyzed. Based on this, the structural design of the leading edge active cooling channel with the vortex generator is optimized.

This study aims to provide technical support for the development of efficient thermal protection systems for hypersonic vehicles in the future.