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ANALYSES OF ACTIVE COOLING TECHNOLOGY FOR HYDROCARBON FUELED SCRAMJET

Abstract

The investigation of the hypersonic vehicle powered by scramjet is focused on recently. Active cooling technology is one of the key technologies ensuring the safe of scramjet engine for liquid hydrocarbon fueled scramjet. The research status of hydrocarbon fueled scramjet is analyzed at home and abroad in this paper. It is found that the scramjet combustor heat sink requirement is superior to hydrocarbon total heat sink as the flight Mach number increasing. The heat flux in scramjet combustor is very high which means more fuel heat sink is needed. The value and the location of the maximum heat flux in scramjet combustor is variable because there are shock wave/expansion wave systems, shock wave/boundary layer interaction, reaction shear layer, pressure diffusion of supersonic flow, and flame diffusion in the supersonic combustion flow field. The injector location and the mass flow of the fuel is changeable with the working conditions of the scramjet engine. All these bring challenges to the structural design of the active cooling technology of hydrocarbon scramjet. The purpose of the cooling structure design for hydrocarbon fueled scramjet engines is to bring away the maximum heat flux of scramjet combustor. It means the heat flux that the coolant can absorb in the location of low heat flux is more than the heat flux needed to bring away. It causes the waste of the fuel heat sink. The fuel mass flow rate used for cooling is more than that used for combustion. The extra fuel is abandoned, which brings negative effect on the thrust-weight ratio and the net thrust of the scramjet engines. The conclusions obtained through the analyses of the above problems are given as bellows: 1) The key problem of hydrocarbon fueled scramjet is the appropriate design of the cooling structure which can make the use of fuel heat sink reasonable; 2) Scramjet combustor made of composite material is the future investigation aspect focused on for liquid scramjet engine; 3) Solid propellant scramjet engine is superior to hydrocarbon fueled scramjet in the thermal protection technology.