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STUDY ON THERMAL PROTECTION MATERIALS ABLATION RESULTING IN CHANGES OF FLOW FIELD PARAMETERS IN SUPERSONIC TURBULENT DUCT ON ARC HEATER

Abstract

As the same as supersonic arc jet, blunt wedge and shroud test techniques, supersonic turbulent duct are widely used to screen the candidate materials on hypersonic vehicles. The nominal flow field parameters of the turbulent duct are decided by the initial area ratio. Sometimes the thermal protection materials will ablate due to the high parameters and the cross area of duct will change result in the flow field parameters changes. This paper studies the change trends and magnitudes through calculating. Two supersonic turbulent ducts with initial area ratios of 2.0 and 3.0 were calculated at three specific heat ratios: 1.1, 1.2 and 1.3. The results included the changes of total enthalpy, static pressure in duct, static enthalpy, recovery enthalpy, cold wall heat flux and cold wall shear with increase of the cross area of duct. It shows the total enthalpy is constant in tests, but other parameters change with the increase of cross area of duct due to the test materials ablation. Mach number increases with the increase of cross area, other parameters decrease. When cross area of duct increases by 20%, Mach number increasing amplitudes is less than 9%, the static pressure decreasing amplitude in duct exceeds 20%. The decreasing amplitudes of static enthalpy and recovery enthalpy are within 8% and 1%. The decreasing amplitudes of cold wall heat flux and cold wall shear are within 20% and 15%. Except the decreasing amplitude of cold wall shear is higher with initial area ratio increasing, the increasing or decreasing amplitudes of other parameters in duct are higher with specific heat radio increasing and lower with initial area ratio increasing.