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EFFECT OF COMBUSTION ON SUPERSONIC FILM COOLING BY HYDROCARBON

Abstract

In our previous studies, in order to extend the cooling capacity of hydrocarbon fuel in a scramjet engine or a combined cycle engine, we proposed a combined cooling method which combined regenerative cooling with supersonic film cooling by using the high temperature gaseous hydrocarbon fuel of exit of regenerative cooling channel as the film coolant. Through basic analysis, during the process of the mixing between the high enthalpy mainstream and the high temperature hydrocarbon fueled film coolant, the total temperature of the film coolant flow becomes much higher than its inlet temperature, therefore, the possibility of combustion of high temperature hydrocarbon must be taken into consideration. The combustion characteristics of supersonic film are not clear and combustion may have contradictory effects on supersonic film cooling. To investigate the combustion characteristics of supersonic film and the effect of combustion of hydrocarbon on the heat and mass transfer characteristics of supersonic film cooling, numerical model was established and a skeletal chemical kinetic model of n-decane with 40 species and 141 reactions was chosen. The results indicate that combustion reaction does happen in the mixing process between the mainstream and the film coolant, in the combustor of scramjet engine. The results of this paper can be a guidance of designing the supersonic film cooling using hydrocarbon fuel as coolant and it helps improve the engine's performance without reducing the film cooling efficiency.