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Hypersonic Air-breathing and Combined Cycle Propulsion, and Hypersonic Vehicle (7)

Author: Dr. Wang Xu
Beihang University (BUAA), China, htwxwork@gmail.com

Mr. Haoming Wu
The 41st Institute of the Fourth Academy, China Aerospace Science and Technology Corporation (CASC), China, gjsx52wx@126.com
Mr. Jiaqi Yu
Beihang University, China, sy2115321@buaa.edu.cn
Prof. Xu Xu
Beihang University, China, xuxu@buaa.edu.cn
Prof. Qingchun Yang
Beihang University, China, yangqingchun@buaa.edu.cn

DESIGN AND STREAM THRUST ANALYSIS OF A MACH 8 SCRAMJET ENGINE WITH AN AFTERBURNER BURNING METAL FUEL

Abstract

Aiming to achieve better acceleration performance of high Mach number air-breathing vehicles in extreme flight conditions. The inert gas from the complete combustion of hydrocarbon fuel can be used to generate bigger thrust by further combustion with metal fuel. Stream thrust analysis taking into account gas property variations was used for preliminary parameters design and performance evaluation of a Mach 8 hydrocarbon-powered scramjet engine with an afterburner.The configuration of an inward-facing two-dimensional scramjet inlet, in conjunction with an obliquely injected hydrocarbon fuel and a step combustor, was adopted. The magnesium powder is injected into the afterburner to further participate in the combustion for raising the operating temperature. The expansion was modeled with quasi-one-dimensional flow equations. Based on the condition that the hydrocarbon fuel in the main combustor maintains an equivalence ratio Φ=1.0 , the powder to inert gas mass ratio f in the afterburner set as 0.04 to 0.2, as well as the static temperature ratio ψ at the outlet of the inlet can be changed between 4 and 7. Results show that compared with a main combustor alone, the maximum unit thrust gain reached 114%.This gain increases as the static temperature ratio rises.However, the increased compression of the inlet leads to a continuous decrease in the heat release of the fuel.Higher powder to gas ratio is beneficial to generate bigger thrust, but the upper limit should be set within 0.16. Under the constrained conditions, the maximum unit thrust can be obtained at a powder to gas ratio f=0.16 and a static temperature ratio ψ=4.0. This research also provided a new idea for expanding the application of hydrocarbon fuels in higher Mach number scramjet engines.