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

Author: Dr. Jinying YE
Northwestern Polytechnical University, China, yjy@nwpu.edu.cn

Prof.Dr. Hongliang Pan
Northwestern Polytechnical University, China, panhl@nwpu.edu.cn
Dr. Fei Qin
China, qinfei@nwpu.edu.cn
Dr. Shaohua ZHU
Northwestern Polytechnical University, China, zhushaohua@nwpu.edu.cn

INVESTIGATION ON HEAT RELEASE MATCHING AND PERFORMANCE OF VARIABLE GEOMETRY RBCC ENGINE IN RAMJET MODE

Abstract

The use of a geometrical variable combustor is one of the most effective methods to improve the performance of a rocket-based combined-cycle (RBCC) engine over a wide operating range. This paper aims to study the heat release matching of variable geometry RBCC engine in ramjet mode by means of full flow path three-dimensional numerical simulation, and to obtain the variation regularity of the performances of engine under different combustion organization strategies, so as to improve the performance of engine. Compared with the RBCC engine with thermal throat combustor operating in ramjet mode, the higher pressure in the variable geometry combustor is more likely to cause the inlet to overflow or unstart, affecting the stable operation of the engine. Therefore, different combustion organization strategies are adopted to ensure the matching between the inlet and the combustor, so as to maximize the engine performance and better expand the application scope of RBCC engine. In the typical state of ramjet mode, i.e. the inflow of Ma 4 and Ma 5, the heat release matching characteristics and performance variation regularity in ramjet combustion mode are studied. The following conclusions are obtained: (1) The combustion efficiency of the engine increases with the increase of the injection fuel equivalent ratio in the isolation section, resulting in an increase of the intensity of the pre-combustion shock train. When the isolation section cannot accommodate the pre-combustion shock train, the overflow resistance of the inlet will increase significantly. Therefore, under the inflow condition of Ma 4 with weak back-pressure resistance capability, it is necessary to sacrifice a certain combustion efficiency to ensure engine thrust and specific impulse performances. (2) At Ma 4 inflow, it is more suitable to inject fuel with an equivalent ratio of 0.2 in the isolation section, which ensures the matching work of the inlet and the combustor. The engine performance is superior and the specific impulse performance reaches 1200s. With the inflow Mach number is increased to Ma 5, the centralized fuel injection with an equivalent ratio of 1.0 in the isolation section is achieved, and the excellent engine performance is obtained with a specific impulse performance of 1222s.