SPACE PROPULSION SYMPOSIUM (C4)
Hypersonic Air-breathing and Combined Cycle Propulsion (9)

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ANALYSIS ON THE PERFORMANCE OF A HYPERSONIC INWARD TURNING INLET WITH THREE COMBINED CHANNELS

Abstract

To maintain acceptable thrust and fuel consumption over a wide flight spectrum, combined cycle engine is a favored solution for high speed air breathing propulsion. Regarding to low impulse of rocket engine, thrust loss of turbine engine at high speed, as well as thrust loss of ramjet engine at low speed, a unique three-channel (turbine-rocket-ramjet) combined cycle engine was suggested. In the present work, the three-channel inlet was designed for a wide Mach range 0-6. From takeoff to Mach 2, the three channels were all open, but only with the turbine engine working. From Mach 2 to 4, the turbine channel was closed whereas the other two channels were both open and working. For Mach number over 4, only the ramjet engine was left to work.

The three-channel inlet has been preliminarily analyzed based on numerical simulations. At cruise Mach number 6, the inlet was nearly fully mass flow capturing with a total pressure recovery 0.61. By decreasing the flight speed to Mach 4, the single ramjet engine channel was still able to start with a mass flow ratio 0.84. For flight speed below Mach 4, the rocket engine channel was open as well. It would hence be a severe issue to control the mass distribution between the both channels. For instance, the mass ratio between the rocket channel and the ramjet channel at Mach 3 equaled to 2 in case that the rocket flow path was fully open. But if only 2/3 of the rocket path was open, the mass ratio between the two channels was nearly unity, since more air was forced to the ramjet channel. If the rocket path was further decreased to 1/3, the mass ratio between the rocket and the ramjet channel would fell around only 0.36, indicating that most captured mass flow was used by the ramjet engine. For flight speed below Mach 2, the turbine channel was also open, forming a three channel inlet. At Mach 1.8, the mass ratio among the three channels (ramjet: rocket: turbine) was 1.8: 2.5: 1 for the current inlet geometry.