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

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NUMERICAL SIMULATION IN OPERATION MATCHING CHARACTERISTICS OF INLET AND COMPRESSOR FOR AIR TURBO ROCKET

Abstract

Air-turbo-rocket (SP-ATR) is a promising propulsion system of the multi-mission tactical missiles because of its outstanding performance. As a kind of combined engine with rocket and turbojet, ATR is sensitive to the inlet and compressor operation characteristics and performances. The unreasonable operation matching of inlet and compressor will lead to the whole air intake system fall into the unstable condition, such as inlet unstart or the compressor surge. So the investigation on operation matching of inlet and compressor has implications for intake system design and performance optimize. In this study, the integral numerical simulation of inlet and compressor has been conducted according to the ATR working principle. The main work and conclusion are as follows: Three dimension RANS Navier-Stocks equations with the Shear Stress Transport (SST) turbulence model is employed to investigate the flow state of full passageway, take into consideration the aerodynamic coupling of the interface between the inlet and compressor. In order to save computational resource and improve the precision of results, the computation region include 1/4 inlet, 1/9 impeller, 1/21 radial diffuser and 1/40 vane cascade. The periodic boundary is used in the trailing end of inlet and the dual-directional coupled boundary is employed in the interface of inlet and compressor, and "stage-mean" method is adopted to calculate the gas velocity in the interface. Then the flow parameters at different specific cross-sections and the performance parameters of two components are calculated. The influence of compressor operation characteristics on inlet performance and the influence of incoming air distortion on compressor performance have also been analyzed. The numerical simulation result shows that the operation effect of the compressor can cause the total pressure recovery and anti-backpressure ability of the ATR inlet to increase. As for the compressor, the outlet distortion of ATR inlet has little influence on the impellor performance. Its total pressure recovery and the efficiency suffered little changes. However, the total pressure ratio and the efficiency of the whole compressor were more sensitive to the intake outlet distortion.