Paper ID: 38354
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SPACE PROPULSION SYMPOSIUM (C4)
Hypersonic Air-breathing and Combined Cycle Propulsion (9)

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PERFORMANCE OPTIMIZATION METHOD OF TURBOCHARGED SOLID PROPELLANT RAMJET(TSPR)

Abstract

Turbocharged Solid Propellant Ramjet (TSPR) is regarded as one of the ideal propulsion system for tactical missiles in the atmosphere. It is the combination of Solid Rocket Ramjet (SRR) and Solid Propellant Air Turbo Rocket (SP-ATR). So, TSPR includes both advantages, and can achieve a high-performance in a wide envelope. However, this innovative motor, which includes the inlet, turbocharging systems, gas generators, combustion chambers, etc, also increases the system complexity. In these circumstances, it making the flight condition, gas parameter, chamber structure and other factors may affect its performance. This leads to it is hard to find a quick and accurate way to improve the performance through the empirical parameters method, and is not giving full play to the motor performance. For this reason, the Haupt function, which is highly non-linear and multi-local extremum function, is used to verify the accuracy of the Polynomial Response Surface, Kriging Function and Artificial Neural Network. Among them, the Radial Basis Function (RBF) neural network is not only meeting the accuracy requirements, but also does well in describing the typical characteristics of the original function. Depending on these results, this paper proposes an alternative model based on RBF. Then, the feasibility of the three algorithms including Multi-Island Genetic Algorithm (MIGA). Simulated Annealing (SA) and Pointer Automatic Optimizer (Pointer) is also verified by Haupt function. Research has shown that: 1) the MIGA algorithm does not obtain the optimal solution within the maximum iterations, and the biggest errors of the other two algorithms is similar, is about 3%; 2) Pointer's iterative number is 9540, which is about sixteen times that of the SA. Consequently, the SA is very appropriate to TSPR's performance optimization. Next, we were conducted to the combustion performance optimization by combining the Optimized Hypercube Design (Opt LHD) and numerical simulation, and obtained optimization parameters such as jet angle and jet velocity of the afterburning gas, and so on. Finally, TSPR ground principle experiment was carried out and the combustion efficiency in TSPR mode is 84.81%. This result demonstrates the feasibility of the above method.