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Author: Ms. Lili Fu
School of Astronautics,Northwestern Polytechnical University, China

Dr. Baoyuan Wu
China

RESEARCH ON THE COMBINATION ACTUATOR SYSTEM OF ADJUSTABLE NOZZLE IN RAMJET

Abstract

Liquid-fueled ramjet has being an ideal propulsion system for near space aircrafts and missiles with its low-cost, high-performance and simple structure. The technology of adjustable nozzle is usually adopted to obtain optimum performance according to the flight attitude and airspeed, especially for integral rocket-ramjet. Compared to traditional fixed geometry convergent-divergent nozzles, the adjustable nozzle can be used to achieve large thrust in low-attitude while high specific impulse in high-attitude, as well as to meet the requirement of the solid booster sneak into the combustion chamber. The mechanical actuator is one of the key components of the adjustable nozzle. In order to minimize the power of the mechanical actuator, the pneumatic balance system is usually designed, so, the combination actuator system of adjustable nozzle consists of the mechanical actuators and the pneumatic balance system. In the first place, the physics model of the adjustable nozzle, which is used to optimize aerodynamic force, is established. It includes four parts along the flow direction: the fixed convergent part, the adjustable convergent part, the adjustable divergent part and the fixed divergent part. Secondly, the number, size and position of balance holes of the adjustable nozzle parts is preselected, and the aerodynamics force distribution is obtained by fluid dynamics simulation, accordingly, the actuator input powers of each state are generated by using the integral method and the moment balance theory. Finally, total pressure recovery coefficient and flow coefficient of the adjustable nozzle are analyzed. The performance of the combination actuator system is estimated under the restrictions of the system power requirement and nozzle efficiency. The structural parameters of the four parts, such as length, the number and size of the balance holes etc., is optimized according to the above mentioned steps until meet the system power requirements. The results shows that the regulation scheme in this study has the ability to realize 120%_170% throat area change using less than 1% working medium flow compared to traditional mechanical regulate devices, while the input power can reduce by about 90%.