Paper ID: 29536
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SPACE PROPULSION SYMPOSIUM (C4)
Advanced and Combined Propulsion Systems (8)

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COMBUSTION CHARACTER OF TURBOCHARGED SOLID PROPELLANT RAMJET(TSPR)

Abstract

The turbocharged solid propellant ramjet (TSPR) is a wide-envelope high-performance engine that represents an evolution of the solid propellant air-turbo-rocket(SP-ATR).Major TSPR components are the inlet,driving-turbo gas generator, compressor, turbo, afterburning gas generator, afterburning combustor and nozzle.The free-stream air is entered through the inlet and subsequently compressed by the compressor, which is driven by a turbo.The turbo is powered by the driving-turbo gas generator. The driving-turbo gas is expanded through the turbo and injected in the afterburning combustor where it is mixed and burned with the compressor air, the afterburning gas which is generated by the afterburning gas generator.Thrust is produced by expansion of the combustion gas through the exhaust nozzle.The selection criterion of the solid propellants was first gave through a complete theoretical study.Parametric analysis was carried out to evaluate propellant dispensations through the engine performance model.This analytical study identified the hydrocarbon and the boron-based fuel-rich propellant as driving-turbo and afterburning propellant respectively.A combustion experimental system was established using the multiple-throat-nozzle simulated the pressure fall function of turbo.The primary combustion character of TSPR was studied on the base of three gas generator experiments.The results approved feasibility of multiple-throat-nozzle, rationality of ignition device, the stability of selective propellants in this paper and provided particle sizes for the numerical method.Finally, the secondary combustion character of TSPR was assessed through six combustion experiments.Experiments analysis to be presented in this paper led to the following conclusion: the combustion experimental system can be used to investigate the combustion character of TSPR; the ignition problem of afterburning combustor occurred under conditions of normal-temperature air and ATR model.This problem was solved by increasing the flow rate of driving-turbo gas or switching the operation mode to TSPR.The upper limit of excess air coefficient is about 2.26 when the driving-turbo propellant is CH01 which combustion temperature is $1340K$.The afterburning combustor can combust stably in ATR model when it ignites in TSPR model;the driving-turbo gas and air adopt coaxial inflow is inapposite,and the combustion efficiency is about 50% under normal-temperature air condition,and it is 70-80% in the high-temperature air condition.