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DESIGN OF LIQUID PROPELLANT SUPPLY SYSTEM WITH WIDE REGULATION RANGE OF PRIMARY ROCKET IN ROCKET-BASED COMBINED CYCLE (RBCC) ENGINE

Abstract

Liquid rocket engine which has a wide range of regulation ability is one of the most important components of Rocket-Based Combined Cycle (RBCC) engine, which can achieve wide flight envelope and high performance. In order to obtain high specific impulse under wide range inflow conditions, the primary rocket which built into the flow path should meet not only high thrust requirements in ejector and rocket mode, but also maintain a relatively stable state of small mass flow rate in ramjet and scramjet mode to hold the flame and enhance the combustion. Moreover, it need to response quickly to meet the requirements of mode transition and regulating condition. Focused on the operation requirements of the liquid rocket engine with a wide range of regulation ability (flow mass rate control ratio: 5:1, oxygen/fuel mixing ratio: 1.4-2.6) and in order to realize miniaturized integrated liquid propellant supply system, firstly the paper has carried on the comparison and selection of several designs of the liquid propellant feed system. As well as, the propellant supply system based on plunger pump as the key component has been proposed in this paper. Secondly, the feasibility of design and the prediction of the system characteristics based on establishing the model of liquid rocket engine supply system have been carried on by using the AMESim simulation software. Main work and conclusions in this study are as follows: (1) In view of the overall structural weight and the dynamic response characters of the liquid propellant supply system, the supply system design that the electrical machine drives the plunger pump to regulate the mass flow rate of liquid oxygen and kerosene propellant has been employed. Furthermore, the operation parameters of the system components (propellant tank, motor, piston pump, valves, piping, etc.) have also been obtained in detail. Finally, the overall design of the propellant supply system has been accomplished based on the components selection. (2) Focused on the liquid propellant supply system with wide regulation range, this study has established the component model in AMESim simulation platform, as well as, has respectively analyzed the static and dynamic characteristics following the law of conservation of mass and pressure balance. Simulation results demonstrate the accuracy of the system component parameters and the feasibility of the liquid propellant supply system. And using the steady state analysis results as the initial operating value, the dynamic response characteristics which the system in the process of startup, shutdown and regulation has been obtained.