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9TONF STAGED COMBUSTION CYCLE LIQUID ROCKET ENGINE STARTUP ANALYSIS

Abstract

Liquid rocket engine operation can be largely divided into a start-up section, and a steady state section. Since the start-up section is in an transient state, it is difficult to predict. And performing the actual combustion test takes a lot of time and money, it is necessary to analyze the transient state through an analysis program to check the engine condition. In addition, the analysis of the start-up section has the goal of increasing reliability by securing the reproducibility of stable starting and reducing the consumption of propellant regardless of thrust generation by shortening the time in the transient state. LRE specification is Thrust 9tonf, propellant Lox/Kerosene, combustion pressure 100barg, O/F ratio 2.6, Isp 350s. The variable vector X and the requirement expression vector F required for analysis were defined using the pressure and flow balance relational expressions. The solution was obtained using the Jacobian method. For the characteristics and balancing of the turbo pump, the empirical formula obtained through the test was used. The physical properties of the combustion chamber and the preburner were calculated from CEA, a chemical equilibrium analysis code developed by NASA. A constant value was used for the turbine pressure ratio during steady state section. However, since the turbine pressure ratio continuously changes during the start-up process, the turbine pressure ratio was calculated using the turbine outlet pressure calculated using the basic shape information of the turbine instead of assuming the turbine pressure ratio to be a constant value. A 9tonf multi staged combustion cycle liquid rocket engine startup analysis program was developed, and it was confirmed that it was in good agreement with the actual combustion test results. Various condition studies will be performed possible using this start-up analysis program.