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INVESTIGATION OF SHUTDOWN DYNAMIC CHARACTERISTICS FOR LOX/KEROSENE ROCKET ENGINE

Abstract

The shutdown process is one of the most important transients of liquid rocket engine(LRE). Qualities of the shutdown process are of great importance in improving reliability and orbital injection accuracy of launch vehicles. LOX/Kerosene Staged Combustion Cycled Engine is the main proplusion system of the Next-Generation lift launch vehicle in China, the engine has many advantages such as high-performance, non-poisonous and green-friendly. The high pressure staged combustion cycle made the shutdown process of this engine very complex. However, reusable attribute requires greater reliability of this engine. So, it is very important to investigate the shutdown dynamic characteristics.

The shutdown process of the LOX/Kerosene Staged Combustion Cycled Engine is studied through numerical simulation. The dynamic mathematic model and simulation code for the shutdown process was developed. The dynamic mathematic model was able to describe the turbo-pump, the combustion chamber and pipeline. By use of this simulation program, the shutdown process at two operating points was calculated. By comparison of experimental data and simulation results, the dynamic mathematic model is validated.

The physical phenomena displayed by the shutdown process are analyzed on the basis of experimental data and simulation results. The cause of the thrust fluctuations was studied and the shutdown process was divided into five phases. The effects of pressure of blowing-off gas, capacity of the cavity, operating condition parameters, time sequence of valves, actuation time of valves and water hammer pressure etc. on shutdown process are analyzed in the thesis. In order to improve the shutdown process, several hot-fire tests with some measures were carried on. Based on the above experimental data and simulation results, pressure of blowing-off gas, capacity of the cavity and operating condition parameters exert a powerful effect on the shutdown process. At last, some improvement measures to the qualities of the shutdown process are put forward.