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RESEARCH ON THE KEY TECHNOLOGY OF THE 'SWING BEHIND PUMP' THRUST VECTOR REGULATION ARCHITECTURE USED IN LARGE THRUST LOX/KEROSENE ENGINE

Abstract

Most of the large thrust LOX/kerosene engines regulate thrust vector mainly by swinging engine. According to the general layout of rocket liquid engine, there are two typical schemes: swaying before pump and swaying behind pump. The engine of swaying before pump needs to swing the whole engine, while the engine of swaying behind pump only swings the thrust chamber, so it is more benefit to reduce the swinging moment, lighten the mass, and make the engine more compact by applying the architecture of swaying behind pump. However, in order to apply this technology, we need to develop the big caliber gimbal joint module that is suitable for high temperature, high pressure, and oxygen-rich gas environment firstly, which has restricted the application of swaying behind pump technology in large thrust liquid rocket engine.

When the large thrust LOX/kerosene engine of swaying behind pump architecture swings, the gimbal joint module should not only compensate the deformation of the fixed part and the movable part of the engine reliably, but also be able to withstand the high pressure (more than 25MPa) oxygen rich gas. Therefore, how to design the gimbal joint module which is capable of balancing the contradiction of maintaining flexible and withstanding high pressure is our most concern.

This article will focus on the development of gimbal joint module. The first is the design of flexible compensation structure. We have designed a new S-shaped bellows with three-tangent arcs, which has the best comprehensive performance of pressure-bearing and deformation-compensation of all the common bellows. The second is the design of high-pressure resistance. We chose the combination of multilayer thin S-shaped bellows and armored ring as the core of flexible joint, of which the armored ring is embedded in bellows and used to enhance the pressure-bearing capacity of bellows. For obtaining the optimal structural scheme of S-shaped bellows and armored ring, we have developed a design and optimization platform, and a group of optimal structure parameters have been acquired through a large number of structure simulation and optimization. Finally, based on the hydraulic test, air tightness test, and life test, the design scheme of flexible joint module has been fully tested. What's more, for validating this technology, we reformed the mature 1200kN (YF-100) LOX/kerosene engine into the swaying behind pump architecture, and the 500s hot test has been carried out successfully.