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DESIGN AND STRUCTURAL CHARACTERISTICS OF GAS GIMBALING APPARATUS IN LOX/KEROSENE ROCKET ENGINE

Abstract

The gas gimbaling apparatus is used as the key flexible joint which connects the gas turbine and thrust chamber of LOX/Kerosene rocket engine. The bad working environment such as high temperature, high pressure, and oxygen enriched gas that makes the design very challenging. When engine sways, the load including fluid pressure, high temperature gas flushing and swinging deformation operate on the gimbaling installation, which test the strength, stiffness, stability and fatigue life of the flexible joint.

Metal bellows is a kind of deformation compensation element which is widely used as the flexible joints in industry, but the bearing pressure of conventional bellows is low. The design standards are lack of guiding the design of high pressure bellows. Considering the bad service condition and large distortion compensation requirements, a new S-shaped bellows with armored structure is designed, whose waveform is composed of three tangential arcs. For bearing high pressure, the thickness of bellows is more than 5mm, which may result in large stiffness and high stress as the S-shaped bellows swings. Therefore, the multi-layers bellows is introduced, which can reduce the stiffness effectively and maintain fine compensation performance. In order to strengthen the pressure bearing capacity of bellows, the reinforced structure named as armored ring is adopted. The metal meshy sleeve that wraps the outer surface of bellows is developed as well.

When bellows, armored ring and meshy sleeve are assembled together, more than 70% figure of bellows are enhanced by armored ring. The simulation results by nonlinear finite element method show that the whole bellows is in uniform stress and deformation as the S-shaped bellows compensates the bending deflection. A series of tests have been carried out, which confirm that the gas gimbaling installation can bear high pressure and keep good flexibility and stability.