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RESEARCH ON FOLDING AND INFLATION PROCESS OF THE DRAG BALLOON DEORBIT DEVICE

Abstract

For satellites at an altitude lower than 800 km, the drag balloon deorbit device is proposed as an effective method for post mission disposal in recent years. Global Aerospace developed a Gossamer orbit lowering device, a light-stage oversized inflatable device, and simulated the satellite de-orbiting process to verify its feasibility. However, due to the inextensibility of the ball, the surface folding is prone to creasing, which increases the uncertainty of airflow and affecting the system stability. Therefore, it is necessary to explore the folding scheme and inflation process. It is known that the balloon needs to be packaged in a limited size device for a long time before use. And due to the complex curved structure, the mathematical model is a challenge; multiple folding process makes the stress distribution complex, and does damage to the film material. The unsuitable inflation rate may lead to other unstable phenomena such as membrane entanglements and large attitude oscillation. Therefore, it is necessary to design a scientific and reasonable folding scheme to achieve high-density folding and reduce the impact caused by material damage.

In this paper, we focus on the folding and inflation process of the drag balloon deorbit device to analyze the effects of different folding schemes as well as physical parameters on the dynamic characteristics and stability of the device. By studying the coupled dynamics model, we aim to achieve a mild inflation process and stable attitude. The main contents of this paper are as follows.

1. A new folding model is proposed in this paper. And the Corpuscular method is employed to simulate the inflation process by introduce high velocity gas inside the capsule. The result is compared with Control Volume method to verify the low damage and high density performance of this model.

2. By establishing the coupled dynamics model of the inflation process, the data of stress distribution, energy change and pressure change of the capsule during the unfolding process are obtained, and the effects of factors such as inflation rate and nozzle diameter on the unfolding speed and stability are studied, so as to smooth the inflation process of the drag balloon.

The results show that the proposed folding method is a low-damage and high-density scheme, and the ball can be smoothly inflated by using optimized parameters. The work promotes the research of the drag balloon deorbit device and provide good reference of folding and inflation simulation.