The spacecraft in orbit will cause a lot of low frequency vibrations, and the vibration will cause extra vibration acceleration, which are not only easy to create some fatigue damage of spacecraft structures, but also affect the stability and orientation accuracy of spacecraft. At present, the smart materials and structures, such as piezoelectric material and composite materials, are mainly used to control the vibration. However, the smart materials are prone to damage and the damage is difficult to predict. That increased the difficulty of modeling.

In order to solve the vibration problems in the aerospace field and increase the reliability, a magnetic fluid damper with adjustable damping is proposed. The dynamic theoretical model of the damper is established. The magnetic field distribution and damping characteristics of the shock absorber are discussed.

The damping system can be equivalent to the second-order vibration system:

\[ f_1 \hat{\xi} + 2\zeta \xi + \xi = 0, \]

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where \( f_1 \) and \( f_0 \) are the pressure gradient, the viscous force and magnetic force respectively. \( f_m \), and \( f_i \) are the load, the viscous force and friction force, respectively.

The damping force is the sum of the viscosity force and the frictional force.

\[ F_m = \eta \dot{\xi} + \xi = C \dot{\xi} + D \dot{\xi}, \]

The motion equation of the magnetic fluid is as follows:

\[ \ddot{\xi} + 2\zeta \dot{\xi} + \xi = 0. \]

The damping liquid is kerosene-based magnetic fluid. The density of the magnetic fluid is 1.76 kg/m³, the saturation magnetization is 1500 kA/m.

In the DC magnetic field perpendicular to the vortex vector of the magnetic fluid, the viscosity will increase with the magnetic flux density, which is the magneto-viscous characteristic of the magnetic fluid. The fitting curve is:

\[ \mu = 6.6312 \times 10^{-6} \text{ S/m} + 0.0002 \text{ m}^{-1}. \]

The theoretical analysis can be divided into two approaches:

1. Combined with the boundary conditions, the flow velocity can be solved by:

\[ \frac{\partial \phi}{\partial y} + \frac{\partial \phi}{\partial z} = 0, \]

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2. Theoretical analysis

In view of the vibration reduction problem in aerospace field, a magnetic fluid damper with adjustable damping is proposed in this paper, and the performance of the absorber is analyzed.

The theoretical results show that in the DC magnetic field, the magnetic fluid can be approximated in a uniform magnetic field, and the magnetic force of the magnetic fluid is approximately 0. The magnetic field is mainly used to regulate the dynamic viscosity of the magnetic fluid.

The numerical results show that the magnetic field distribution of damper is approximated uniform between the vessel and the inertia mass, and the amplitude of the beam and inertia mass can be detected. In a certain radius \( r \), the flow of a magnetic fluid approaches a sinusoidal flow. That is good agreement with the theoretical results.

Theoretical analysis

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