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Author: Ms. Shaojuan Wei
Northwestern Polytechnical UniversityNPU, China, weisj060004@mail.nwpu.edu.cn

Prof. Peijin Liu
Northwestern Polytechnical UniversityNPU, China, liupj@nwpu.edu.cn
Dr. Bingning JIN
Northwestern Polytechnical University, China, xuelang-8655@163.com
Dr. Wenjing Yang
Northwestern Polytechnical UniversityNPU, China, yangwj@nwpu.edu.cn

PARTICLE DAMPING CHARACTERISTICS OF LOW AND MEDIUM FREQUENCY OSCILLATION IN SOLID ROCKET MOTOR

Abstract

Instead of high frequency (>1000Hz) combustion instability, nonlinear combustion instability in the low and medium frequency (100-1000Hz) has been observed in solid rocket motor (SRM) in recent years. Therefore, in this paper, particle damping characteristics of low and medium frequency oscillation in SRM are analyzed. Particle damping is highly dependent on the particle size distribution of the propellant condensed combustion products in the SRM, which is actually affected by the operating pressure and the initial aluminum particle size in the propellant. Therefore, in order to determine the particle size distribution of the condensed combustion products, three propellant samples with different initial aluminum particle sizes (13μm, 24μm and 29 μm) are used, and the collecting experiments are carried out under different operating pressure (3-10 MPa). Particle damping of the condensed combustion products is calculated with the distribution of particle size as input using the method modified by Culick. The T-burner test equipment is used to measure the particle damping, and experimental results are compared with the calculation. Then the effects of different operating pressure and initial aluminum particle sizes on the particle damping in the range of 100-1000Hz are analyzed. It is found that while the particle size is in the range of 0.5-200μm, the particle damping is larger for low and medium frequency oscillation. The optimal particle diameter for frequency in 100-500Hz is between 15-20μm, while it is between 8-15μm for frequency in 500-1000Hz. It is also found that the decrease of the mass fraction of the small-scale (D<10μm) particles of condensed phase results to the increase of particle damping, which return is correlated to the low operating pressure and small initial aluminum particle size. For example, the particle damping under 3MPa is about 30% larger than that under 7MPa. Under the operating pressure of 10MPa, the particle damping with the 29μm initial aluminum particle is 93.5%-52.4% higher than that with 13μm initial aluminum particle.