Paper ID: 35200
student

SPACE PROPULSION SYMPOSIUM (C4)
Interactive Presentations (IP)

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IMPROVEMENT OF NONLINEAR COEFFICIENT ON COMBUSTION INSTABILITY PREDICTION IN SOLID ROCKET MOTORS

Abstract

Nonlinear combustion instability is harmful to solid rocket motors (SRM). Limit cycle amplitude, mean pressure shift and energy transfer between modes are key characteristics of nonlinear combustion instability in SRM. Flandro's extended energy balance corollary, aims to predict the limit cycle amplitude of complex, nonlinear pressure oscillations for rockets or airbreathing engines. It's known that both linear and nonlinear coefficients occupy an important role in nonlinear estimation. The Limit cycle amplitude is proportional to the linear coefficient amplitude while it is inversely proportional to the nonlinear coefficient, which is easily seen from the nonlinear equations of pressure amplitude. This paper applies Faldro's method to data analysis in SRM. The linear coefficient of each mode determines the energy flowing in or out of the mean flow and oscillatory system. The non-linear coefficient determines the energy transportation between modes due to the coupling effect of harmonic modes. Although the nonlinear term neither generates nor consumes energy, it determines the energy redistribution between the harmonics. The nonlinear coefficient indirectly influences the change of energy in each mode, affecting the growth of wave and the limit cycle amplitude. Thus an accurate nonlinear coefficient is the basis for nonlinear calculations. This paper makes a study of the nonlinear coefficient based on theoretical analysis and experimental data. It focuses on giving the expression of the nonlinear coefficient suitable for prediction of nonlinear combustion instability in experimental SRM.