SPACE PROPULSION SYMPOSIUM (C4)
Propulsion System (2) (2)

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THRUST OSCILLATIONS IN STATIC TESTS OF LARGE SEGMENTED SOLID BOOSTER OF ISRO

Abstract

Unwanted pressure and thrust oscillations are observed in ground firing tests of large segmented solid booster of ISRO's heavy lift launch vehicle. These thrust oscillations have impact on the launch vehicle structures and in turn the payload capability. The present work details the measurement and analysis carried out on the pressure and thrust oscillations experienced in three ground firing tests of a large segmented solid booster. Fast Fourier Transform analysis indicated that the pressure oscillations vary from 22 Hz to 28 Hz. These oscillations occurred mainly in the first longitudinal acoustic mode of the port cavity of the motor. Oscillations at about 17 Hz are also seen around 90s, which could not be explained by the acoustic oscillations in the port cavity. Corresponding to the pressure oscillations, oscillations are seen in thrust also. Additionally, the thrust data shows a low frequency oscillation of frequency varying from 8 Hz to 14 Hz corresponding to the natural frequency of the test stand, which will vary due to the mass of the loaded motor. The lower frequencies correspond to the initial part of the motor operation when the motor mass is high. A dominant frequency near 50 Hz due to the alternating current in the power grid is also seen in the pressure data and this oscillation existed even after the motor cease burning. Normally, pressure oscillations due to combustion instabilities are of the order of a few percent of the mean pressure. The maximum percentage pressure oscillations observed are 0.74% and 0.35% of mean pressure with amplitude (mean to peak) of 26 kPa and 14.2 kPa respectively in two ground firing tests. And the maximum percentage thrust oscillations observed are 7.67% and 3.62% of mean thrust with amplitude of 280 kN, and 140 kN. Based on the measured pressure and thrust oscillations the upper limit of the theoretical transfer function $(\Delta F/F)/(\Delta p/p)$ (severity of thrust oscillation related to severity of oscillatory pressure) for the motor worked out to 6 in the beginning to 14.2 at the web burn out time.