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

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ANALYSIS OF PRESSURE SPIKES IN LARGE SEGMENTED SOLID ROCKET BOOSTER MOTOR

Abstract

In PSLV rocket, the first stage is a five segmented solid booster motor which carries about 139000 kg of composite solid propellant. In the pressure history of the motor, small pressure spikes (less than 1.5 kgf/cm2) are observed occasionally between 50-100 s of the motor burning time. Sharp rise in pressure (rise duration less than 100 ms) is the main characteristics of these pressure spike and the magnitude of pressure rise is very small compared to the maximum operating chamber pressure (63 kgf/cm2) of the motor. Trend analysis of the flight data of 26 numbers of motors with 52 observed pressure spikes are discussed in this paper. It is observed that, about 96 percentage of pressure spikes are less than 1.5 kgf/cm2 and the maximum magnitude is 2.5 kgf/cm2. The pressure spikes are expected to be because of 1) partial blockage of nozzle throat due to the passage of partially burned debris 2) sudden increase in burning surface area due to voids or cracks in the grain, or due to de-bond between propellant and side-inhibition or motor case insulation, and 3) large difference in burning rates of propellant batch mixes within a segment.

About 42-62 mm thickness polyurethane based slab is provided between every segment as inhibition in the motor. Post-test observations of the static tested motor showed, partially burned inhibition at the first two segments joints (from motor fore-end) and no left over inhibition at the third and fourth joints. This indicates that the pieces of the protruding partially burned inhibition might have passed through the throat resulting in the pressure spikes. In addition to the pressure spike, a gradual pressure increase pattern (up to 0.5 kgf/cm2 with duration greater than 1 s) was also observed in some motors during its last end of the sliver burning. The analysis indicated that the gradual pressure rise pattern can be due to dispersion of individual mix burning rates from the average burning rate or due to small growing circumferential de-bonds between propellant and insulation interface creating additional burning surface area.