Paper ID: 58741
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IAF SPACE PROPULSION SYMPOSIUM (C4)
Solid and Hybrid Propulsion (2) (4)

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PERFORMANCE EVALUATION OF MODIFIED LOOSE FLAP VENTING SCHEME INTRODUCED FOR THE PROPELLANT PROCESSING OF UPPER STAGE SRM THROUGH HOT TEST

Abstract

Third stage of PSLV employs a Solid Rocket Motor of composite case loaded with 7.6 tonnes of HTPB based propellant. The motor has case-bonded grain configuration and loose flaps (unbonded insulation/free flap) are provided to relieve the high thermal stress occurring during curing at grain termination region, interfacing with insulation, to avoid any interface defects. For the above motor, five loose flaps are provided intermittently between bonded insulation, along the length of the motor. As each of these loose flaps form a closed volume, they are vented through slits made by puncturing the loose flap, to evacuate the air prior to casting. However, there is always a chance of ineffective venting resulting in possible air entrapment. This entrapped air in the loose flap cavity is subsequently driven out into the motor chamber when the propellant slurry level rises above the vent path and result in propellant voids. Similarly if the loose flap puncturing is not proper, the air will be retained in the loose flap cavity resulting in loose flap bulge. Towards improving the effectiveness of venting loose flap cavity and to avoid the above defects, a modified evacuation scheme was adopted in which a vent path (unbonded portion) of 100 mm width at 3 circumferential locations (1200 apart) was introduced through the bonded insulation such that all the loose flaps are interconnected and an evacuation channel is established from head end to nozzle end of the motor. The nozzle end loose flap cavity is connected to vacuum chamber through a breather material for complete venting of air from the entire loose flap cavity. Trials carried out with spare motor case to assess the effectiveness of the modified venting scheme by monitoring the pressure difference between loose flap cavity and chamber have shown promising results and no bulging of loose flap was noticed, confirming that the process followed is robust. Venting effectiveness can be verified before casting and human dependency on loose flap puncturing can be avoided. Structural assessment of the motor with the modified venting scheme was carried out for thermal, storage and flight acceleration loads, and adequate/comparable grain structural margins were ensured. The modified scheme was successfully implemented in the processing of PSLV's third stage SRM and no defects were observed in NDT-RT. The motor cast with modified venting scheme was successfully hot tested and the observed ballistic performance was within the predicted bounds.