SPACE PROPULSION SYMPOSIUM (C4)
Propulsion Technology (2) (5)

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PROCESSING OF FLEX SEAL FOR LARGE SOLID ROCKET BOOSTER FLEX NOZZLE

Abstract

S200 Motor, Asia's largest solid rocket booster, employs state of the art submerged flex nozzle control (FNC) system for steering the LVM3 vehicle. Maximum vectoring capability of the flex seal permits guidance up to 7.8deg. Flex seal consists of alternate layers of steel shims and natural rubber based low shear modulus elastomer pads. It is designed with aft pivot point, cylindrical body and spherical shims. Nitrile rubber boot is its primary thermal protection. End rings made of high-strength steel are used for interfacing with the fixed housing and movable part of the flex nozzle. Size of the flex seal is about ϕ1.7m OD and 0.5m height weighing around 1T. The moulding technique to be followed for S200 flex seal was challenging especially on the curing schedule owing to its size. Exclusive moulding facility was commissioned with 2000T capacity hydraulic press having 2.5mx2.5m platen, thermic fluid system to heat the platens and the mouldwith proper flow control to achieve uniform heating. ϕ2m size mould was designed and realized with provision for circulating hot thermic fluid. Cumite blasting facility was established for the surface preparation of the shims and end rings. To control the thickness of the elastomer pads, innovatively designed "Spacers" of diamond cross section are used. Detailed characterization was carried out with different rubber formulations to reduce the shear modulus to limit the actuation load requirement. Detailed cure cycle analysis was carried out to ensure complete curing of the pads. Unbonded trials were carried out to evolve the process parameters and operation sequence. Detailed instrumentation during moulding was employed for in-situ process control. First moulded flex seal was subjected to developmental and qualification level loads. Neither change in the geometry nor indication of any debond noticed during inspection after the tests. Static fired flex seals were subjected to full cycle of acceptance tests to demonstrate re-use capability. Design margins on flex seals were demonstrated for operating load conditions in three static tests and maiden successful LVM3-X flight. Performance of all the flex seals moulded till date including re-used ones in the developmental/qualification tests are consistent indicating the design and process maturity.