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DEVELOPMENT OF THERMAL PROTECTION BOOT FOR S200 FLEX SEAL OF LARGE SOLID ROCKET BOOSTER FLEX NOZZLE

Abstract

Flex seal in solid rocket motor experiences severe thermal and mechanical loads during motor operation. Flex seal in S200 motor flex nozzle is protected from the severe thermal loads by flexible boot made of sacrificial layers. The development of thermal boot to protect the S200 flex seal in Asia's largest solid rocket booster is presented in this article. Initial choice for thermal boot was Silicone for its lower stiffness. Material was later changed to ROCASIN owing to its comparatively better performance noticed in sub scale motor tests. Thermal boot is designed with double bellow configuration. It is bonded with flex seal end rings and retained by metallic strips. FG/Epoxy tape is wound over strips and machined for providing the interface requirements with other flex nozzle sub assemblies. In cold bench tests, the thermal boot stiffness was estimated to be 30% of the S200 flex seal stiffness. Flex seal was well protected by the boot in the first static firing test but bellow regions had less/no margins at some locations due to the deposition of slag and post test heat soak. Study was pursued to improve margin at these locations by providing Carbon cloth at selective locations. Amid different options, the best one which is thermally as well as stiffness wise better was chosen for the subsequent test. Effect of vectoring on erosion was also considered during the above selection process. At specimen level an augmentation of 5% stiffness was noticed with 39% reduction in the erosion rate in comparison to the case of boot without reinforcement. At flex seal system level, around 8% increase in the actuation load requirement was evaluated. The same configuration was tested in the second S200 motor static firing with 52% additional duty cycle than the first test. Overall performance of the reconfigured thermal boot was satisfactory and no further change was recommended for the flight after critical design. Maiden success of the LVM3-X mission qualified the flex seal system with ROCASIN thermal boot for further flights.