

SPACE PROPULSION SYMPOSIUM (C4)
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DEVELOPMENT OF THREE VARIANTS OF REVERSE FLOW MULTIPLE NOZZLE SOLID
ROCKET MOTOR

Abstract

Development of special purpose solid rocket motors started in Vikram Sarabhai Space Centre (VSSC) of Indian Space Research Organisation (ISRO) with development of small and reliable solid motors for the rocket aided takeoff of aircrafts. Conventional Solid Rocket Motors employ one straight nozzle attached to the aft end of motor case with its axis same as that of motor. VSSC has developed special purpose solid rocket motors with canted nozzle having cant angle up to 90 degrees. The complexity of design and realization of solid motors with canted nozzle increases with higher cant angles in view of the flow turning from the motor axis to nozzle axis. Unlike conventional solid rocket motors, Reverse Flow Multiple Nozzle Solid Rocket Motor (RFMNM) employs number of nozzles with cant angle more than 90 degrees for flow reversal and thrust orientation. As a Technology Development Programme (TDP), three different configurations of Reverse Flow Multiple Nozzle Motor (RFMNM) was designed, realized and tested. The objectives of TDP were to understand and establish the reverse flow propulsion features and to understand design and fabrication intricacies. The main issue to be addressed, other than the design configuration of this complicated system, was the fabrication aspect of reverse flow nozzle. Advantages and disadvantages of each configuration with design, fabrication methodology, NDT requirements are described in detail. The testing of the rocket in a vertical test stand with thermal protection for the motor case, test fixture, instrumentation and measurement systems was also challenging. The intricacies involved in the design and realization of the reverse flow multiple nozzle motor were understood and resolved and the new technology was demonstrated satisfactorily through successful static test. Thrust, pressure, strain and temperature measurements were comparable with the prediction. The test gave adequate confidence on the design methodology adopted and ensured the capability for design and development of such motors. The static test of reverse flow multiple nozzle motor has given enough confidence to take up the design and development of next generation special purpose solid motors for upcoming missions of ISRO.