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

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STRATEGIES OF THE GRAIN CONFIGURATION DESIGN FOR LARGE SOLID BOOSTER MOTORS

Abstract

Large solid boosters are necessary for launch vehicles to place heavy payloads in orbit. ISRO develops a new launcher to put 4 T class satellites in GTO which has two solid strap-on motors in the booster stage. Each strap-on motor is 3.2 m in diameter, 25 m long loaded with about 200 T of HTPB-AP-Al propellants. It is the largest solid rocket motor developed in India. For the development of such motors, the primary and basic requirement is to design the propellant grain configuration based on most important mission-related aspects such as 1) geometrical constrains on the motor viz. outer diameter and length, 2) the allowable peak pressure that the motor case can withstand and 3) required thrust profile derived from the initial weight of the vehicle, and required trajectory, velocity, duration of flight. Among these, while the first aspect determines the outer dimensions of the grain, the other two aspects determine the port configuration of the grain. In fact, these aspects are interrelated. Moreover, they related with other parameters such as flight dynamic pressure, vehicles angle of attack and movement of center of gravity. In addition, the mechanical and casting properties of the propellant are also to be taken into account in grain design so that the grain should have sufficient structural margin. Therefore, iterative as well as trial and error computation incorporating all the above aspects is necessary to obtain the optimum configuration of the grain. Two 200 T class developmental booster motors with this grain configuration are successfully static tested recently at Sathish Dhavan Space Centre, Sriharikota. The test show that the motors deliver thrust as expected. The measured histories are close to the prediction. After the first static test, the values of the input parameters for prediction are fine-tuned and these values are used for the prediction of the performance of the second motor. The present paper discusses the characteristics of the final grain configuration selected for the 200 T class booster motor and methodology followed to compute the performance. Also, the paper analyses the delivered performances of the two developmental motors, compare with predicted performance, discusses about the variation observed in the input parameters used for prediction, and its effect in the prediction.