DESIGN AND DEVELOPMENT OF CONICAL/CONTOUR NOZZLE FOR SLOW BURNING SOLID BOOSTER OPERATING IN SUB-ORBITAL MISSION

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Abstract

In order to optimize the performance of the solid booster operating in sub-orbital altitude the contour of the nozzle needs to be tailored. The conventional convergent/divergent nozzle design is either over or under expanding for the altitude of operation. Therefore, minimizing the flow separation and losses is extremely difficult and cumbersome. In this regard, the divergent portion of nozzle plays vital role to attain the maximum performance with suitable design modification. A novel and promising concept of conical and contour nozzle divergent for slowburning propellant motors operating in sub-orbital altitude is designed and being realized for qualification test. Conical and contour nozzle divergent is a viable solution to avoid flow separation during the lower pressure and lower altitude region of the mission. The design arrived as per the mission requirement, has a conical divergent up to 737 mm from throat plane and third order polynomial profile up to exit, which will give a turn back angle of 5°.The injection point of Secondary Injection Thrust Vector Control System (SITVC) of nozzle is chosen at 45% of total distance from throat plane to exit plane. The present study brings out the theretical estimations of a conical/contour nozzle perfromance with a slowest burning solid booster operating at lower altitude, < 35 km. Theoretical Computational Fluid Dynamics (CFD) simulation study is carried out to assess the effect of nozzle profile on the flow transition. The basic design methodology adopted to avoid flow separation and the governing formulations are presented in this paper.

Keywords: Sub-orbital, Simulation, Flow separation, Area ratio, Contour, Dual bell, Slow burning propellant