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EXPERIMENTAL STUDY OF FLOW SEPARATION IN A SUBSCALE PARABOLIC CONTOUR NOZZLE

Abstract

The increasing demand for higher performance in rocket launchers promotes the development of nozzles with higher performance, which is basically achieved by increasing the area ratio. However, during nozzles operating at chamber pressures below design pressure, the flow will not be fully attached, but separated. The separation line will move towards the nozzle exit as the chamber pressure increases (during start-up) or when the ambient pressure decreases (during the vehicles ascent). This may induce unstationary, asymmetric forces, so-called side loads, which may present life-limiting constraints on both the nozzle itself and other engine components. An experimental investigation has been carried out on a cold flow subscale parabolic contour nozzle to study the flow separation phenomena. Two rows of static pressure ports were machined into the nozzles in line at the 0 degree and 180 degree azimuths with an axial pitch of 6mm to study the flow field features at various nozzle pressure ratios. The area-ratio of the nozzle is 25 and the test gas is air. Nozzle wall pressure profiles for separated nozzle flow at many NPRs are presented and discussed in detail. An asymmetric pressure distribution was observed, which indicates an asymmetric flow separation. The transition of separation pattern from free-shock separation to restricted-shock separation occurred at about NPR=27. The experiment results provide a key basis for future study on fatigue life of reusable rocket nozzle.