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Development and assessment of a backward facing steps planar convergent divergent nozzle

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Conventional bell nozzles with high area ratio are designed to provide maximum performance at high altitude where the flow becomes completely expanded. However, at low altitude, the ambient pressure is higher than the nozzle exit pressure which increases the possibility of asymmetric flow separation leading to a high side loads which can damage the nozzle. A promising two-mode altitude adaptive nozzle that can decrease the side loads during low altitudes operation is the dual-bell nozzle. Although the dual-bell nozzle improves the performance at low altitudes, it suffers from a high side load that occurs during the transition from low to high altitude. This paper presents and assesses a new nozzle that consists of backward facing steps to minimize the side loads at all operating altitudes. The backward facing steps geometry guarantees fixed stable local separation at the steps edges at all altitudes, thus decreasing the possibility of side loads as the rocket ascends. The assessment of the nozzle performance is carried out using CFD simulation of turbulent fluid flow in three-dimensional planar nozzle. The computed results are obtained using Fluent 14.5 solver for a dual-bell nozzle and backward facing steps nozzle and the results compare very well with experimental data.

Biography

Mohamed Mandour has completed his MSc in Mechanical Engineering from the Military Technical College, Egypt and he is now a PhD candidate at Department of Aerospace Engineering and Engineering Mechanics, University of Cincinnati.

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