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COMPUTATIONAL ANALYSIS OF BOUNDARY LAYER IN DUAL THROAT NOZZLE WITH SECONDARY INJECTION.

Abstract

The micro propulsion system has been explored since the 1970s to maneuver miniature satellites in orbit. The vectoring capabilities of such a system are still a challenge to optimize. Fluid thrust vectoring is an upcoming technique that is used to minimize the movable parts. Introducing a dual throat nozzle with secondary injection in the micro propulsion system has shown significant improvement to the conventional technology as it involves combines the principle of throat shifting and shock vectoring. But the boundary layer loss has significant cutbacks, thus must be analyzed. The influence of the boundary layer due to the interaction with the wall slip condition will not only reduce thrust but might have an impact on the extent of vectoring capability as well, hence the focus of the present study. The aim of the paper is to analyze the boundary layer for the micro nozzle and dual throat nozzle with and without injection. The thrust vectoring efficiencies for varied secondary injection rates and corresponding changes in the boundary layer are evaluated. The NPR ratios are varied as well to understand the underlying pattern for vectoring values. The 2D analysis was performed to understand the flow pattern. But to analyze the effect of dept, 3D CFD simulations were performed. Linear growth was observed in the boundary layer thicknesses on the sidewalls, and the viscous losses produced a significant reduction in the performance to about 80%. A notable reduction in vectoring capability was expected, but on the contrary, it had very little effect. The boundary layer thickness for the designed model of micronozzle is compared and analyzed for each case to obtain an optimal model. The techniques to minimize the viscous losses are discussed based on the outputs obtained.