ROCKET NOZZLE DESIGN: THE ROLE OF INTERNAL THROAT ANGLES IN CONICAL CONFIGURATIONS

Abstract. *The design and geometry of rocket nozzles play a vital role in the overall efficiency of propulsion systems. While the bell-shaped nozzle is the ideal configuration for maximizing thrust through effective gas expansion, its manufacturing complexity poses a challenge for those without access to advanced CNC machinery capable of creating the precise contours. As a result, many developers opt for conical nozzles, which are easier to produce but offer slightly lower performance.*

This study aims to evaluate the effects of the internal finishing angle within the throat of rocket nozzles. The internal throat angle is critical in shaping the flow of exhaust gases and can significantly impact performance, particularly in the transition from the throat to the diverging section. This work investigates how variations in the finishing angle influence the nozzle's flow dynamics and overall propulsion efficiency.

Through computational fluid dynamics (CFD) simulations, the internal gas flow in nozzles with different throat angles is modeled and analyzed. The simulations provide insight into how the angle affects parameters such as pressure distribution, gas velocity, and temperature gradients within the nozzle. The results show that conical nozzles, although simpler to manufacture, are sensitive to throat angle variations, which can either enhance or diminish their performance.

In conclusion, this study emphasizes the importance of the internal throat angle in rocket nozzle performance. For developers without access to precision machining for bell nozzles, optimizing the internal throat angle of conical nozzles offers a practical solution for improving performance while maintaining simpler manufacturing techniques.

Keywords: *Propulsion, Nozzle, Engine, Angle*