MODELLING AND ANALYSIS OF ROCKET NOZZLE MODELS BY USING CATIA AND ANSYS CFD

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ABSTRACT: In this work, seven models of rocket nozzles (convergent – divergent nozzle) have been designed to analyse the mechanics of fluid flow. These models have been designed by using a 3D modelling tool called CATIA V5 and have been analysed by using an analysis tool called ANSYS Fluent. The convergent divergent nozzle is a prominent part of the rocket to provide optimum thrust to drive it into the space with required high velocity.

In this work, the models have modified and designed in various ways that allows to gain insight into many general principles of theory of sonics of rocket nozzles and the amount of lift force, for instance the interplay between the dimensions of convergent, throat, and divergent in determining the optimal model. The work presented here consists of comparisons among Mach Number, Static pressure, Static Temperature, Velocity Magnitude, Lift Force, Lift Co-efficient, and stream lines for all seven models.

Key words: Design, Analysis, Mach Number, Rocket Nozzle, Lift, CFD analysis, CATIA V5

INTRODUCTION

NOZZLE

The nozzle may be thought of as a device that converts enthalpy into kinetic energy with no moving parts. A nozzle is used to give the direction to the gases coming out of the combustion chamber. Nozzle is a tube with variable cross-sectional area. Nozzles are generally used to control the rate of flow, speed, direction, mass, shape, and/or the pressure of the exhaust stream that emerges from them. The nozzle is used to convert the chemical- thermal energy generated in the combustion chamber into kinetic energy. The nozzle converts the low velocity, high pressure, high temperature gas in the combustion chamber into high velocity gas of lower pressure and temperature. The convergent nozzle is a simple convergent duct as shown in Fig.1. When the nozzle pressure ratio Pte/Po is low, the convergent nozzle is used. The convergent nozzle has generally been used in engines for subsonic aircraft.

The convergent and divergent type of nozzle is known as DE-LAVAL NOZZLE. Throat is the portion with minimum area in a convergent-divergent nozzle. The divergent part of the nozzle is known as nozzle exit area or nozzle exit. In the convergent section the pressure of the exhaust gases will increase and as the hot gases expand through the diverging section attaining high velocities from continuity equation. In nozzle the combustion chamber pressure is decreased as the flow propagates towards the exit as compared to the ambient pressure i.e. pressure outside the nozzle, this result in maximum expansion known as optimum expansion and nozzle is known as adapted.

The convergent-divergent nozzle is used if the nozzle pressure ratio is high. High-performance engines in supersonic aircraft generally have some form of a convergent-divergent nozzle. If the engine incorporates an afterburner, the nozzle throat is usually scheduled to leave the operating conditions of the engine upstream of the afterburner unchanged in other words, the exit nozzle area is varied so that the engine doesn't know that the afterburner is operating. Also, the exit area must be varied to match the internal and external static pressures at exit for different flow conditions in order to