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Improvement Performances of the Supersonic Nozzles at High Temperature Type Minimum Length Nozzle

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Abstract : This paper presents the design of axisymmetric supersonic nozzles, in order to accelerate a supersonic flow to the desired Mach number and that having a small weight, in the same time gives a high thrust. The concerned nozzle gives a parallel and uniform flow at the exit section. The nozzle is divided into subsonic and supersonic regions. The supersonic portion is independent to the upstream conditions of the sonic line. The subsonic portion is used to give a sonic flow at the throat. In this case, nozzle gives a uniform and parallel flow at the exit section. It's named by minimum length Nozzle. The study is done at high temperature, lower than the dissociation threshold of the molecules, in order to improve the aerodynamic performances. Our aim consists of improving the performances both by the increase of exit Mach number and the thrust coefficient and by reduction of the nozzle's mass. The variation of the specific heats with the temperature is considered. The design is made by the Method of Characteristics. The finite differences method with predictor-corrector algorithm is used to make the numerical resolution of the obtained nonlinear algebraic equations. The application is for air. All the obtained results depend on three parameters which are exit Mach number, the stagnation temperature, the chosen mesh in characteristics. A numerical simulation of nozzle through Computational Fluid Dynamics-FASTRAN was done to determine and to confirm the necessary design parameters.

Keywords : flux supersonic flow, axisymmetric minimum length nozzle, high temperature, method of characteristics, calorically imperfect gas, finite difference method, trust coefficient, mass of the nozzle, specific heat at constant pressure, air, error

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