A STUDY OF THE AERODYNAMIC BEHAVIOR OF A HYPERSONIC WAVERIDER VEHICLE BY MEANS OF CFD

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Abstract. Hypersonic aerodynamics has had a huge interest since its beginnings stemming from all the particular phenomena encountered at very high-speed flight conditions. In the last decades, this practical interest has been increasing due to the possible applications. Nowadays, applied hypersonic aerodynamics captures the attention for the design and development of vehicles that could offer better performance with such conditions at the extreme end of the whole flight spectrum. The waverider is a lifting body, which has an attached shock wave all along its leading edge, producing more lift at lower angles of attack than generic hypersonic vehicles. In this sense, waveriders possess a higher lift-to-drag ratio (L/D) than other hypersonic vehicles. The maximum L/D for a flight vehicle is a measure of its aerodynamic efficiency. Thus, the waverider is a promising candidate as a base design for feasible hypersonic vehicles. This study aims to carry out an aerodynamic analysis of a wedge-derived waverider model, which was previously obtained through metaheuristic methods of optimization that attempted to maximize both the aerodynamic efficiency (L/D) and the payload fuselage (V). The methodology adopted to do this type of research was by solving the governing flow equations for the flow field numerically, through the use of a computational fluid dynamics (CFD) commercial software. The proposed CFD simulations were performed to investigate the influence of the inflow at free-stream Mach numbers of M∞ = 5, M∞ = 6, and M∞ = 7 and the angle of attack on the vehicle (AoA = 0◦). The objective was to examine the aerodynamic performance in terms of lift and drag and identify features such as the boundary and shock layer behaviors, the viscous interaction in the flowfield, and its impact on the vehicle surface pressure distribution. The obtained results help to generate a preliminary aerodynamic database and in addition, to validate the obtained models. Therefore, the study of these kinds of optimal preliminary designs of a generalized waverider is of utmost importance as a conceptual basis for the designers of the next hypersonic vehicles, considering that it provides a foreseeable behavior of the vehicle and the flow phenomena present around it.

Keywords: Aerodynamics. Hypersonics. Hypersonic Vehicle. Waverider