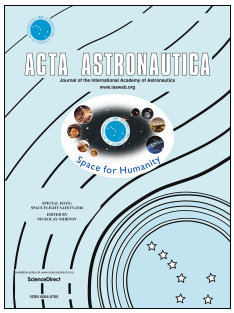
Accepted Manuscript



Effect of thermochemical non-equilibrium on the aerodynamics of an osculating-cone waverider under different angles of attack

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PII: S0094-5765(17)30329-6

DOI: 10.1016/j.actaastro.2017.07.013

Reference: AA 6382

To appear in: *Acta Astronautica*

Received Date: 1 March 2017

Revised Date: 19 May 2017

Accepted Date: 9 July 2017

Please cite this article as: Z. Liu, J. Liu, F. Ding, K. Li, Z. Xia, Effect of thermochemical non-equilibrium on the aerodynamics of an osculating-cone waverider under different angles of attack, *Acta Astronautica* (2017), doi: 10.1016/j.actaastro.2017.07.013.

Effect of thermochemical non-equilibrium on the aerodynamics of an osculating-cone waverider under different angles of attack

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Abstract

In order to research the effect of thermochemical non-equilibrium on the aerodynamics of an osculating-cone waverider, thermochemical non-equilibrium flow and perfect gas model are employed to study the aerodynamics of an osculating-cone waverider under different angles of attack. The obtained results show that the slope of the oblique shock wave has little difference when considering the thermochemical non-equilibrium effect under the condition of zero angle of attack. However, under the condition of other attack angles, the slope of the oblique shock wave diminishes when considering the thermochemical non-equilibrium effect. Furthermore, the non-equilibrium effect moves the pressure center of the osculating-cone waverider forward by as much as 1.53% of the whole craft's length, which must be taken into consideration in the balance design of aircraft.

Keywords: Osculating-cone waverider; Thermochemical non-equilibrium flow; Perfect gas; Angle of attack.

1 Introduction

During reentry and gliding, hypersonic vehicles carry out complex chemical reactions in the surrounding air, leading to different degrees of dissociation and ionization of oxygen and nitrogen. Moreover, the internal energy modes of molecules and atoms have different degrees of excitation. These phenomena are the high-temperature real gas effects, including chemical equilibrium/non-equilibrium and thermal equilibrium/non-equilibrium effects [1]. Because of the low density effect at high altitude, the thermochemical non-equilibrium effect occupies the main position in the reentry process [2,3].

So far, investigations of non-equilibrium flow around simple configurations such as wedges, sharp corners and blunt bodies have been reported by Spurk[4] and Rakich[5]. In recent years, researchers have performed many studies on the aerodynamic force, aerodynamic heating and