University of Tokyo High Temperature and High Enthalpy Wind Tunnel
Kashiwa Campus, Suzuki Laboratory, Dept. of Advanced Energy

Experimental Investigation of Aerospikes for Possible Control of Aerodynamic Drag and Heat for Lifting Body Configurations representing Spacecrafts

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Experiment Schedule: - 21st – 28th February 2011

Research Theme: -

The increased drag and convective heating associated with vehicles at hypersonic speeds have a significant impact on their design. To alienate this problem, prototypes representative of lifting body shapes with Aerospikes as shown in Fig. 1, manufactured from Bakelite material using Rapid Prototyping Machine (Roland MDX 540-A), are placed inside flow of Mach 7. As a preliminary design study, the efforts were focused on analysis of using forward-facing aerospikes and its effectiveness with varying angle of attack (-10° to +10°) and spike-nose configuration (Conical/Square/Hemispherical), on key aerothermodynamic phenomena of drag and heat reduction for prospective application to lifting body configurations. The Experiments were performed in the High Temperature and High Enthalpy Hypersonic Wind Tunnel. Flow visualization was done using the recorded Schlieren Pictures. Measurements made at freestream Mach number 7 by 6-component Force balance system revealed a 100% increase in the Lift/Drag Ratio (for Hemispherical Case) compared to No-spike case, as shown in Fig. 2, with aerospikes proving worthy at high angles of attack; thereby indicating their practical feasibility for eventual future applications to spacecrafts.
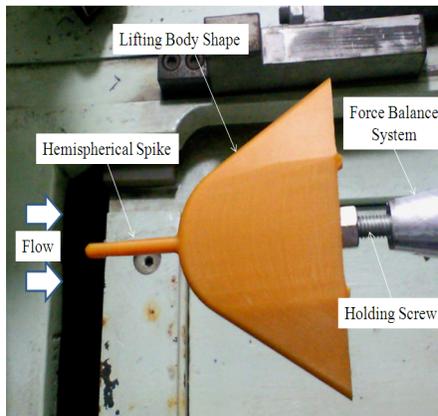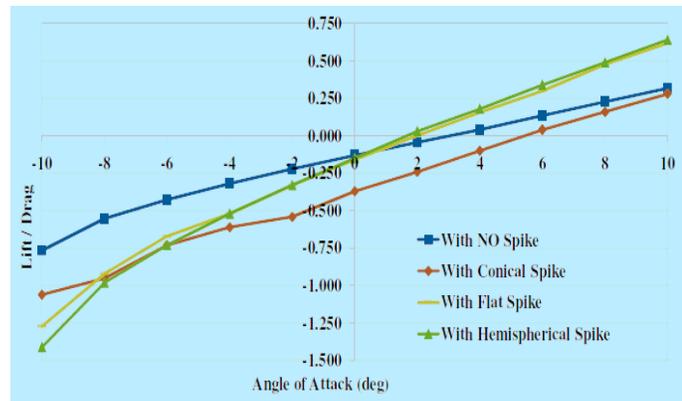

Fig. 1 Experiment Model

Fig. 2 Aerodynamic Analysis for various Spikes

References: -
[1] Shashank Khurana, PhD Thesis, The University of Tokyo (2009-ongoing).
[2] S.P.Mahulikar, "Theoretical aerothermal concepts for configuration design of hypersonic vehicles", *Aerospace Science & Technology*, Vol. 9, No. 8, pp. 681-685, Nov. 2005.
[3] R. Kalimuthu and E. Rathakrishnan, "Aerodynamic Characteristics of Blunt nosed body with and without Aerospike at Mach 5.87", *10th Asian Symposium on Visualization,* 1st-5th March 2010, Kattankulathur, India.