スパイクおよび鈍頭部ブリード孔つきリフティングボディの空力特性

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Experimental Investigation of Passive techniques for Possible Flow Control around Lifting Body Configurations representing Spacecrafts

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The increased drag and convective heating associated with vehicles at hypersonic speeds have a significant impact on their design. To alienate this problem, two types of passive flow control techniques, namely an aerospike and breathing blunt nose (B.B.N.), had been investigated for its application to lifting body configurations. A forward-facing aerospike is a surface protruding from the vehicle nose which selected optimally, can be capable of modifying the flow field around the body and entire aerodynamic characteristics. BBN concept requires bleeding (sucking) of high-pressure air from the nose and discharging it at the base, thereby reducing the positive pressure (drag) on the vehicle. The prototypes representing the lifting body shapes, as shown in Fig. 1 with Aerospike, are manufactured from Bakelite material (due to its good thermophysical properties) using Rapid Prototyping Machine (Roland MDX 540-A), are placed inside flow of Mach 7. The efforts were focused on analysis of using aerospikes and its effectiveness with varying angle of attack (-4° to +10°) and spike-nose configuration (Conical/Square/Hemispherical), and with different hole sizes for BBN case, 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, which acted as a very useful tool for the investigation. Flow visualization was done using the recorded Schlieren Pictures as shown in Fig. 2. Measurements were made at freestream Mach number 7 by 6-component Force balance system for both Aerospikes and BBN cases thereby providing an insight into the flow physics with these passive flow control methods, and their practical feasibility for eventual future applications to spacecrafts.

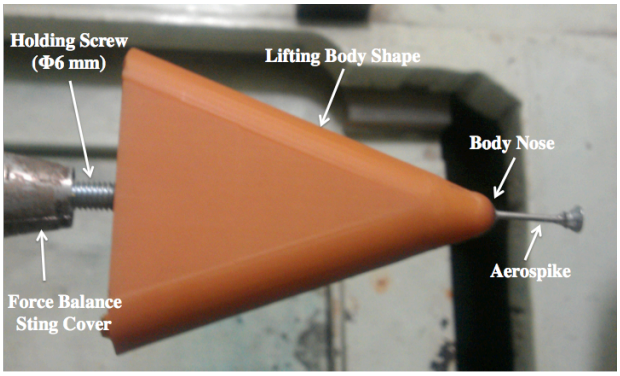

Fig. 1 Experiment Model with Aerospike

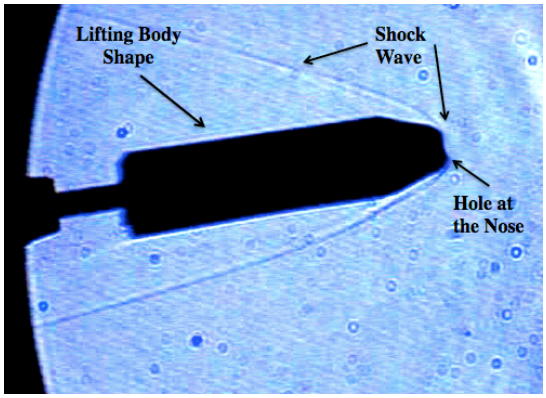

Fig. 2 Flow visualization using Schlieren technique with BBN model

Publications

[1] Shashank Khurana and Kojiro Suzuki, "Hypersonic flow investigation of aerospikes for delta-type lifting body configuration", *28th International Symposium on Space Technology & Science*, Okinawa, Japan, 5th -12th June 2011.

[2] Shashank Khurana, Kojiro Suzuki and Ethirajan Rathakrishnan, "Application of Breathing Blunt Nose Concept to Lifting Body Configuration", *30th A.I.A.A. Applied Aerodynamics Conference,* New Orleans, Louisiana, U.S.A, 25th-28th June 2012.