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SPACE EXPLORATION SYMPOSIUM (A3)
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Author: Mr. Chrishma Singh-Derewa
National Aeronautics and Space Administration (NASA), Jet Propulsion Laboratory, United States, starhunterceo@hotmail.com

Mr. Srikanth Raviprasad
University of Illinois at Urbana-Champaign, United States, srknthr2@illinois.edu
Ms. Maitreyee Sharma Priyadarshini
University of Illinois at Urbana-Champaign, United States, sharmap2@illinois.edu
Mr. Divye Singh
India, sdivye92@gmail.com
Mr. jafar ali habshee
india, India, phantom_jj80@yahoo.com

LOW DENSITY SUPERSONIC DECELERATOR USING MAGNETO HYDRODYNAMICS AND DYNAMIC DIFFUSERS

Abstract

NASA's Jet Propulsion Laboratory continues to push the boundaries of entry, descent and landing with heavier exploratory systems. Our heat shields must dissipate more than 90 percent of the spacecraft's kinetic energy and keep the aeroshell interior safe from these extreme temperature gradients. Mars Science Laboratory (MSL) mission was a major breakthrough for human space expedition as it taught JPL many things about this high speed descent as it hurdled to the surface of Mars at nearly a ton. The MSL aeroshell was a 4.5 m diameter spherically-blunted 70-degree half-angle cone made of an ablative material called Phenolic Impregnated Carbon (PICA). The data gathered indicated the urgent need for an optimized entry design for heavier payloads increasing the marginal probability of safety.

The STARSHIELD concept adopted in this technology demonstration will redirect and vector the surrounding plasma by using nozzles built into the shield to allow propulsion free adjustments to trajectory, thereby reducing the velocity during Re-Entry. To obtain the same, supersonic and hypersonic diffusers are strategically mounted along the aeroshell of the vehicle. This concept is universal in the sense it can be employed for non – axis symmetric vehicles as well.

The STARSHIELD will also incorporate in itself the concept of Magneto Hydrodynamics for successful increase in atmospheric drag. The jettison of plasma flow from the diffuser causes an upward thrust. While passing through the diffuser duct this ionic plasma experiences an additional magnetic force generated by an electromagnet placed inside the forebody of the vehicle. The interaction of plasma and the magnetic field accelerates the flow through diffusers, which in turn increases the upward thrust. This thrust opposes the ionized air flow producing a compressing effect on it, hence increasing the density and the pressure drag on the vehicle, enabling safer re-entry. Magneto hydrodynamics also takes thermal protection system to the next level by increasing the boundary layer thickness of flow and efficiently dissipating more heat.

A low density supersonic decelerator, coupled with the concept of Magneto hydrodynamics and Dynamic diffusers for vectorable atmospheric entry, will help compensate for wind shear, provide course directional capabilities and reduce shock-waves across turbulent boundary layers associated with TPS degradation in flight. These capabilities will revolutionize the entry, decent and landing on Mars enabling ever larger payloads to its surface.