

Numerical and Feasibility Study of MHD Power Extraction on Supersonic Vehicle

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The previous studies [1-2] have shown that there is sufficient ionized plasma surrounding the vehicle with a flight Mach number equal or greater than 10 which could sustain the plasma power extraction process via current collection electrodes and proper magnetic field methods. Thus, it is suitable to equip hypersonic vehicles with onboard thermal plasma energy extraction system, i.e. MHD power supply system.

In this paper, a reduced model containing main features of on-board MHD generators has been constructed and problems have been solved numerically for the purpose of providing preliminary guidelines for the design of external MHD generators on board hypersonic vehicles. As it shows, the power extracted from the plasma flow field was related to profiles of magnetic field and fluid velocity, fundamental plasma characteristic, geometry parameter of electrodes, spacing and load voltage between electrodes. Based on the numerical results, an onboard MHD power extraction scenario was proposed accordingly, and systematic feasibility studies were performed. The results revealed that the power output of the MHD generator is capable of providing substantial energy output up to several hundred kilowatts or tens of kilowatts per square meter from the alkali-seeded/non-seeded boundary layer for typical flight condition, separately.

[1] Macheret, S. O., et al, AIAA Paper 2004-2560 (2004)

[2] Sheikin, E. G., et al, AIAA Paper 2005-1335 (2005).