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SINGLE AND MULTIPLE RETRO-JET EXPERIMENTS IN A HYPERSONIC FLOW

Abstract

Experimental studies using ground test facilities have been carried out continuously for stable launching and mission completion of space launch vehicles. Recently, there has been a growing interest in retro-propulsion used in re-entry and vertical landing for effective rocket recycling after the launch of space launch vehicles. As a basic study on retro-propulsion experimental study, it is necessary to acquire database on shock wave pattern, mach disk, jet boundary, bow shock, recirculating region, and so on.

In this study, a high-altitude environment experiment including a retro-jet (Helium cold gas) was conducted with the Mach number and Reynolds number similitude using a KAIST K1 shock tunnel at a Mach number 6, unit Reynolds number of about 17.8×10^3 /m, and total enthalpy of about 1.9 MJ/kg. After flow establishment, in order to confirm aerodynamic characteristics and normal and oblique shockwaves, the flow verification was carried out by measuring stagnation pressure and heat flux of a pitot probe, and shockwave stand-off distance of a hemisphere model. From the results of the three verification tests, it was confirmed that the flow was replicated with the error of about $\pm$ 3%.

A special shape was applied to reduce the disturbance due to the side strut-support for mounting the test model, and a high-altitude environment experiments including a single and multiple retro-jet plumes were conducted. Through a schlieren photography, the overall shock wave pattern and the interference pattern between the retro-jet plume and the free-stream flow were experimentally confirmed. Using the laser doppler velocimeter (LDV), the retro-jet module thrust generated by the retro-jet plume injection was predicted by the vibrational analysis. In addition, a detailed quantitative flow interference pattern was confirmed by applying a background oriented schlieren (BOS), a non-intrusive density field measurement technique. This paper presents the possibility of an efficient and easy retro-jet comparison studies at low cost in a limited test space.