SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Future Space Transportation Systems (4)

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A CONCEPTUAL ANALYSIS AND COMPARISON OF A TWO-STAGE-TO-ORBIT REUSABLE LAUNCH VEHICLE USING AIRBREATHING PRECOOLING HYPERSONIC ENGINES

Abstract

Based on a Precooling Hypersonic Engine (PHE) concepts, which could work in airbreathing mode and rocket mode, two possible Two-Stage-To-Orbit (TSTO) Reusable Launch Vehicle (RLV) concepts with typical goal of sending a specific payload to Low Earth Orbit (LEO) are constructed and presented in this paper. The two vehicles are stage-separated at Ma 5and Ma 10 respectively. The PHE engines work in only pure airbreathing mode and airbreathing + rocket modes for Ma 5 Concept and Ma 10 Concept respectively. Trajectory optimization via General Pseudospectral Optimization Software codes (GPOPS) with restrictions of dynamic pressures, heat fluxes, and so on, along the trajectory have been performed. Averaged specific impulses, averaged effective specific impulses, propulsive coefficients along trajectory, fuel consumption, time of climbing to separated points, climbing trajectory strategies et al along the trajectories, have been compared and analyzed. As a result, how to fully take advantages of PHE engine's working modes and performance characteristics with taking vehicle and trajectory design influencing factors into account are analyzed and confirmed, which shows significant different working ways to other airbreathing combined cycle engines for an RLV application. The research results shows technologies challenges and requirements faced by an PHE powered RLV vehicle. And the conclusions also provide insights into RLV vehicle design with different airbreathing combined cycle engines as propulsion systems to accomplish a desirable orbit launching mission of space explorations.