SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
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A FEASIBILITY STUDY AND CONCEPTUAL PROPOSAL OF A REUSABLE MULTISTAGE WINGED SPACE TRANSPORTATION SYSTEM WITH TANDEM ORBITER-CARRIER CONNECTION BY HORIZONTAL TAKE-OFF AND LANDING

Abstract

As the single-stage orbit entry technology requires a higher efficiency of the power plant, and in the premise of meeting the overall thrust-to-weight ratio demand for winged aircraft, power plant should have a sufficiently large specific impulse. In order to solve this problem, Germany has proposed a parallel multi-stage project called SANGAR. However, the program is compromised by a large loss of velocity due to aerodynamic drag ,involvement of flight crew responsible for operating the airplane-booster as well as the existence of violent aerodynamic heating and other fundamental shortcomings and ultimately failed to achieve the goal. Based on the analysis and comparison of SPACE SHUTTLE, BURAN, HERMES, HOPE-X, X-34, X-38 and HOPPER projects, this paper proposes a multistage winged transportation system with horizontal take-off and landing capability, the system is featured by a tandem connection between orbiter and carrier booster, and also a foldable winglet. Firstly, this paper discusses the technical problems encountered in design process of carrier-payload system ranging from weight estimation of winged orbiter, aerodynamic layout, volume and weight design, flight envelope scheduling to overall structural mock-up. Extra attention was also payed to such problems as excessive movement of center of gravity of entire carrier-payload system during flight. In the second part of this paper, the feasibility and benefit provided by the foldable winglet of orbiter was investigated. The winglet of orbiter basically distinguishes it from traditional space shuttle. Research reveals that orbiter of this kind can not only meet the requirement of hypersonic lift to drag ratio, but also has satisfactory low speed take-off and landing characteristics from the aerodynamic perspective. Through the study of this paper, we can draw the following main conclusions: 1. The maximum cross-sectional area of the tandem-scheme multistage carrier-payload transportation system is much smaller, this feature is desirable not only to reduce the aerodynamic drag during flight and hence the consequential velocity loss , but also to relieve the severe aerodynamic heating. 2. A canard-like layout is formed by placing the orbiter in front of the tandem-scheme transport system, vortex lift is generated at high angle of attack, this effect helps to reduce the focus movement of the flight vehicle during the transonic process as well as to improve the aerodynamic performance at low speed 3. The system is able to carry astronauts without designated pilot crew. The tandem-scheme saves the weight of the booster crew members and weight of its cockpit.