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Author: Ms. YAN LYU
China Academy of Launch Vehicle Technology (CALT), China

DESIGN OF A REUSABLE AIR-LAUNCHED ROCKET FOR SMALL SATELLITES LAUNCH

Abstract

Air-launched rockets is designed to provide flexible, affordable, and dedicated launch for small satellite while the application of mature recovery technology represented by vertical recovery on small launch vehicle such as air-launched rocket result in insufficient payload capacity. A reusable air-lunched rocket and its reusable technology are introduced to reduce the payload capacity loss. The three-stage air-launched rocket, weighing approximately 20,000kg/44,100lbm is lifted by a carrier aircraft to a flight condition of about 11,900m/39,000ft and Mach0.8. A reusable Lox/kerosene engine is equipped for the first stage. The configuration of the air-launched rocket and its mission profile is presented. The rocket reached a payload capacity of up to 300kg/661lbm to 500km/270nmi Sun-Synchronous Orbit (SSO). The recovery of the first-stage booster is achieved by the air rudders assembled for both flight control at the ascent section of the main mission and the recovery section. Four air rudders near the tail of the first stage achieve flight control in the dense atmosphere after launch, which can also be used in the recovery section. Based on the analysis of the aerodynamic characteristics, the recovery point can be adjusted by the synthetic angle of attack. The guidance and flight control system for the recovery section is proposed and the accuracy of the recovery point is examined by Monte Carlo simulations. The contributions of the recovery technology in terms of orbit efficiency and economic efficiency are analyzed quantitatively. Based on a 10 times recovery, the recovery of the first stage booster sacrifices a payload capacity of 1kg/2.2lbm to 2kg/4.4lbm while reducing the economic cost by approximately 62% for each launch mission. The air rudder recovery technology does not require the first-stage engine to have re-lighting and thrust adjustment functions, making it easier to design and manufacture.