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SYSTEM DESIGN OF UPPER STAGE IN KSLV-II USED IN KOREAN LUNAR EXPLORATION PROGRAM

Abstract

Based on the successful launch of Korea Space Launch Vehicle I (KSLV-I) as part of its technical cooperation with Russia in 2013, South Korea aims to develop the KSLV-II by 2021. KSLV-II consists of 3-stages that can be used in delivering 1.5 ton-class payload into solar synchronous orbit, (inclination 98 degrees) with the altitude of 700 km. If the launch vehicle is successfully developed, the Korean Lunar Exploration Program will be implemented in 2030. In such Lunar program, launching Lunar lander as a KSLV-II is expected. In this case, the existing 3-staged-KSLV-II does not have the necessary energy to ensure a transfer from Earth to the Moon. Therefore, upper stage must be added to launch vehicle. For the TLI (Trans-Lunar Injection) maneuver, from an altitude of 300 km parking orbit around Earth, delta-v of the upper stage is required approximately 3106 m/s. Also for implementation of the LOI (Lunar Orbit Injection) maneuver, delta-v of the Lunar lander is required approximately 833 m/s.

This paper considers a preliminary design analysis of the upper stage, taking into account the geometric constraints payload fairing of the KSLV-II. For the main engine of the upper stage, Bipropellant rocket engine is used, the requirements for which are determined from the design-ballistic analysis. Then the initial design of the upper stage, which depends on the fuel components, was carried out, and the design project of the fuel tank was also carried out respectively. The design of the fuel tank optimizes the mass, taking into account the operating loads.

Additionally, the fuel tanks and the oxidizer of the Lunar lander are expected to be used as 2 spherical tanks which arranged one above the other (vertically). This arrangement makes it easier to keep the center of mass on the center axis, but requires more mass for fixing the tanks than if the tanks were located horizontally. Also in vertical arrangement of the tanks, which is subjected to heavy axial loads, and the stability of the Lunar lander deteriorates when landing on the moon.

Consequently, the study deals with the modification of the arrangement and shape of the tank to increase stability when landing on the moon and confirm variations in the mass of the Lunar lander. The existing vertical arrangement of tanks will be placed on the same plane to distribute the load, and the number of tanks also will be changed.