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SOLAR THERMAL POWER PROPULSION SYSTEM FOR SHORT LEO-TO-GEO MISSION

Abstract

Presently, it is actual to consider the combined “liquid propellant rocket engine plus apogee electric propulsion” upper stages for payload injection from LEO into GEO within 60-120 days. In this case, to have a gain in solar thermal propulsion (STP) payload at relatively short time of 25-35 days of the trip, it is necessary to consider the optimal transfer trajectories allowing significantly decreasing of characteristic velocity (Delta-V) by means of using of optimal pitch and yaw angles changing programs together with the choice of the STP switching at relatively short active segments of the multi-burn transfer trajectory. The obtained results show that the optimal trajectory for 30-day mission contains three active segments where the STP multiple burning is being realized.

The STP with “concentrator-absorber and sun tracking” system (CATS) is considered in two variants: (i) monopropellant hydrogen engine and (ii) bi-propellant engine with the heated hydrogen after-burning by oxygen or fluorine with different oxidizer excess ratios. The CATS is performed with use of non-isothermal type of the absorber with higher optical-thermal properties as compared with absolute-black body absorber of cavity type. This allows to increase hydrogen temperature up to 2800 K and higher to provide the STP specific impulse of 900 sec or more. In some cases the heated hydrogen after-burning is required to decrease the total volume of the “solar” upper stage and to arrange it within launch rocket cargo bay. As a part of power system, the high-temperature CATS have the possibility to include thermal-ionic converters to supply the payload by electric power on the final orbit. The high-temperature absorber together with thermal energy storage (optional) makes this task as a feasible problem.

The obtained results show that in the case of the optimal injection trajectory corresponding to the non-isothermal CATS for the considered STP it is possible to increase payload mass twice as compared with the state-of-the-art chemical propulsion within short trip time 25-35 days. As compared with the advanced combined “liquid propellant rocket engine plus apogee electric propulsion” upper stages, it is also possible to increase payload mass at the significantly shorter mission time.