Paper ID: 15128
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SPACE PROPULSION SYMPOSIUM (C4)
Electric Propulsion (4)

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APPLICATION OF STATIONARY PLASMA THRUSTERS FOR SPACECRAFT INSERTION INTO THE GEOSTATIONARY ORBIT

Abstract

Application of electric propulsions (EP) allows increase for the efficiency of solving a number of transportation problems in space. Such problems include the problem of spacecraft insertion into high operational orbits. Multiple studies are devoted to proving the efficiency of EP use for solving such transportation problems. Characteristics of spacecraft (SC) insertion into the geostationary orbit by the transport space system based on the "Soyuz-2/1B" launch vehicle, "Fregat" upper stage and solar electric propulsion system are discussed in this paper for "Kourou" cite. Sustainer electric propulsion system (EPS) consists of four stationary plasma thrusters SPT-140 by EDB "Fakel" [1] (including 2 primary thrusters operating simultaneously and 2 reserve thrusters) with the following parameters: thrust – 0.58 N, specific impulse – 1770 s, consumed electric power 9 kW. Several parameters are considered while analyzing projects of insertion into the operational orbits, into GEO in particular, with the use of electric propulsion systems. The analysis of this paper is limited by the following two parameters: time of transportation task execution (is parameterized), and SC mass at the moment of insertion (considered in this study as some optimization criterion for the given insertion times). Such mission pattern is selected, which would maximize SC mass. We consider the problem of choosing an optimum pattern of SC insertion into GEO and optimum parameters of space system (including CPS fuel mass, optimum EPS xenon mass, and parameters of an intermediate orbit), which secure insertion of maximum mass during the fixed time period. Depending on the time of SC transfer from reference orbit to GEO, the orbit inclination is secured mainly by the operation of CPS (relatively short time) or EPS (relatively long time). At the leg of EP operation, control is optimized in accordance with statement, in which Pontryagin's principle of the maximum is used as the basic method. According to the analysis made, application of electric propulsion system based on the stationary plasma thrusters produced by EDB "Fakel" makes it possible to secure insertion into GEO of a spacecraft with higher mass than in the case of common method of spacecraft delivery to GEO. So, in the case of launch from Kourou launch site is used, the space transport system can secure delivery of a satellite with the mass of 2150...2380 kg during the spacecraft insertion time of 60...90 days.