SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Going To and Beyond the Earth-Moon System: Human Missions to Mars, Libration Points and NEO's (8-A5.4)

Author: Dr. Vladimir Lapygin
Central Research Institute for Machine Building (JSC TSNIIMASH), Russian Federation, vil1940@mail.ru

Dr. Uspensky Georgy
Central Research Institute for Machine Building (JSC TSNIIMASH), Russian Federation, georgyuspensky@rambler.ru
Mrs. Tatiana Sazonova
Central Research Institute for Machine Building (JSC TSNIIMASH), Russian Federation, tpliss@yandex.ru
Dr. Andrey Gorshkov
Central Research Institute of Machine Building (TSNIIMASH), Russian Federation, ab_gorshkov@mail.ru

LIMITING VELOCITIES OF SPACECRAFT MOTION IN EARTH AND MARTIAN ATMOSPHERES

Abstract

Direct entry (without prior flight along circumplanetary basic orbit) of a spacecraft into the Earth/Martian atmosphere with reduction of its velocity due to aerodynamic braking and subsequent soft landing on the surface of the planet is discussed. Two schemes of the spacecraft motion in the atmosphere are examined: without flight outside the atmosphere and with flying away from it to altitude of basic circular orbit, which the spacecraft reaches using propulsive burn. Within both schemes the spacecraft accomplishes rectilinear motion up to the braking orbit (reference orbit at altitude H0). Here, inducing a negative angle of attack, lift force is formed toward the planet that reaches a value of centrifugal force excess as compared with gravity at this altitude, and the spacecraft begins its motion at the reference orbit at altitude H0. According to the first scheme the spacecraft is orbiting with negative angle of attack since its velocity, due to drag, is reduced down to circular velocity for this altitude. Then the spacecraft turns at roll at 180 degrees and forms lift force toward the planet, in that way it continues orbiting in spite of insufficient centrifugal force of the spacecraft as compared with gravity that is connected with reduced velocity due to drag. At design moment the spacecraft deorbits in order to execute soft landing at prescribed region at the planet surface. According to the second scheme the spacecraft moves with required lift force toward the planet while its velocity is reduced down in such a way that it can fly along an elliptical orbit with altitude at apogee that equals altitude of basic circular orbit with H=400km. On reaching this altitude the spacecraft forms propulsive burn that allows getting this basic orbit. A feature of this method is stability of computational results regarding G-forces and their duration against variations of lift and drag forces. Application of examined schemes with prior flight at reference orbit at altitude H0=30 km for the spacecraft with mass about 50 ton descending at Martian atmosphere allows reducing significantly spacecraft velocity in rarified atmosphere in order to make easier its flight at more dense layers.