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Author: Dr. Victor Leonov
Bauman Moscow State Technical University, Russian Federation

Mr. Vladimir Zarubin
Bauman Moscow State Technical University, Russian Federation
Mr. Dmitrii Kremnev
Bauman Moscow State Technical University, Russian Federation

ANALYSIS OF APPROACHES TO ENSURE THE RETURN OF CARGO DESCENT VEHICLES FROM THE MOON WITHOUT HEAT SHIELD DESTRUCTION

Abstract

This paper presents our analysis of the approaches allowing to return from the Moon re-entry vehicles of different classes without destroying their heat shielding. Considered are spherical ballistic class vehicles, semi-ballistic vehicles (gliding descent) of segmental-conical shape characterized by hypersonic aerodynamic quality in the range of 0.15-0.5, and vehicles of the "lifting body" class, i.e., vehicles having hypersonic aerodynamic quality equal to 0.8-1.5.

Thermal impact on the re-entry vehicle's surface can be reduced by reducing the speed at which it enters dense atmosphere. If not using descent engines, the same effect may be achieved by charting trajectories with multiple atmosphere entries. In that case, after the vehicle first passes the Earth atmosphere, its orbit would look like an ellipsis with the apogee getting progressively lower on repeat reentries. Short duration and low depth of the device's immersion in the upper atmosphere serve to incrementally reduce its speed.

The unevenness of temperature distribution over the surface and thickness of the heat shield can be reduced by high thermal conductivity of the heat shield material in the tangential direction. At the same time, the material should have relatively low lateral heat transfer properties in order to avoid overheating the vehicle's internal compartments. Those are properties of heat shield materials with high heat transfer anisotropy.

The analysis of different variants of heat protective coating design has shown that it is more effective to make it multilayer.

In this paper we propose the structure and composition of multilayer heat protective coating that provides acceptable thermal and thermal stress states of the re-entry vehicle structural elements.