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PREDICTION OF PERFORMANCE OF MESH PHASE SEPARATORS IN GEO SATELLITE CAPILLARY INTAKE DEVICES

Abstract

Today, extending the useful lifetime of geosynchronous orbit satellites(GEO) from 15 – 20 to 30 years or more, including through in-orbit refueling, is one of the most pressing challenges facing the aerospace industry. One example of such a promising life extension program (in progress) is NASA's Robotic Refueling Mission (RRM). In January 2013, after many years of testing in terrestrial conditions, the RRM performed its first test on board the ISS, demonstrating that remotely controlled robots could successfully transfer fuel in space to GEO satellites which are decommissioned and retired in graveyard orbit. In this regard, it should be noted that the long-term exposure of capillary intake device (CID) mesh phase separators (MPS) to aggressive propellants (or their vapor) in the propellant supply continuity systems leads to a deterioration in their basic performance characteristic, i.e. capillary retention capacity. The author analyzed the results of long-term experimental and theoretical studies into the effect of long-term exposure (for more than 30 years) of the MPS to liquid propellants such as N2O4 and (CH3)2N2H2, and established the ratio of change in their capillary retention capacity (CRC) over time. The loss of the MPS CRC over 31 years of their exposure to the liquid propellants has been determined. The main factors affecting the change in the CID performance characteristics have been analyzed: uniform corrosion damage and local changes in the microstructure of the mesh structural material, as well as a change in the contact angle between the propellant and the mesh material. The results obtained make it possible to accurately predict the survivability of the CID MPS after their long-term exposure (for more than 30 years) to liquid propellants, which ensures failure-free multiple ignitions of a GEO satellite propulsion system in zero gravity during the efforts to extend the useful lifetime of GEO satellites from 15 – 20 to 30 and more years (through in-orbit refueling).