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PRELIMINARY EVALUATION OF ENGINE HEALTH MONITORING FOR HALL THRUSTER

Abstract

In the recent years, the electric propulsion has become a valid alternative with respect to chemical propulsion for several in-space propulsion applications. The current trend foresees that a growing number of satellite providers will transit to electric thrusters in next decade. Among different electric thruster concepts, Hall thrusters have been identified as the most suitable technology for fulfilling the future challenging mission needs. They combine many advantages, such as: a high value of thrust density, quite easy scalability to different power levels and relatively long operational lifetime. However, they continue to suffer from degradation effects or other impeding malfunctions, mainly caused by erosion and high heat fluxes in specific element of the thruster. These events could potentially jeopardize the thruster operations, reducing the operation range or totally precluding the thruster use. According to NASA Technological Roadmap, published in 2015, in view of a desirable mass expansion of the use of these propulsion systems, new Engine Health Monitoring (EHM) methodologies and techniques shall be implemented in order to ensure greater reliability and fault tolerance. These procedures can enable the automatic identification of emerging malfunctions or failures, while allowing the possibility of undertaking recovery corrections. Several EHM procedures have been already developed for the monitoring of gas turbine, in particular for maintenance scheduling and optimization of engine availability. However, in the space propulsion field, they have been used only for rocket engines to establish the degradation of specific engine components. With the same purposes, this paper presents a preliminary application of an EHM procedure on Hall Thrusters for the monitoring of their operations. The procedure implementation relies on the use of a Gas Path Analysis (GPA) based model, which considers a combination of theoretical analysis of the thruster operation and empirical data. The proposed approach is then applied to a high-power Hall thruster tested at SITAEL and validated using experimental data. Finally, main conclusion and general prospects of the method are discussed with a particular focus on the application of the developed procedure to on-ground testing and flight operations.