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BRAZILIAN VLM - ATMOSPHERIC STAGE SEPARATION ANALYSIS

Abstract

The Brazilian Microsatellite Launch Vehicle (VLM) is a three-stage launcher, whose motor cases for first and second stages are manufactured by using filament-winding technique (carbon fiber). This vehicle is under development in the Institute of Aeronautics and Space – Brazil. In this project, the staging of the first stage during the atmospheric phase of flight (about 25km) is a critical issue that plays an important role of interest. At this altitude, the VLM is still under effect of non-negligible aerodynamic loads and, in the case of cold separation, the loss of control or re-contact between jettisoned part and the main body of the vehicle can occur. In the last years, methods based on CFD has been applied in the stage separation analyzes. However, these methods present high computational cost and consume a lot of time to process sensibility analyzes or Monte Carlo method due high number of cases to process. As a consequence of the problems addressed before, the main purpose of this paper is to discuss, model and analyze the atmospheric staging of the VLM considering hot separation and uncertainties and variations in the vehicle mass properties, inertia matrix, thrust rise time and TVC deviation. In order to achieve the purpose of this study, it is developed a 6-DoF mathematical model to simulate two body interactions during a hot separation process, by using a modified analytical technique for predicting the plume impingement force during tandem stage separation, including the reversed flow effects. Preliminary studies have shown good results in absence of uncertainties. By applying this new approach it is expected a fast and reliable methodology for hot separation analyzes.