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# REACTION CONTROL SYSTEM USING HYBRID MICRO-THRUSTERS, MODEL AND EXPERIMENT

**Abstract**

In this paper we develop a calculus model based on dedicated experiments for an innovative Reaction Control System (RCS) using hybrid rocket engine technology. Our RCS uses several hybrid micro-thrusters with their thrust modulated by a separate control system. For RCS, each of the thrusters will be able to burn a few minutes and its thrust will be modulated within certain limits by controlling the oxidizer flow. The basic idea is not to stop any of the engines during system's operation but to minimize their thrust reducing the oxidizer flow. By creating thrust imbalance between various hybrid micro thrusters, one can create torques with which the attitude of the vehicle can be adjusted. A feedback loop will be implemented between the guidance navigation unit of the vehicle and the hybrid micro-thrusters. We envision a system of 6 micro-thrusters. The system will contain two circuits, one for the control system representing the control loop of the RCS and the second, the oxidizer circuits. At each of the thrusters, by distributor, the oxidizer flow is adjusted and the thrust is controlled. There are tree thrusts pairs, one for each rotation: yaw, pitch and roll. The thrusters of a pair are positioned back to back so that the nozzles are in very close planes in order to obtain a symmetric torque. The average thrust value of each micro - thruster can be adjusted by the size of the fuel grain, this being proportional to the burning surface area. Technologically speaking, the achievement of the RCS system in this functional concept is favoured by the subsystem symmetry. Also, in order to increase system efficiency, the nozzle is tilted, making two components for the thrust vector, a lateral one and other longitudinal. In terms of computational model developed, it starts from our theoretical and experimental studies, which aimed to build a computational model for hybrid rocket engine highlighting his controllability. It continued through experiments based on RCS with two micro-thrusters, were tested in dynamic regime, highlighting the response time of the system and losses in the exhaust system. These studies are based on our own experiments performed in Electromecanica Ploiesti. Based on this concept we achieve a calculation of the performances of the RCS and an evaluation in their size. Conclusions and any discussion will be focused on technical solution adopted for achieving the system and possible areas of application for this RCS.