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REPLACEMENT OF HYDRAZINE-BASED SYSTEMS BY MEANS OF HYBRID ROCKETS

Abstract

Environmental and economic reasons are pushing towards the replacement of hydrazine-based propulsion units with more convenient choices. Being a long-term storable liquid, hydrazine grants also hypergolic ignition in combination with nitrogen tetroxide and allows for easy implementation of a multiple-firing throttleable liquid system. However, special procedures and safety equipments are necessary due to its high toxicity, causing an increase of the costs associated to its handling, fueling and disposal.

An alternative solution for some applications can be represented by hybrid rocket technology. Being intrinsically safe due to the physical separation of fuel and oxidizer respectively in solid and liquid form, hybrid rockets allow for throttleable thrust by varying the oxidizer mass flow rate. Moreover, multiple re-ignition capability can be achieved by selecting an oxidizer that decomposes before injection in the combustion chamber and, finally, interesting performance levels can lead to propellant mass savings, maintaining an environmentally friendly propellant. As drawbacks, we shall recall that hybrid rockets are featured by limited regression rates, thus requiring large combustion surfaces to reach interesting thrust level. Moreover, such motors are featured by the presence of combustion slivers and by a combustion chamber that varies its geometry in time.

The development of hybrid rocket engines have reached a good development status, even though space applications have not yet been implemented. The configuration of a hybrid rocket is relatively simple since it is composed by a polymeric fuel grain and an injector which introduces the oxidizer in the combustion chamber. In the perspective of a potential replacement of hydrazine-based systems, this paper considers the AVUM space platform (fourth stage of VEGA launcher) as a benchmark and explores the possibility to use a hybrid rocket instead of its UDMH/NTO liquid engine. The investigation will take into consideration mission specifications (mainly ΔV) and will consider the potential application of different propellant choices, looking at performance parameters, estimation of masses, thrust and their variation during firing.