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THE HYBRID PROPULSION TO SERVE SPACE EXPLORATION AND MICRO-GRAVITY EXPERIMENTS

Abstract

Liquid and solid propulsion received strong investments to make them today nearly unavoidable for large space launchers and sounding rockets. However, each of them has significant drawbacks: cost, complexity and relatively low reliability and operation in case of liquid propulsion, and low specific impulse, no shut-down or thrust modulation capability and pyrotechnic security concerns in case of solid propulsion. These drawbacks may become more limiting when considering new transportation vehicles for space exploration missions or micro-gravity experiments for which simplified, low cost, faster and thrust modulated operations may be wished together with a high level of performance, reliability and availability. These capabilities could be reached through hybrid propulsion which combines a solid fuel with a liquid oxidizer.

If the idea is not new, hybrid propulsion has nevertheless never been developed, partly because of the huge investments that were done on liquid and solid propulsion. The demand for new small launch system could today justify maturing this technology. Hybrid propulsion applied to sounding rockets would allow reducing the costs of upper atmosphere experiments. Thrust modulation capability would allow space exploration vehicles to better reach their targeted landing area or orbit. Thanks to its safety and environmental friendly operation, this technology could also be used advantageously as a new approach to create propulsion power for air transport vehicles. The first type of vehicles to be considered would be the suborbital aircrafts for which the hybrid propulsion will help gaining in flexibility and safety compared to existing engines. Micro-gravity experiments would be revisited in such aircraft. Compared to the Zero-G Airbus providing a series of 30 parabolic manoeuvres of 25 seconds each, the suborbital aircraft would allow reaching one manoeuvre of a few minutes or, by restarting the engine, a few manoeuvres of one minute each. The technology could be further implemented to thrust regional aircrafts with passengers up to an altitude of 80 km for intercontinental trips. According to ESA, the carbon print of such flights would be less than for the current intercontinental flights.

To reach this objective, the hybrid propulsion concept has first to be further investigated in order to be later optimized and qualified as a technology potentially capable of pioneering the space exploration missions and the air transport of the future. The paper will present the state-of-the-art in hybrid propulsion, the achievements obtained so far at ONERA and the required research roadmap to further mature the technology.