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IN-SITU RESOURCE UTILIZATION: STUDY OF METHANE-POWERED COMBUSTION ENGINE CONCEPTS FOR MECHANICAL APPLICATIONS ON TITAN

Abstract

When considering prolonged and complex missions on the celestial bodies of the Solar system, the concern for a sustainable energy source comes as a major design driver. Robotic exploration has already proven the relevance and reliability of several technologies, among them solar-powered systems, fuel cells, rocket engines and nuclear-powered generators. However, these solutions prove unadapted for many applications in possible future missions. For instance, many energy sources may be unavailable in some environments. Moreover, construction and mining for long-term human habitats would need sustained, high-power machinery that current solutions cannot uphold; the same case can be made for airborne vehicles and surface rovers.

In the specific case of a manned mission on Titan, the incoming solar flux is way too low to be significant. Furthermore, using radioisotope thermal generators (RTG) implies running the risk of environmental contamination, radioactive as well as chemical; an undesirable outcome if we consider a human settlement. Instead, Titan offers other solutions: the Saturnian moon is provided with a thick atmosphere, which is mainly composed of nitrogen and, among other hydrocarbons, methane. This resource is abundant on Titan, and is the perfect candidate for a possible fuel source in-situ. Combustion engines have already proven their efficiency on Earth under many forms, and can be used in other environments allowing their operation.

The purpose of this work is to study the potential of several methane-powered combustion engines on Titan, and evaluate the range of applications they can fulfill. After a detailed presentation of the environment and the challenges such engines would face, their performance and possible forms will be assessed. From the oxidizer, to the possible vehicles and equipments they could power, the benefits and drawbacks of such systems deliver a new perspective on how a human colony on Titan could be conceived.