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SPACE PROPULSION SYMPOSIUM (C4)
Propulsion System (2) (2)

Author: Mr. Philippe GAUTIER
Herakles (Safran group), France

Dr. Olivier ORLANDI
SME (Safran group), France
Mr. Stéphane Henry
Herakles (Safran group), France

ORPHEE PROJECT SYNTHESIS FOR HYBRID PROPULSION

Abstract

Hybrid technology appears as an innovative, high performance and promising propulsion technique in number of space missions. By combining characteristics taken from both solid and liquid propulsions, this technology is expected to provide mainly high performance with throttleability and stop - restart capabilities. However, the current state of the art outlines that the standard fuels (mainly based on a hydrocarbonic polymer) suffer a low regression rate which induces complex grain shapes and low loading ratio for high thrust applications. In order to achieve advanced fuels and to acquire a better knowledge, the Operative Research Project on Hybrid Engine in Europe (ORPHEE) was conducted from 2009 to end 2011, on the cooperation of nine partners (SME, Astrium SAS and Astrium GmbH, Avio, Onera, DLR, Politecnico di Milano, University of Naples, University Polytechnic of Bucharest, Thyia), and supported by funding from the European Commission's Seventh Framework Programme (FP7/2007-2013). The overall logic of this project was devoted to increase the readiness of advanced fuels from a TRL1 to TRL2-3 and propose a coherent approach dealing with promising applications identification, mathematical models building, demonstrators and test bench designs, and technological roadmap definition.

A first study aimed to select potential interesting fuels by characterising the fuel composition and its combustion at small scale. A specific task was devoted to the scaling up of these compositions in order to manufacture 7kg weight grains. One focused on the process of metallic powders addition and the verification of the grains integrity and homogeneity. The obtained fuel grains were fired by using gaseous oxygen. Accurate study of test results allowed describing the regression rate evolution in function of global mass flux and geometric shape of the grain and gave experimental data for numerical tools validation. More specifically, these tests provided information on the aptitude of metallic powders to increase the regression rate at medium scale. It is observed that their effect is much less important than it was demonstrated at small scale.

Based on these results, two preliminary road-maps have been built by the ORPHEE partners. They address suitable hybrid propulsion demonstrators that are dedicated to space applications (selected through a market survey and system analysis). Technological needs in term of development and associated time periods are presented to achieve a TRL of 6 for the two demonstrators.