SPACE PROPULSION SYMPOSIUM (C4)
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EARLY STUDIES AND FIRE TESTS OF A GREEN LIQUID APOGEE ENGINE BASED ON DECOMPOSITION OF 98% HYDROGEN PEROXIDE

Abstract

The paper presents theoretical study, design and test campaign of a staged combustion liquid rocket engine using 98% hydrogen peroxide HTP-class (High Test Peroxide) as oxidizer. The engine was designed for 500 N in vacuum which is consistent with LAE (Liquid Apogee Engine) class thrusters. The staged combustion is understood as prior catalytic decomposition of the oxidizer (first stage) which flows into the combustion chamber in gaseous phase, mixes and burns with a liquid fuel (second stage).

The subject of the investigation consists of a wide range of issues including: analysis of existing LAE engines, definition of the concept, "green" fuel selection by a trade-off analysis, design, integration and fire tests of the thruster. The engine was designed in a modular manner. Two main interchangeable components were applied: catalyst chamber integrated with a gaseous oxidizer/liquid fuel injector and a combustion chamber. The catalyst bed decomposing hydrogen peroxide was investigated and optimized (by means of its geometry and configuration) in the framework of an earlier activity and used as input to the thruster design.

The test campaign was divided into two parts. The first part consisted of ignition and combustion tests with various oxidizer/fuel injection concepts. Tests lasting 1.5 and 2 seconds of combustion were performed. Test results confirmed that one of these injectors (the winner) provided over 91% of C* (characteristic velocity) efficiency.

The second part of the test campaign was dedicated to the experimental optimization of the combustion chamber length. The main criterion for the optimization was the thruster performance. Three chamber lengths were investigated, each test lasted 2.5 second. This limitation resulted from thermal constrains of material from which combustion chambers were made (AISI 316L). Results confirmed that the proper range of chamber lengths was designed and tested since the optimum C* efficiency has been determined.

Current research has proved that the concept is promising for further development. Future work including 10 second tests and steady state operation (using high temperature material for the combustion chamber) have been planned.