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Title

Optical investigation of paraffin-based fuel combustion in a hybrid rocket slab burner

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Abstract

A hybrid rocket slab burner has been recently developed at Université Libre de Bruxelles, to increase the research capabilities of the department and to work in synergy with the main 1kN Hybrid Rocket Engine (HRE). The design of the test facility, named MOUETTE (*Moteur OptiqUe pour ÉTudier et Tester Ergols hybrides*), has been evaluated during a preliminary commissioning test campaign [1]. The main design driver behind the development was the conception of a small combustion chamber that could be used to preliminary investigate the performance of solid fuels before investing in a commercial-scale HRE test. The slab burner uses gaseous oxygen as oxidizer and has been designed to sustain an operative pressure of 10 bar for 10 seconds of burn time. The operating conditions can be modified by adjusting the throat area of the exhaust nozzle or the oxidizer mass flow rate through a calibrated orifice. The slab burner has been subsequently exploited to analyze the effect of metallic and non-metallic additives on the performance of paraffin-based fuels [2] and to evaluate the effect of stepped geometries on the regression rate characteristics of slabs [3].
The main advantage of a slab burner over a conventional HRE is the possibility of integrating optical accesses in the test facility, which can be used to investigate experimentally the internal ballistics of the solid fuel combustion. For this purpose, MOUETTE is fitted with two quartz glass windows, that allow to record of high-speed video of the combustion and perform analysis using chemiluminescence or schlieren techniques.
In this paper, the results of a new experimental campaign based on paraffin-based fuel grains will be presented, where the optical access capabilities of the test facility will be fully exploited. After describing the modifications and improvements over the test setup and an overview of the test campaign results, optical images of the solid fuel slab combustion will be presented, acquired using a high-speed camera, to evaluate the intensity and the height of the flame at different combustion chamber pressure and gaseous oxidizer mass flux. The main objective of the research is to extend the correlation between the experimentally measured regression rate with the features of the flame which can be evaluated only through the advantage given by an optical access to the combustion chamber.

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