Aerospace Europe Conference 2023
Joint 10th EUCASS – 9th CEAS Conference

Abstract #XXX *(to be filled by the organizers)*
Preferred Topics: PROPHY
Corresponding author: PALACZ Tomasz
e-mail of corresponding author: palacz@agh.edu.pl
Type: Oral
Status of corresponding author: Student
For student corresponding author: student member of one of the following:
3AF / AAAR / AIAE / AIDAA / CzAeS / DGLR / FTF / NVvL / PSAA / RAeS / SVFW / EUROAVIA

Title

Preliminary testing and analysis of the end-burning swirling flow hybrid rocket engine using torch igniter

Authors

Tomasz PALACZ [1], Jacek Cieślik [2]*

** Corresponding author*
[1] AGH University of Science and Technology, Al. Mickiewicza 30, 30-059 Cracow, Poland, palacz@agh.edu.pl
[2] AGH University of Science and Technology, Al. Mickiewicza 30, 30-059 Cracow, Poland

Abstract

In recent years, there has been growing interest in satellites' commercial and scientific use, especially in the smallsat segment (< 500 kg). The fast development of small satellites in large numbers resulted in high demand for dedicated propulsion systems to perform various maneuvers such as orbit change, constellation deployment, station-keeping, formation flying, CAMs, or attitude control. Miniaturized electric thrusters enable high-performance, low-thrust maneuvers, but traditional chemical propulsion cannot be easily adapted for small satellites' needs. The major requirements are to be green, safe, reliable, low-cost, and, simultaneously, have high performance. Hybrid rocket engines, usually used for sounding rockets, may offer these benefits.

An end-burning hybrid rocket engine is a concept first proposed by Rice et al. [1], in which the fuel disk is placed on top of the combustion chamber, while the oxidizer is injected tangentially to create a so-called vortex flow field or swirling flow. The exposed fuel area is kept constant throughout the burn, which should translate to the constant thrust and OF ratio in theory. Some variations have been studied by Hayashi et al. [2] and Paravan et al. [3]. A significant amount of work has been done within the HYPROGEO project, whose goal was to develop a constant 250 N thrust, long-burn hybrid engine using an end-burning, swirling-flow design [4]. Different ignition methods have been used, such as pyrotechnic, torch ignition, or catalytic decomposition.

In this paper, we develop the 20 N end-burning, swirling-flow hybrid rocket engine to study ignition, internal dynamics, and thermal aspects of the thruster. The thruster uses nitrous oxide and low-regression rate polymer fuel, which can be readily used in space. The results provide useful information for designing and developing the hybrid rocket engine for space applications.

References

[1] E. E. Rice, M. J. Chiaverini, C. P. St. Clair, W. H. Knuth, and R. J. Gustafson, "Mars ISRU CO/O2 hybrid engine development status," *38th Aerosp. Sci. Meet. Exhib.*, no. c, 2000, doi: 10.2514/6.2000-1066.
[2] D. Hayashi and T. Sakurai, "A Fundamental Study of An End - Burning Swirling - Flow," in *51st AIAA/SAE/ASEE Joint Propulsion Conference*, 2015, pp. 1–8.
[3] C. Paravan, J. Glowacki, S. Carlotti, F. Maggi, and L. Galfetti, "Vortex combustion in a hybrid rocket motor," *52nd AIAA/SAE/ASEE Jt. Propuls. Conf. 2016*, pp. 1–21, 2016, doi: 10.2514/6.2016-4562.

[4] J. Y. Lestrade, J. Anthoine, A. J. Musker, and A. Lecossais, "Experimental demonstration of an end-burning swirling flow hybrid rocket engine," *Aerosp. Sci. Technol.*, vol. 92, pp. 1–8, 2019, doi: 10.1016/j.ast.2019.05.057.