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# SUSTAINABLE SPACECRAFT PROPULSION: A 1N THRUST-LEVEL BI-PROPELLANT THRUSTER UTILIZING NITROUS OXIDE

**Abstract**

The rapid expansion of the space market within the framework of the New Space Economy necessitates high-performance and cost-effective chemical propulsion systems that utilize low-toxicity and storable propellants. This requirement has propelled FOTEC's efforts in developing a system capable of meeting these demands.

The propulsion system discussed in this paper is a 1N bi-propellant thruster that uses nitrous oxide (N2O) as the oxidizer, with investigations into two different fuels: ethane (C2H6) and propylene (C3H6). The primary objective of the project is to research and develop small-scale bi-propellant thrusters for use in satellite systems, owing to their high specific impulse and minimum impulse bit capabilities. Additionally, the goal is to advance the design to a Technology Readiness Level (TRL) 5 through experimental validation in a relevant environment.

The paper provides a detailed discussion on the design and development approach, including the preliminary design of critical sub-components of the thruster and design optimization through combustion CFD simulations. Given the high combustion temperatures in bi-propellant thrusters, special attention is given to predicting wall temperatures. Two technical solutions are explored to maximize the thruster's single burn capability without causing overheating: the first involves the use of refractory material composites with an iridium liner for the combustion chamber and nozzle, and the second involves the imple-

mentation of a regenerative cooling system. The paper also examines the high-temperature materials and manufacturing techniques employed to produce the thruster.

The prototype thruster underwent testing at FOTEC's propulsion laboratories. The test facility, having proven its reliability in the development of monopropellant thrusters with comparable thrust values, required only minor modifications to accommodate and test the innovative thruster. Testing activities focused on vacuum hot fire testing, evaluating both steady state and pulse firing modes for characterizing the thruster in terms of specific impulse, minimum impulse bit, throughput, thrust variation, and combustion stability.

Preliminary testing has shown promising results and indicates potential for the development of a complete propulsion system. The data collected serves as a validation for the simulations and is utilized to develop an Engineering model to tackle system-level challenges.

The high flexibility of the propulsion test facility enables the testing of various chemical propulsion thrusters, positioning FOTEC for collaboration with external companies and research institutes and offering testing services.