Paper ID: 70589
oral
student

IAF SPACE PROPULSION SYMPOSIUM (C4)
Solid and Hybrid Propulsion (1) (3)

Author: Mr. Brendan Griffin
Faculty of Engineering, Carleton University, Canada, brendan.griffin@carleton.ca

Mr. August Lear
Faculty of Engineering, Carleton University, Canada, augustlear@live.com
Mr. Simon Golla
Faculty of Engineering, Carleton University, Canada, simongolla@cmail.carleton.ca
Mr. Nykoda Cooper
Faculty of Engineering, Carleton University, Canada, nykocooper@cmail.carleton.ca
Mr. Philip Hagerman
Faculty of Engineering, Carleton University, Canada, philiphagerman@cmail.carleton.ca

DEVELOPMENT OF A STUDENT-DESIGNED SUPERCHARGED HYBRID ROCKET ENGINE TEST STAND

Abstract

This paper discusses the activities of the students of Carleton University's CU InSpace undergraduate rocket engineering team pertaining to the development, testing, and construction of a paraffin wax - nitrous oxide hybrid rocket engine test stand. This rocket engine test stand is used to measure and verify thrust, combustion performance, and propellant feed system conditions prior to the assembly and launch of the integrated engine and launch vehicle. The test stand under development is designed to be safer than traditional designs used for nitrous oxide. Traditional nitrous-oxide test stands use the convenient self-pressurizing properties of the nitrous oxide vapour to reduce complexity of the test stand and to minimize flight vehicle weight. The addition of supercharging and pressurization gases such as helium or nitrogen to an already self-pressurizing propellant allows for potential performance increases due to the possibility of using subcooled propellants. It also decreases the probability of rapid unintended decomposition of the vapour within the propellant tanks, allows for tighter control of upstream conditions of the propellant feed system without the dangers associated with gaseous nitrous oxide. Finally, it allows for potential uprating of the vehicle's thrust by using upstream pressures higher than the vapour pressure of nitrous oxide at ambient temperatures. Design of the test stand includes both the modelling of the propellant flows throughout the system and modelling of test stand structural components. The data acquisition systems are then carefully planned to ensure the students have all required data when performing tests of the feed system and rocket engine. Fluid system components are accepted via system simulations that verify nominal pressures, flowrates, and temperatures through the components. These are then physically tested to verify theoretical simulations. The development of this rocket engine test stand allows the students of CU InSpace to develop, test, and fly Carleton University's first undergraduate student-made rocket engine. The proposed rocket engine is expected to produce an average thrust of 3.8 kN, with the possibility of increasing the thrust given nitrous oxide density improvements and the uprating of the maximum pressure of the system to higher than the originally designed 6.9 MPa (1000 psi). Successful development of this rocket engine test stand opens the possibility for subsequent hybrid and liquid rocket engine development, allowing the students of Carleton University to take on more ambitious and exciting rocket propulsion projects in the future.