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AQUASONIC II – HYBRID PROPULSION ANALYSIS FOR 3D-PRINTED FUEL GRAINS

Abstract

The AQUASONIC II project is aimed to develop a sounding rocket based on a hybrid propulsion system using the propellant combination nitrous oxide and a 3D-printed fuel grain. It takes place in the frame of the STERN 2 (Student Experimental Rockets) programme founded by the German Space Agency (DLR) in order to promote students in the area of launch vehicles. Main element of the project is the AQUASONIC II rocket, which shall reach a flight altitude at least 6 km and a velocity of MACH 1. All major activities like design, manufacturing, verification and, finally, the launch campaign will be performed by students. The rocket shall be launched at Esrange Space Centre (Sweden) in 2019. Thus, students are able to apply their skills and knowledge to a real project like it is conducted by the space industry or research organisations. The AQUASONIC II project is driven by the experience and knowledge of the AQUASONIC project. The propellant combination was nitrous oxide as oxidizer and polyethylene with high density as fuel. One focus for AQUASONIC II lies on the design of an improved fuel grain to increase the performance as well as the efficiency of the rocket motor compared to the previous design of AQUASONIC. Particularly with respect to the desired performance increase, a free form fuel grain will be an ideal solution. Fuel grains based on different 3D-printable plastic materials such as ABS, PLA, PP and PE are investigated, since the conventional manufacturing of the fuel grain imposes too much restrictions in possible geometry. Also, the thrust over burn time will be adapted by the inner fuel grain geometry together with an appropriate oxidizer injection geometry. Currently, with different test campaigns with a scaled laboratory rocket engine are ongoing to check, which type of plastic material will be the best fuel grain material for the AQUASONIC II mission profile. The overall concept together with the results of the fuel grain test campaigns will be presented and discussed.