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SPACE PROPULSION SYMPOSIUM (C4)
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DEVELOPMENT OF A SOLID ROCKET MOTOR FOR THE STRATOS II ROCKET

Abstract

In March 2009 the Delft Aerospace Rocket Engineering (DARE) student society broke the European altitude record for amateur rocketry with the Stratos rocket, which reached an apogee of 12,2km above the launch pad. Since then, DARE has set a new challenge: to launch a student-built rocket with 15 kg of payload half way to space, to an apogee of 50km. In order to achieve this, a new solid propellant needs to be formulated, and a motor needs to be designed and tested around the propellant. The propellant development consisted of a theoretical study followed by a series of practical experimentations and iterations, which resulted in an Ammonium nitrate-Aluminium based propellant termed Alan-7. This process is described in [Olthof et al, 2010] and [Olthof et al, 2011]. A high-performance (Isp = 200s, SL ISA), relatively safe and inexpensive, easily manufacturable, and environmentally-friendly propellant was obtained. The next step is to develop the solid propulsion system that will propel the Stratos II rocket to the target altitude. The Stratos II solid propulsion system consists of two identical-motor stages with a total impulse of 70kNs each. This paper describes the steps taken towards the production of this motor, starting from the finalizing of the propellant formulation. Firstly, a detailed investigation of the performance and characteristics of the propellant in a complete motor is performed. To this end, a small-scale, re-usable Ballistics/Materials Evaluation Motor (BEM)is developed. The flexible design allows for the investigation of the ballistic properties of the propellant and the use of different types of lightweight composite materials and manufacturing processes. Secondly, the propellant is certified by an independent certification bureau for production in large quantities and transportation. Thirdly, a manufacturing process for the propellant is developed. The method used for manufacturing propellant for small-scale tests is not suitable for this, as for a full-scale motor, 35kg of propellant is produced at a time. Following this, the full-scale motor is designed and manufactured. The ballistic behavior is predicted by means of an in-house developed finite-element method. For the material selection and manufacturing processes, the results gained in the BEM tests are used. With this motor successfully tested on the ground, DARE will have developed the propulsive means to bring the Stratos II rocket to the target altitude of 50 km.