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SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Small Launchers: Concepts and Operations (7)

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THE INFINITE STAGING ROCKET–FIRST STEP TO REALIZATION

Abstract

The goal of the project is the development of a small flying rocket, the combustible case of which is

used as its main propellant. It is presumed that the rocket consists of three main parts: (1) a payload and electronics bay, (2) an engine element, and (3) the fuel-oxidizer element, consisting of a polymeric hydrocarbon shell filled with solid oxidizer. The engine-propellant system length is variable: the engine element moves along the case by means of its own thrust, as propellant is consumed. The rocket does not have any special propellant tank structure and uses one engine element during all stages of its flight. Thus, the well-known mass and cost limitations for the maximal number of rocket stages can be overcome and their number can be considered as infinite. Such an infinite-staging rocket has an extremely simple structure; there is no complicated feed system, as the gasified propellant is fed into the engine by means of inertial forces. Theoretically, this makes dedicated launches for nano- and picosatellites feasible, by means of small and cheap launch vehicles with an initial mass of several hundred kilograms. As this is beyond the possibilities of modern technology, the infinite-staging rocket can open attractive prospects of access to space for small/amateur teams or individuals.

The first stage of the project was carried out at Dniepropetrovsk National University (Ukraine), City University London and the University of Hertfordshire (the UK), Delft Aerospace Rocket Engineering and Delft University of Technology (the Netherlands). The main goal of this stage was the development and testing of the infinite-staging rocket engine lab-scale models. The direct feed gasification chambers, intended for gasifying coaxial propellant rods, have been tested successfully for the first time. The rods with a 20mm diameter consisted of a polyethylene outer shell filled with solid oxidizer. Potassium nitrate, ammonium perchlorate, and potassium perchlorate were tested as oxidizers. The tests brought to light several distinctive features of the engine operation. The analysis of the test results led to a new enhanced design of the engine equipped with a reverse-feed gasification chamber.

The paper presents experimental results and schematics of the engines. The next stage of the project is discussed as well.