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AUTOPHAGE NANOLAUNCHER - A SOLID SSTO LAUNCH VEHICLE

Abstract

One of the problems in developing smaller launch vehicles is the weak scalability of modern rocket technology: the smaller the launch vehicle, the larger the structural mass fraction becomes, until the payload fraction is reduced to zero. The smallest feasible vehicle, with conventional concepts, is about 1 tonne of initial mass. To lower this limit, an autophage (self-consuming) rocket, which consumes its own structure for propellant, is proposed. This paper presents the conceptual design of an autophage nanolauncher, along with our recent progress in testing lab-scale autophage motors.

The body of an autophage nanolauncher is a tube of solid fuel (polypropylene with fine metal or metal hydride powder), filled with a solid oxidizer (ammonium perchlorate). During flight the inertia of the propellant column feeds it into the engine, where the propellant components are gasified and injected into a combustion chamber through a series of valves.

According to our experiments, the feeding rate of autophage engines depends on the feeding force, and this in turn affects the throttle setting. However, in practice, the mass of the vehicle would gradually decrease, which would cause a gradual decrease in its inertially-driven feed rate and throttle setting. In fact, the rocket would fly at a constant g-loading, while its length would decrease logarithmically.

To compensate for the changing atmospheric pressure, the launch vehicle is equipped with an aerospike. The aerospike also helps to maintain pressure in the combustion pressure as the throttle setting is reduced. This is achieved by retracting the back of the vehicle, which reduces the nozzle annulus around the base of the aerospike itself.

The advantages of the autophage, SSTO, solid launch vehicle are: (1) no stage impact areas, (2) no costly turbines and pumps, (3) safe storage, transportation and assembling of solid propellant with separated oxidizer and fuel, and (4) constant low g-loading, which is favorable for satellites with fragile instruments.

Such a launch vehicle has a relatively low mass fraction of payload, about 0.5% of its initial mass, in contrast to the typical 1.5-3% for larger, modern launch vehicles of conventional design. However, scaling makes small conventional launch vehicles impossible, but has only a weak influence on 'caseless' autophage structures. This means that the autophage vehicle can yield a much smaller and more responsive vehicle.