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UPDATES ON THE DEVELOPMENT OF A WATER ELECTROLYSIS PROPULSION SYSTEM

Abstract

An update on the development of the propulsion system based on water electrolysis is given, which is being developed at university of Stuttgart in cooperation with ArianeGroup, Lampoldshausen. The propulsion system makes use of the green propellant water, which is easy to store and poses no harm while handling or launch. Water is being decomposed via electrolysis, once the spacecraft is on orbit, to generate highly pressurized hydrogen and oxygen. These gases are stored in separate gas tanks until recombined in a one Newton bipropellant thruster engine. Compared to conventionally used propellants like hydrazine and its derivatives, water has many advantages: It is non-toxic, easy to handle, low-cost and offers high Isp in its decomposed state. Shipping of and working on an already fuelled spacecraft reduces integration complexity and cost. The propulsion system comprises a low-pressure water tank, an electrolysis unit, capable of generating highly pressurized and dry gases, as well as gas storage tanks and a thruster. Conventional, earth-bound electrolysis systems have no need for drying the gases, but for thruster applications, any water in the gas should be avoided for combustion process and to prevent clogging of propellant lines. Drying of the gases and pressurization shall occur passively, so there is no need for pumps or centrifuges. An electrolyzer has been developed which is able to generate highly pressurized and relatively dry gases, without water droplets in zero-g environment. A thruster running on stoichiometric mixture ratio of the gases delivered by electrolysis has been developed and characterized. The thruster is ignited by a platinum catalyst and therefore does not require a spark plug with high voltage. A non-premixed ignition takes place, since only hydrogen is fed through the catalyst, while oxygen is being injected into the combustion chamber. This protects the catalyst from high combustion temperatures expected at stoichiometric mixture ratio. The experimental outcome including thrust measurements will be discussed in this paper.

Synergies with the power supply system of a spacecraft offers advantages with respect to mass and energy density when combined with a fuel cell. Highly pressurized hydrogen has higher gravimetric energy density than conventional lithium batteries. Additionally, synergy with the life support system is imaginable to use excess oxygen as breathing gas. In situ propellant generation by electrolysis, where water is available, increases payload mass and offers new possibilities for future exploration missions.