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Author: Mr. Seungho Lee
Korea Advanced Institute of Science and Technology (KAIST), Korea, Republic of, myshlee520@kaist.ac.kr

Mr. Wonjae Yoon
Space Solutions Co. LTD, Korea, Republic of, wjyoon@spacesolutions.co.kr
Prof. Sejin Kwon
Korea Advanced Institute of Science and Technology (KAIST), Korea, Republic of, trumpet@kaist.ac.kr

DESIGN OF CUBESAT PROPULSION SYSTEM USING HYDROGEN PEROXIDE MONOPROPELLANT THRUSTER

Abstract

Recently, CubeSat and related propulsion system have been growing rapidly around the world. However, the localization of CubeSat propulsion system in Republic of Korea is significantly slow. Therefore, the research about design of CubeSat propulsion system using hydrogen peroxide monopropellant thruster based on KAIST Rocket lab. was conducted. The research was divided into the two steps: the miniaturization of the thruster and the design of the propulsion system. The key elements of the miniaturization of the thruster are the catalyst with the large surface area per unit volume, the high stiffness, and the high heat resistance, the slenderness ratio of the catalyst bed with the upper limit of the propellant residence time, and the high temperature of the combustion chamber without the heater to emphasize the cold startability of hydrogen peroxide. By considering these points, hydrogen peroxide monopropellant thruster with the target thrust of 0.25N was fabricated. The specifications was as follows: 90wt.% hydrogen peroxide as the propellant, 16-20mesh MnO2/La/Al2O3 as the catalyst, 5bar as the combustion chamber pressure, 0.7 as the discharge coefficient, 0.377g/s/cm3 as the catalyst capacity, and 5.3 as the slenderness ratio of the catalyst bed. The experimental results were as follows: 6.978bar as the pre-injector pressure, 0.256g/s as the mass flow rate of hydrogen peroxide, 5.007bar as the combustion chamber pressure, 481.469'C as the combustion chamber temperature, 0.980 as the characteristic velocity efficiency, and 0.637 as the thermal efficiency. The requirements of the design of the propulsion system were as follows: 1U as the size, the controllability of the attitude over 2 axis and the orbit, the duplication of the valves between the pressure tank and the thrusters for the safety, the isolation from the other systems, and the maximization of the performance about the minimum impulse bit, the total impulse, and the velocity increment. Hence, by considering the miniaturization of the components, the minimization of the number of the components, and the blow down type propulsion system, the propulsion system consists of the pressurant and propellant filling and purging special valves, the diaphragm or piston type pressure tank, the propellant supplying solenoid valve, and the 4 parallel thrusters with the individual solenoid valves. The velocity increment was calculated as tens of m/s, so the phasing maneuver from the sun synchronous orbit to change the true anomaly and the right ascension of ascending node due to J2 perturbation are expected to be achievable.