SPACE PROPULSION SYMPOSIUM (C4)
Propulsion Technology (3)

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DEVELOPMENT OF A NITROUS OXIDE MONOPROPELLANT MICRO-THRUSTER AT BUAA: 2010

Abstract

Nitrous oxide (N2O) is suggested to be a potential monopropellant for micro-thruster applied in micro-spacecrafts as a result of its special properties, such as non-toxicity, self-pressurization, and self-sustaining reaction. It has drawn great interests from universities due to the low cost and little hazard in handling. Beihang University (BUAA) has been dedicated in developing a sub-Newton N2O thruster since 2005. After building vacuum experiment system and carrying out thrust measuring for two types of sub-Newton N2O monopropellant thrusters in 2009, the latest research was targeted on lowering the preheating power as well as measuring the activation temperature, life-span, and impulse magnitude of the thruster. Activation experiments and long-term hot-firing experiments were conducted using the former thruster structures to evaluate the activation performance and life-span. The experiment results indicate that a lower activation temperature and longer life-span can be attained by reducing the loading factor of catalyst-bed, whereas the reaction temperature decreases at the same time. Since the influence of loading factor on three performance parameters (namely activation temperature, reaction temperature and life-span) conflict, trade-off must be conducted when setting the N2O mass flow rate for operation. Based on the analysis of preheating process of the N2O monopropellant thruster and the characteristics of the N2O decomposition reaction in the catalyst-bed, a novel thruster employing an inner-heater was designed and fabricated. By shifting heater from the outer wall of reaction chamber into the catalyst-bed, the preheating efficiency of the heater was promoted observably. The preheating power consumption of the thruster was thus reduced to around 10W. Vacuum-thrust measuring tests were carried out for such a thruster with an inner-heater. Static vacuum thrusts ranging from around 320mN to 490mN were attained with the flow rates altering from around 0.2 g/s to 0.32 g/s, and the corresponding specific impulses were around 160s. A long-term hot-firing test longer than 12000s was also implemented with a loading factor of 2.45 kg/m2•s. In addition, the pulsed operation performance of the inner-preheating thruster was studied by means of measuring chamber pressure. Impulses with different magnitudes were produced by adjusting the opening duration of the control valve. The minimum impulse was around 60 mN•s. Future work will be aimed at studying the detailed process of the flow and reaction mechanism of N2O in the catalyst-bed, as well as the heat-transfer process between the decomposition products and the catalyst-bed.