SPACE PROPULSION SYMPOSIUM (C4)
Electric Propulsion (4)

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DEVELOPMENT OF ELECTRICAL PROPULSION FEED SYSTEMS FOR SMALL SATELLITE STSAT-3

Abstract

Science and Technology Satellite 3(STSAT-3) is being developed and will be launched in 2010 in Korea, that is the first whole- structure composite small satellite equipped with hall thruster propulsion system(HPS) for the purpose of scientific investigation. The HPS is to get some sort of electrical propulsion by using ionized xenon gas eruption of high-speed thrust

This study is about the development of xenon feeding system (XFS) which delivers xenon gas from storage tank to hall thruster head through piping & valve system. A newly applied advanced technology is the application of hybrid composite propellant storage tank which is advantageous in weight, cost and design robustness. The objective performances of the present ion thruster are weight: <4.2kg, Thrust: >10mN, specific impulse: >1000s, xenon storage tank pressure: 150bar, mass flow rate: 0.7-1mg/s, Power consumption: <300W, propellant: xenon, xenon weight: 2.7kg and etc.

HPS consists of four sub-assemblies such as XFS (xenon feeding system), PCM (propulsion control module), PPM (power processing module), HT (hall thruster). PCM is a module that controls the entire HPS system to implement closed loop control by feed-back flow. PPM supplies constant power to the HPS

Composite tank for storing xenon gas is composed of hybrid structures of inside aluminum liner with multi-layer stacked carbon fiber reinforced composite materials overlapping the liner. 2L capacity tank and xenon gas is filled to 150bar. Its test data showed that the burst pressure reached up to 1054 bar and outgassing level also satisfies the criteria of TML<1%, CVCM<0.1%.

Enabling to precise flow control of xenon, Moog PFCV(proportional flow control valve) was used that regulates the pressure down from the xenon propellant tank and provides the xenon flows to the anode and cathode. In order to always keep the xenon in super-critical condition (16.7 Centigrade, 58.4bar), temperature and/or pressure should be controlled, however temperature only handled with both thermostat and 10W-heater attached to the tank.

Structure and thermal analyses had performed in the first phase of development, and then after complete the development, environment tests(vibration, thermal-vacuum) and overall system performance tests were conducted. Xenon flow control and each parts performance got satisfactory results. A more detailed test results will be mentioned in the main full paper.

This manuscript includes technical contents and function results of the developed XFS ranging from concept design, manufacturing to function test. Even though there was more or less disturbance in efficiency according to environment conditions, the average operating efficiency of the developed HPS showed to high-efficiency of approximately 38-40%.