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# DEVELOPMENTAL STATUS OF THRUSTER IN MHI (MITSUBISHI HEAVY INDUSTRIES, LTD.)

**Abstract**

MHI has been developing thrusters for satellites and spacecraft since around 1965 and has over 500 products so far. In this paper, we will introduce recent developments status of thrusters. At first, the development of 10N class bipropellant ceramic thruster is reported. We aimed at "high performance", "no operational limitation" and "good availability". Silicon nitride monolithic ceramics are used for the combustion chamber and the nozzle in a ceramic thruster. Silicon nitride is a kind of non-oxidizing ceramic and it has high toughness and the high heat resistance of approximately 1500 degree and it is superior in strength and thermal shock resistance compared with metal. In addition, ceramic chamber doesn't need oxidation resistant coating which is essential to the metal chamber. It means that the ceramic chamber had no life constraints. The specific impulse of continuous firing at nominal pressure achieved nearly 300s which is the highest of the bipropellant thruster in the world. Now the vibration test is ongoing and almost all development will be completed. The second theme is 500N class bipropellant ceramic thruster for SLIM (Smart Lander for Investigating Moon). This thruster is required to the large V in the sequence from rocket separation to lunar landing (insertion of moon transition orbit, launch of lunar orbit, power descent landing, etc.). The stable performance is required over a wide range of thrust because of the blowdown operation. Landing on the moon is performed by pulse operation. Though it is usually used in small thrust thrusters, the realization with a 500 N class orbit change engine faced various issues such as the detonation and the combustion instability. These problems are currently achieved through the qualification test. We will show the current status. The third activity is the Green Propellant Reaction Control System (GPRCS) including HAN-based green propellant thruster. Recently, higher performance, operability improvement for safer handling and cost reduction are required to thrusters for the attitude control of the spacecraft such as rockets, satellites and space probes. MHI has been developing 1N class green propellant thruster that use SHP163, a green hydroxyl ammonium nitrate (HAN)-based propellant that has the potential to achieve higher performance than hydrazine. GPRCS FM is being demonstrated on the orbit.