Paper ID: 83335
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IAF SPACE PROPULSION SYMPOSIUM (C4)
Interactive Presentations - IAF SPACE PROPULSION SYMPOSIUM (IPB)

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IODINE AS A PROPELLANT: 5 YEARS OF SUCCESSFUL USE IN SPACE

Abstract

Iodine has been considered as a viable propellant alternative for the electric propulsion since early 1960s, bringing all the advantages of the solid propellant to the electric propulsion system. The most noticeable benefits are the high storage density and low cost without any pressurization requirements. The propulsion system architecture can be similar to the classical xenon-fed system (including both gridded ion and Hall thrusters), delivering similar performances. Despite all the advantages, implementation of the iodine propulsion systems took multiple decades and required multi-disciplinary studies on plasma physics, material science, chemistry, and extensive engineering effort. The first flight of iodine-fuelled system was performed with a precursor cold gas system I2T5 in 2019, aimed to validate zero-gravity storage and flow control of the sublimating iodine propellant. Shortly after that, in late 2020, a complete iodine-fuelled electric propulsion system NPT30, based on the gridded ion thruster, has been launched onboard a 12U cubesat BeihangKonkshi-1 and performed multiple satellite manoeuvres validating the overall concept and bringing important space data for confirming ground testing results and theoretical models. As of today, 17 systems with iodine propellant have been launched to space onboard various satellites with the mass ranging from about 10 to almost 200 kg, over 40 systems are waiting for the integration, and many more are scheduled to be delivered during the following years with the exponential ramp-up of the production capacity. Despite the general success of iodine propulsion, today it is mastered only by one entity (ThrustMe), while many other research groups and companies including well-established players and start-ups had either failed the in-orbit demonstration or are still on the way of building a flight-ready system. In addition, only the gridded ion thruster technology has reached the successful iodine "conversion". In this work we are trying to analyse the reasons of such high entry bar into the iodine propulsion, and look into constrains of iodine implementation for various electric propulsion concepts, including the most demanded Hall thruster technology.