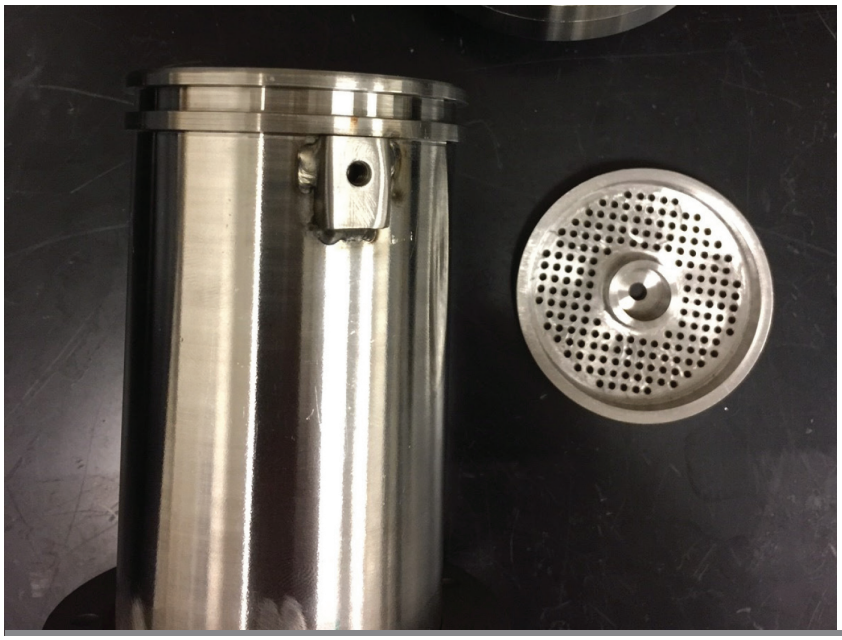

National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Propulsion

Sublimable Propellant Source for Iodine-fed Ion Propulsion System

Enables reliable and robust storage and delivery of iodine propellant to a thruster

NASAs Marshall Research Center has developed a system for generating iodine vapor from solid iodine, for use as a propellant in a Hall or ion thruster propulsion system.

Xenon has generally been the preferred propellant of choice for these spacecraft ion propulsion systems, but more recently iodine-based systems have gained significant attention due to comparable performance to xenon, and the system-level advantages of low storage pressure and higher storage density with more propellant per unit volume. However the solid iodine, in comparison to gaseous xenon, must be sublimated into a vapor for ionization, and a heat source must be used to increase the sublimation rate of the solid iodine to a level that is useful for propulsive purposes. The subject innovation is a spring-loaded mechanism to optimize the contact of the solid iodine with the heated structure in the zero-gravity environment of space.

BENEFITS

- Iodine propellant for ion thrusters offers significant improvements in volume/space efficiency over xenon propellant systems presently in use today.
- The propellant can be stored in its solid state at very low pressure, whereas xenon must be stored in a compressed gas state at high pressure requiring additional tankage structure to contain the gas.
- The technology has been the subject of considerable research effort and investment, and is nearing readiness for flight testing.

THE TECHNOLOGY

NASAs iodine vapor feed system is based on a mechanism that holds and maintains the solid iodine is contact with a heated surface, in this case the walls of the propellant tank. The mechanism provides a robust and reliable steady-state delivery of sublimated iodine vapor to the ion propulsion system by ensuring good thermal contact between the solid iodine and the tank walls.

To date, the technology development effort includes extensive thermal, mechanical and flow modelling together with testing of components and subsystems required to feed iodine propellant to a 200-W Hall thruster. The feed system has been designed to use materials that are resistant to the highly-reactive nature of iodine propellant. Dynamic modeling indicates that the feed system tubing can be built is such a way as to reduce vibrationally-induced stresses that occur during launch. Thermal modeling has been performed to demonstrate that the feed system heater power levels are sufficient to heat the tank and propellant lines to operating temperatures, and sublime the iodine in the storage tank to supply propellant for reliable and long-term operation.

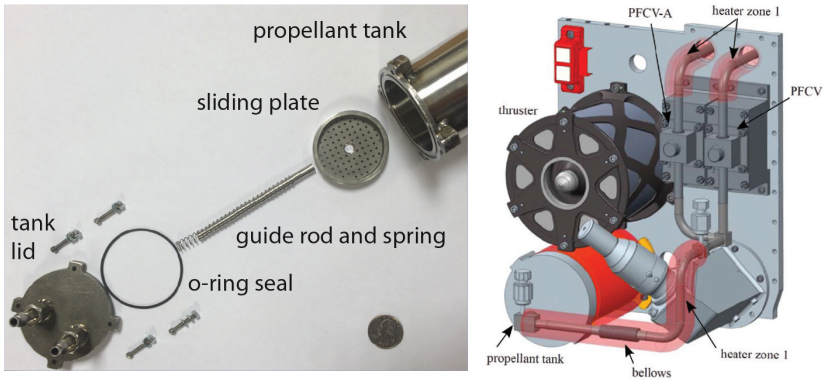

FIGURE Exploded view of the laboratory model propellant tank.

APPLICATIONS

The technology has several potential applications:

- Applications include the development of, and use of, iodine-based ion thruster propulsion systems. These advanced propulsion systems can be used in government sponsored deep-space missions, as well as in commercial and government orbital satellite applications where size and safety are of paramount interest.

PUBLICATIONS

Patent No: 10,399,708

KA Polzin, JF Seixal, SL Mauro, AO Burt, A Martinez, AK Martin, The iodine Satellite (iSat) Propellant Feed System - Design and Development, in 35th International Electric Propulsion Conference, Atlanta, GA, Oct. 8-12, 2017. IEPC Paper 2017-11

Kurt A. Polzin, Steven R. Peeples, Armando Martinez, Joao F. Seixal, Stephanie Mauro, Adam O. Burt, and James L. Myers. "Engineering Model Propellant Feed System Development for an Iodine Hall Thruster Demonstration Mission", 52nd AIAA/SAE/ASEE Joint Propulsion Conference, AIAA Propulsion and Energy Forum, (AIAA 2016-4730)

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