Recovering Residual Xenon Propellant for an Ion Propulsion System

Most of the otherwise unusable xenon is recovered.

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Future nuclear-powered Ion-Propulsion-System-propelled spacecraft such as Jupiter Icy Moon Orbiter (JIMO) will carry more than 10,000 kg of xenon propellant. Typically, a small percentage of this propellant cannot be used towards the end of the mission because of the pressure drop requirements for maintaining flow. For large missions such as JIMO, this could easily translate to over 250 kg of unusable xenon.

A proposed system, the Xenon Recovery System (XRS), for recovering almost all of the xenon remaining in the tank, would include a cryopump in the form of a condenser/evaporator that would be alternatively cooled by a radiator, then heated electrically. When the pressure of the xenon in the tank falls below 0.7 MPa (100 psia), the previously isolated XRS will be brought online and the gas from the tank would enter the cryopump that is initially cooled to a temperature below saturation temperature of xenon. This causes xenon liquefaction and further cryopumping from the tank till the cryopump is full of liquid xenon. At this point, the cryopump is heated electrically by small heaters (70 to 80 W) to evaporate the liquid that is collected as high-pressure gas (<7 MPa; 1,000 psia) in an intermediate accumulator. Check valves between the tank and the XRS prevent the reverse flow of xenon during the heating cycle. The accumulator serves as the high-pressure source of xenon gas to the Xenon Feed System (XFS) downstream of the XRS. This cycle is repeated till almost all the xenon is recovered. Currently, this system is being baselined for JIMO.

This work was done by Gani Ganapathi, P. Shakkottai, and Jiunn Jenq Wu of Caltech for NASA’s Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

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A Proposed Xenon Recovery System promises to reduce waste of valuable cargo space on distant missions.

This work was done by Nathan Thomas, John F. Doyle, Andy Kurk, John C. Vellinger, and Paul Todd of Space Hardware Optimization Technology, Inc., for Johnson Space Center.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

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