

Title: Liquid Acquisition Devices for Advanced In-Space Cryogenic Propulsion Systems

Speaker: Dr. Jason Hartwig/NASA Glenn

The enabling of all future in-space cryogenic engines and cryogenic fuel depots for future manned and robotic space exploration missions begins with technology development of advanced cryogenic fluid management systems upstream in the propellant tank. Gravity affects many fluidic processes, such as the separation of the liquid and vapor phases within the propellant tank. By design, all in-space cryogenic engines and cryogenic fuel depots require vapor free liquid delivery. To meet these fluid transfer requirements over a wide range of mission flow rates, gravitational and thermal environments, propellant management devices, particularly, porous metallic screen channel liquid acquisition devices (LADs), will be required to favorably position liquid and vapor within the tank.

This talk will present recent technology development, testing, and modeling of cryogenic screen channel LADs, drawing from Hartwig's recently published book. A historical perspective is first given to understand the purpose and need for LADs and to present recent flight PMD applications. Then models are developed and presented for the influential factors which govern cryogenic porous screen channel LAD performance, which include bubble point pressure, flow-through-screen pressure drop, wicking rate, and screen compliance. Next, the numerical flow model is presented where the Navier-Stokes equations are solved for flow through the porous LAD channel. Lastly, the models are used to determine the optimal LAD screen for a liquid hydrogen fuel depot operating in Low Earth Orbit.