Contribution ID: **34** Type: **Contributed Oral**

M4Or1B-04: Thermal performance of common bulk-fill cryogenic insulation materials in helium and hydrogen background gasses

Thursday 22 May 2025 10:15 (15 minutes)

Maritime shipping of vast quantities of liquid hydrogen (LH2) will be necessary to facilitate a global hydrogen ecosystem; with some studies estimating volumes up to 172,000 m3 for individual tanker ships, and requiring stationary storage tanks at terminals of 50,000 m3 to 100,000 m3—ten to fifteen times larger than the current largest tank, located at launch pad B at NASA Kennedy Space Center (KSC). Such a radical scale-up will push the boundary of traditional, vacuum-insulated tank designs. Hence, a potential need exists for non-vacuum solutions, which necessitates exploring the thermal performance of insulation materials in non-condensable background gasses at LH2 temperatures, namely helium and hydrogen. Testing of two bulk-fill insulation materials common to large LH2 storage tanks, perlite and glass bubbles, in helium and hydrogen was recently conducted by the Cryogenics Test Laboratory at KSC using the Cryostat-100 liquid nitrogen boiloff calorimeter per the ASTM C1774 standard methodology. Effective thermal conductivity (ke) and heat flux (q) results for each insulation/gas combination are presented across the full vacuum range, as well as thermal profiles through the insulation thickness, and estimates of ke and q as a function of temperature between 80 K and 300 K.

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Session Classification: M4Or1B - Hydrogen Technology and Compatible Materials