Contribution ID: **107**

Type: **Invited Oral**

M1Or4B-01: [Invited] Thermal Conductivity of Polymer Aerogels at Different Vacuum Levels for Cryogenic Insulation Applications

Monday 19 May 2025 16:15 (30 minutes)

Effective management of the heat transfer into cryogenic piping and storage reservoirs is accomplished with low thermal conductivity insulation systems. Polymer aerogels are renowned for their low density, high mesoporosity, high internal surface area, low thermal conductivity, mechanically robust structural integrity, and high acoustic impedance. These unique properties present in one material envelope result in an advanced, multi-functional technology ideally suited for space applications. This study focuses on polymeric aerogels fabricated in various structural dimensions while maintaining low thermal conductivity over a wide temperature range, with a focus on cryogenic temperature environments. To measure the thermal conductivity, a NASA Cryostat-400 flat plate comparative boiloff calorimeter is used to measure the thermal conductivity of these materials at residual gas pressures ranging from high vacuum, soft vacuum, and atmospheric pressure. The calorimeter uses the boiloff of liquid nitrogen to measure the heat transfer through the insulation sample. Measurements of thermal conductivity will be between a cold boundary temperature maintained by the liquid nitrogen (80 K) and hot temperature boundary which was at room temperature (290 K). A pressure control system is used to maintain vacuum pressure in the cryostat at different levels using nitrogen as the residual gas. For better understanding of the heat transfer measurement, a numerical model of the system was developed in Python. This model is used to estimate heat flow across the sample to validate the one-dimensional heat flow used for determining thermal conductivity.

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Session Classification: M1Or4B - Insulation & Impregnation Materials: Polymeric Materials