

Faculty of Engineering

Summer Research Program 2023-2024

Project Title: Thermal Design of Cryogenic Physical Property Measurement Systems Relevant to Liquid Hydrogen Storage

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Objective

The main objective of the project is to complete the thermal design of a cryogenic system to measure the thermal conductivity, heat capacity and/or mechanical properties of structural and insulation materials relevant to liquid hydrogen storage.

Project Details

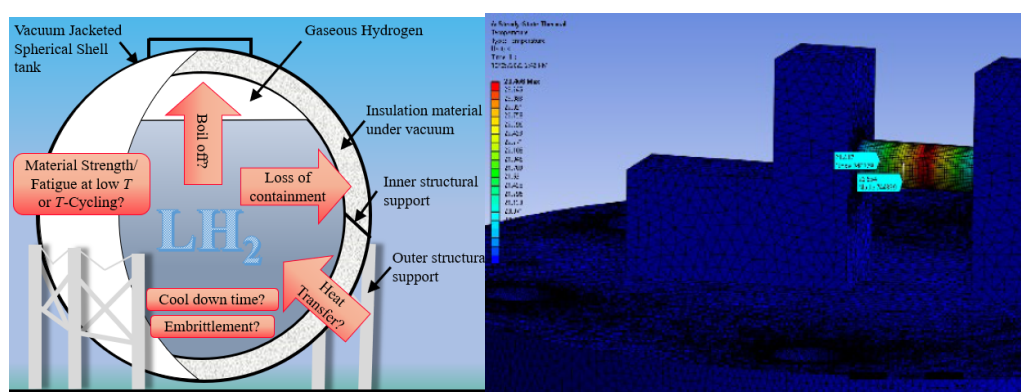


Figure 1, Left: Liquid hydrogen is stored in double walled tanks in which the annulus is filled with bulk insulation material under high vacuum to limit heat transfer. To estimate the liquid hydrogen boil off rate it is necessary to understand the thermophysical properties of the structural and insulation materials. To ensure the integrity of the tank is important to know the mechanical properties of the structural materials. Right: thermal simulation of basic thermal conductivity apparatus.

Hydrogen is an energy vector which offers the potential to decarbonize difficult to electrify sectors like long distance trucking, aviation and shipping. Storage as cryogenic liquid hydrogen (LH₂) offers the advantage of reducing the storage volume by a factor of over 800 while maintaining purity and offering a potentially useful source of cold energy during regasification. However, storage as LH₂ is not without challenges. To liquefy hydrogen, it needs to be cooled and condensed at 20 K (-253 °C). Therefore, to maintain the hydrogen as a liquid and prevent boil-off of the liquid a well-insulate storage tank is needed, typically a double jacketed vacuum tank as illustrated in Fig. 1. The thermal properties of the structural and insulation materials are needed over a wide range of temperature to allow the calculation of the hydrogen boil off rate and the mechanical properties are need to ensure the structural integrity of the tank. In this project the student will investigate the design of instruments and cryostats for measurement of the heat capacity, thermal conductivity and/or mechanical properties of the structural and insulation materials relevant to liquid hydrogen storage. This will involve considering the thermal design of instruments to ensure high quality measurements of these properties and will involve thermal simulations.

Prerequisites

Students of any engineering specialisation with experience in computer aided design (CAD) or finite element analysis (FEA) would be highly desirable.

Additional Information

Applicants may be required to attend an interview