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Dynamic modelling of catalyzed vapor cooled shield for accelerated chill down of a liquid hydrogen tank during refilling.

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Liquid hydrogen is a promising vector for long distance clean energy distribution through shipping. The rapid onloading and offloading times necessary for liquid hydrogen export and the need for regular tank inspections require tanks to be warmed up and chilled down quickly and efficiently. For large tanks utilizing evacuated powder insulation, this can be a slow process due to the low thermal diffusivity of insulation materials [1, 2]. Concepts for vapour cooled shields (VCS) have been proposed in the literature for reducing steady state heat transfer for cryogenic storage in the order of 30 to 70% [3, 4]. However, a VCS could serve to provide a faster chill-down of the tank by passing vapour through channels in the tank annulus. Furthermore, coupling of the VCS with a para-orthohydrogen converter could enhance this process by utilizing the endothermic nature of the spin-isomer catalysis.

This study investigates the transient chill down performance of a proof-of-concept liquid hydrogen storage tank using a VCS. A reduced order heat transfer model was developed in Matlab coupled with a kinetic model for para-orthohydrogen conversion. The rate of tank chill down and the resulting boil-off losses were quantified to assess the feasibility of utilizing a VCS for accelerated liquid hydrogen refilling. The results help frame the path to advance VCS design and optimization for rapid chill down and minimal boil off liquid hydrogen tank refilling.

1. Liebenberg, D.H. and E. Murley, Initial Warmup of 500,000-Gallon Liquid Hydrogen Dewar. 1967, Los Alamos Scientific Laboratory.
2. Liebenberg, D.H., R.W. Stokes, and F.J. Edeskuty. Chilldown and Storage Losses of Large Liquid Hydrogen Storage Dewars. in Advances in Cryogenic Engineering. 1966. Boston, MA: Springer US.
3. Liggett, M.W., Space-based LH2 propellant storage system: subscale ground testing results. Cryogenics, 1993. 33(4): p. 438-442.
4. Shi, C., et al., Performance analysis of vapor-cooled shield insulation integrated with para-ortho hydrogen conversion for liquid hydrogen tanks. International Journal of Hydrogen Energy, 2023. 48(8): p. 3078-3090.

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