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C2Po2B-07: Pressure and boil-off gas management of liquid hydrogen storage onboard maritime carriers for export

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Achieving the targets set out in the 2015 Paris Agreement requires expanding the usage of renewable power generation globally. The cost of renewable energy is highly dependent on location and countries such as Japan are unlikely to have sufficient renewable power capacity to meet their energy demands. Exporting renewable energy in the form of liquid hydrogen is one means to achieve this.

Without active refrigeration, heat leakage into the tank cannot be avoided. Export-scale tanks (40,000 cbm) typically cannot operate significantly above atmospheric pressure (<0.5 bar), requiring venting of vapour. This venting may not coincide with onboard hydrogen consumption for propulsion, leading to a loss of product. The rate of self-pressurisation is highly dependent on convective boundary layer flows within the liquid which forms a thermally stratified layer close to the surface, enhancing evaporation. The development of thermal stratification remains poorly understood at high Rayleigh numbers and non-uniform, non-steady state heat transfer.

The goal of this project is to investigate the development of thermal stratification and pressurisation in export-scale liquid hydrogen storage tanks, with the aim of informing tank design and shipping operations. Using analytical and numerical methods, this study investigates the effect of heat transfer and vapour removal on thermal stratification in the liquid and vapour phases, and the role of sloshing and jet-mixing in inducing condensation.

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