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Measurement of critical heat flux and heat transfer coefficient via quenching experiments in cryogenic fluids.

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The emergence of the liquid hydrogen (LH2) industry promises transformative potential across sectors like energy storage, propulsion, and synthetic fuels. However, the complex thermophysical behaviour of LH_2 —applicable to production, storage, transportation, distribution and end use —requires deeper understanding to enable efficient system design. Some examples include cryogenic phase change dynamics, cool-down times and multiphase heat exchanger performance. A critical aspect is pool boiling and boil off, where Critical Heat Flux (CHF) and Heat Transfer Coefficient (HTC) are highly sensitive to surface-liquid interactions, particularly influenced by surface microstructures. Accurate measurement of CHF and HTC on cryogenically relevant surfaces remains elusive.

This study introduces an Inverse Heat Transfer (IHT) model to calculate HTC and CHF from thermocouple data during quenching with a cryogenic fluid. The methodology is initially validated with a fluorocarbon using transient and steady state test conditions. The technique is then extended to liquid nitrogen and applied to surfaces with different microscale features to determine HTC and CHF. The research provides novel pool boiling measurements of HTC and CHF on cryogenic fluids using different metals and identifies the limitations of using an IHT model with cryogenic fluids.

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