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C1Po1A-09: Impact of wave breaking on heat and mass transfer in a horizontal circular tank under non-isothermal sloshing conditions.

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Liquid sloshing in next generation sub-cooled liquid hydrogen aircraft fuel tanks can induce rapid pressure drops in the ullage space when wave breaking is present. Significant pressure drops can result in problems such as cavitation in cryogenic pumping systems, thrust oscillations in the combustion chamber and structural instabilities on the tank walls. In flight, civilian aircraft are subjected to horizontal and vertical gusts which can induce large accelerations, leading to highly non-linear wave breaking conditions. Consequently, quantifying the pressure drop under different wave breaking conditions is essential to inform remedial measures such as active pressurisation and tank baffles.
This study explores wave breaking at resonance conditions for a range of vertical and horizontal excitations at a constant ullage pressure. A simplified horizontal circular tank has been manufactured for physical modelling, the tank has transparent faces allowing a high-speed camera to capture images of the sloshing dynamics. Two pressure sensors in the ullage space measure the pressure evolution for each test case and a vertical array of temperature sensors quantifies the thermal stratification between the vapour and liquid phases. The fluid HFE 7000 is used as a surrogate working fluid in the liquid and ullage space of the sloshing tank. This experimental research further investigates the effect of breaking waves on the ullage pressure, contributing valuable insights into the sloshing induced pressure drop for aircraft fuel tanks.

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