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A preliminary experimental study on thermal stratification in horizontal cylindrical cryogenic liquid storage vessels

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Thermal stratification is of major concern in the design of cryogenic liquid storage vessels. In closed (isochoric) storage systems, a developing thermal stratification leads to higher pressure increase rates compared with isothermal conditions and therefore to premature boil-off losses. The development of a thermal stratification is a consequence of non-uniform distribution of the heat inleak into and subsequent heat transfer processes inside the storage system. For conventional storage geometries, i.e. vertical cylindrical dewar vessels, the processes and relations inside the fluid are well understood. However, the application of cryogenic liquid hydrogen as an alternative fuel for future sustainable mobility mostly implies the usage of horizontal cylindrical vessels with fixed-floating bearing arrangements. This setup changes the distribution of the entering heat flow and causes a substantially different temperature profile inside the storage vessel. Experimental data on thermal stratification in horizontal cryogenic liquid tanks are not found in literature; data generated by means of simulation are scarce. As a first step for better understanding the thermal stratification in horizontal cylindrical cryogenic storage units, a standard laboratory liquid helium dewar vessel was investigated. For this, the vessel was put in a horizontal position while the temperature distribution at different cross sections of the tank was measured. This paper reports on those preliminary experimental results.

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