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C1Po1B-08 [08]: Experimental study on effect of non-uniform heat flux on self-pressurization and thermal stratification in a ground cryogenic tank

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Simulations on self-pressurization and thermal stratification in cryogenic propellant storage tanks have been widely conducted in the literature. However, for the applications on orbit, the heat flux entering the tank could be non-uniform as the solar radiation angle varies, which may result in deviation of the behavior of pressurization and thermal stratification from regular conditions. That is, the knowledge on uniform heat load situations may not be applicable to practical ones. Moreover, few experimental studies on the non-uniform heating effect are available in the literature. In the present study, a ground experimental system has been established to investigate the self-pressurization and thermal stratification behaviors of liquid nitrogen with various fill-level under non-uniform heat leakage conditions. The comparative heat flux application modes include liquid-wetted-surface heating only, semi-liquid-wetted-surface heating, ullage-wall-surface heating only, semi-ullage-wall-surface heating, semi-liquid-semi-vapor surface heating, and all-liquid-vapor- surface heating. The fill-level of liquid nitrogen ranges from 30% to 90% for each mode. The pressurization rates and the temperature profiles within the liquid and ullage are both recorded and compared. Mechanism of the effects are discussed in perspective of cryogenic fluid convection.

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