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NUMERICAL ANALYSIS OF THE SELF-PRESSURIZATION IN A CRYOGENIC STORAGE TANK

Abstract

Self-pressurization phenomenon is one of the most important problems in the storage of cryogenic liquid. The accurate prediction of pressure rise is necessary for the tank design. A theoretical thermal diffusion model is investigated in the paper by using a lumped mass and energy model in the vapor and a one-dimensional conduction model in the liquid. The validation of the predictive capability is conducted by comparing the predictions with experimental data. Favorable agreement is found for both the experimental cylindrical and oblate spheroidal tanks. The effect of heat load, heat distribution, fill level and tank size is also studied. The influence of reduced gravity on the self-pressurization is carried out by using the CFD software package, Ansys Fluent, and an in-house developed code to calculate the source term associated with the phase change. A heat and mass transfer model is implemented into the Fluent code for solving problems involving evaporation or condensation. This is implemented in User Defined Functions (UDFs) as a mass source for the continuity equation. This numerical study provides benefits in understanding the phase change process under microgravity conditions and gives guidance for pressure control in cryogenic tanks.