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C1Or4A-05: Lumped-element modeling of density wave oscillations in two-phase hydrogen flow

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Density wave oscillations (DWO) are one of the most common instability types in flow boiling systems. In liquid hydrogen (LH2) pipe flow with heat ingress, DWO can cause large fluctuations of temperature, pressure, void fraction, and flow rate, which puts strain on the system and makes LH2 transfer processes unstable. Predicting the onset of these oscillations and the magnitudes is important for designing robust liquid hydrogen fuel lines. In this study, lumped-element modeling of density wave oscillations in two-phase hydrogen flow is undertaken to evaluate the instability threshold and limit-cycle oscillations in a single heated channel with different orientations. Nonlinear time-domain simulations and linearized stability analysis are employed. The variable parameters include initial liquid subcooling, flow rate, and heat supplied to the channel wall. Stability plots using non-dimensional groups relating these parameters and examples of stable and unstable behavior of the system will be presented. The present results can assist developers and operators of liquid hydrogen transfer systems.

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