Direct Computational Simulations for Internal Condensing Flows and Results on Attainability/Stability of Steady Solutions, Their Intrinsic Waviness, and Their Noise Sensitivity

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The paper presents a new two-dimensional computational approach and results for laminar/laminar internal condensing flows. Accurate numerical solutions of the full governing equations are presented for steady and unsteady film condensation flows on a sidewall inside a vertical channel. It is found that exit conditions and noise sensitivity are important. Even for stable steady solutions obtained for nearly incompressible vapor phase flows associated with unconstrained exit conditions, the noise sensitivity to the condensing surface's minuscule transverse vibrations is high. The structure of waves, the underlying characteristics, and the ''growth/damping rates'' for the disturbances are discussed. A resonance condition for high ''growth rates'' is proposed and its efficacy in significantly enhancing wave motion and heat transfer rates is computationally demonstrated. For the unconstrained exit cases, the results make possible a separately reported study of the effects of shear, gravity, and surface tension on noise sensitive stable solutions.