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The effect of noncondensables on the thermocapillary-buoyancy convection in volatile fluids TONGRAN QIN, LAURA ANFINSON, George W. Woodruff School of Mechanical Engineering, Georgia Institute of Technology, Atlanta, GA, ROMAN GRIGORIEV, School of Physics, Georgia Institute of Technology, Atlanta, GA — Convection in a liquid layer with free surface subject to a horizontal temperature gradient is one of the classic problems in fluid mechanics and heat transfer. In thicker layers the flow is driven by a combination of buoyancy and thermocapillarity in the liquid layer. Unlike buoyancy, thermocapillarity depends rather sensitively on the boundary conditions at the liquid-vapor interface. In particular, for volatile fluids, convective patterns are found to vary significantly with the composition of the gas phase. The interfacial temperature which defines thermocapillary stresses is controlled by the variation of the vapor concentration along the interface. At ambient conditions when the gas phase is dominated by air, the latter is found to be controlled by diffusion of vapor in (essentially static) air. At the opposite extreme where vapor dominates, we find that it is the diffusion of air in (quickly moving) vapor that controls the concentration and temperature distribution, leading to significant differences in the flow patterns found in these two limits. These findings show that the results of the studies conducted under atmospheric conditions are not applicable in the (near) absence of noncondensables (air) and resolve the disagreement between previous numerical and experimental results in the vapor-dominated limit.

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