Abstract Submitted
for the DFD08 Meeting of
The American Physical Society

Stationary condensation and draining of a liquid film on a horizontal disk LEONID G. BOLSHINSKIY, UAH, ALEXANDER L. FRENKEL, UA

— On the top of a subcooled horizontal disk, a liquid film condenses from saturated vapor. The liquid is forcedly removed at the disk edge, to which it is conveyed in a radial flow. Stationary regimes of the flow are studied such that (i) gravity is negligible, being eclipsed by capillary forces; (ii) the maximum film thickness is much smaller than the disk radius; and (iii) the slow-flow lubrication approximation is valid. A highly nonlinear differential equation for the film thickness as a function of the radial coordinate is obtained. The (two-dimensional) fields of velocities, temperature, and pressure in the film are explicitly determined by the radial profile of its thickness. The equilibrium is controlled by two parameters: (i) the vapor-disk difference of temperatures and (ii) the mass transfer, or the liquid outflow, rate. For the flow regimes with a nearly uniform film thickness, the governing equation linearizes, and the film interface is analytically predicted to have a concave-up quartic parabola profile. Thus, perhaps counterintuitively, the liquid film is thicker at the edge and thinner at the center of the disk. This work is a part of research on low-gravity condensation-flow processes for conditioning cryogenic liquid acquisition devices to be used in space-based propulsion systems.

Alexander Frenkel
UA

Date submitted: 31 Jul 2008 Electronic form version 1.4