Stability of Evaporating Liquid Films

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Abstract- The interface instability during the liquid-vapor phase change process of a capillary-driven flow is experimentally and analytically investigated. The problem is highly complex and is governed by various thin-film phenomena including evaporation, capillary and disjoining pressure effects, thermocapillary stresses and vapor recoil. A better understanding of these instabilities is crucial to avoid some modes of operational anomalies and even failures of heat exchange equipment using evaporating meniscus to improve transfer of heat. The specific interest in this work is loop heat pipes. In this talk, the thin-film instability will first be described, followed by the explanation of an analytical treatment of the problem. Then, experimental results obtained in a saturated environment will be presented. In these experiments, the porous structure found in heat pipes is approximated using a glass capillary tube. The experimental results mainly consist of visual observation of the interface and temperature measurements. Finally, the influence of several parameters leading to the destabilization of the evaporating meniscus is discussed together with the comparison of the experimental and analytical results. Based on the obtained results, some design guidelines to limit the instability-induced temperature oscillations will be presented.