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Theoretical Analysis of Critical Marangoni Number for Oscillatory Flows with High Prandtl Number Fluids Driven by Surface Tension SHINICHI YODA, SATOSHI MATSUMOTO, Japan Aerospace Exploration Agency, ATSUKI KOMIYA, Tohoku University — Many experiments to determine the critical Marangoni number (Ma_c) at the onset of oscillatory flows for high Prandtl number (Pr) fluids have showed a dependence of a characteristic length. This fact contradicts the similarity principle in fluid physics. This paper investigates the reasons why the critical Marangoni number has shown such a dependency by considering the difference in temperature distribution on the free surface. higher Pr fluids form a thermal boundary layer with a steep temperature gradient in the vicinity of both the hot and cold disks, although the middle of the free surface has no temperature gradients. The temperature distribution produced a velocity distribution on the free surface. This velocity distribution generates characteristic length dependence for the Ma_c in higher Pr fluids. By considering the partial temperature distribution on the free surface, a basic model for the understanding of Ma number for higher Pr fluids is proposed by introducing a dimensionless parameter, the effective Ma number. Experimental results showed that this effective Marangoni number does not have the characteristic length dependence at the onset of oscillatory flows. This parameter is consistent with the similarity principle in Marangoni convection behavior.

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