

Abstract Submitted
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Simultaneous Liquid Flow and Drying on Rotating Cylinders

CHANCE PARRISH, SATISH KUMAR, Department of Chemical Engineering and Materials Science, University of Minnesota — The coating and drying of non-flat discrete objects is an important manufacturing step for a broad variety of products. Flow of a thin, non-volatile liquid film on the outside of a rotating cylinder is commonly used as a model problem for these processes. Here, we use lubrication theory to study the behavior of a volatile, particle-laden coating. Two coupled evolution equations describing variations in coating thickness and composition as a function of time and the angular coordinate are solved numerically. In the limit of a rapidly-rotating cylinder, results from linear stability analysis and nonlinear simulations demonstrate that non-uniform drying at larger drying rates may cause thickness and composition disturbances to regrow after initially decaying. When gravity is reincorporated, poor leveling of the coating thickness at lower rotation rates and larger drying rates leads to less uniform coatings. Colloidal particles hinder leveling at high concentrations through increases in the viscosity, but help prevent coating rupture at more moderate concentrations, leading to a composition "sweet spot". A parametric study is then used to show that thickness and composition variations are minimized at large rotation rate, low drying rate, and moderate particle concentration.

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