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Thin film flow along partially immersed rotating cylinder. MOHAMED A. SAMAHA, NASTARAN NAGHSHINEH, Rochester Institute of Technology - Dubai, BRIAN T. HELENBROOK, Clarkson University, STEVEN J. WEINSTEIN, Rochester Institute of Technology — The steady-state withdrawal of a liquid film from a partially immersed horizontal rotating cylinder in a pool is examined theoretically. A boundary layer form of the Navier-Stokes Equations (NSE) is coupled with pressure variations induced by the interface. Following the approach of von-Karman and Polhausen, the equations are integrated to obtain an integro-differential equation with an assumed parabolic velocity profile to obtain an approximate first-order nonlinear-ordinary differential equation that governs the film thickness. A removable critical point singularity (Weinstein & Ruschak 1999, Chem. Eng. Sci. 54) arises in the film equation at the location where inertia and gravitational effects balance, and removal of this singularity sets the volumetric flowrate and the height of the film as a function of azimuthal location along the cylinder. The azimuthal location of the critical point location is linked to the submerged depth of the roller. Although the film equation is designed to enable the interface profile to approach a horizontal pool surface away from the roller, the choice of parabolic profile precludes this limit. Full numerical solutions of the NSE are used to determine an alternative non-parabolic velocity profile that enables the horizontal pool limit.

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