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Rupture Limit of Thin Moving Films JUAN C. PADRINO, DANIEL D. JOSEPH, HYUNGJUN KIM, University of Minnesota — The rupture of a thin film in another fluid is studied including the effects of disjoining pressure. The study considers the linear stability of a moving viscous film in a motionless inviscid fluid and of a stagnant viscous film in a motionless viscous fluid. These are analyzed by means of the Navier–Stokes equations and the dissipation approximation based on potential flow. Results reveal that the dissipation method provides a good approximation for the case of a moving film, whereas its predictions are off the mark for the stagnant film case. The thickness of the gap at the trough of Kelvin-Helmholtz waves locates the formation of holes. The wavelength at final collapse is determined by the length of waves at the trough of the corrugated film. The disjoining pressure effects cause very fast break-up for very thin films. These effects influence the cutoff wavenumber. In the limit of small gaps on this corrugated film, the Reynolds and Weber numbers tend to zero with the gap size, the Ohnesorge number increases like the reciprocal of the square root and the Hamaker number like the reciprocal of the square of the gap. The motion of the film does not enter at the point of formation of holes. Moreover, for the most unstable wave, the ratio of the wavelength to film thickness is found to decrease with decreasing film thickness.

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