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Self-similarity and scaling transitions during rupture of thin free films of Newtonian fluids SUMEET THETE, CHRISTOPHER ANTHONY, School of Chemical Engineering, Purdue University, West Lafayette, IN 47907, PANKAJ DOSHI, Pfizer Worldwide RD, Groton, Connecticut 06340, USA, MICHAEL HARRIS, OSMAN BASARAN, School of Chemical Engineering, Purdue University, West Lafayette, IN 47907 — Rupture of thin liquid sheets (free films) is central to diverse industrial and natural phenomena, e.g. foam stability. Rupture of Newtonian films is analyzed under the competing influences of inertial, viscous, van der Waals, and capillary forces by solving numerically a system of spatially one-dimensional evolution equations for film thickness and lateral velocity. As the dynamics close to the rupture singularity is self-similar, the dynamics is also analyzed by solving a set of ordinary differential equations in similarity space. For sheets with negligible inertia, the dominant balance of forces involves solely viscous and van der Waals forces. By contrast, for sheets of inviscid fluids, the dominant balance is between inertial, capillary, and van der Waals forces. For real fluids, the afore-mentioned viscous and inertial regimes are demonstrated to be transitory and hence can only describe the initial thinning of highly viscous and slightly viscous sheets. Moreover, regardless of the fluids viscosity, it is shown that for sheets that initially thin in either of these two regimes, their dynamics transition to a final inertial-viscous regime in which all forces except capillary force remains important, in accordance with Vaynblat, Lister, and Witelski (2001).

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