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Static Stability of Helically Supported Fluid Interfaces at Zero Bond Number[1] JORGE BERNATE, DAVID THIESSEN, Washington State University — When gravitational effects are negligible with respect to capillary effects, it is possible to stabilize an infinite channel of liquid with a helical wire. Capillary-driven flow in such minimal support structures may have applications for use in heat- or mass-transfer processes under microgravity conditions or at small scales in micro- and nano-fluidic applications. Stability issues limit the initial penetration of the meniscus into the structure as well as steady flow. The static stability of infinite-length helical interfaces is theoretically determined at zero Bond number as a function of the contact angle and two dimensionless geometric parameters. The theory predicts a minimum and maximum stable pressure and corresponding volumes at which respectively breakup and blowout of the interface occurs. An approximate theory for the equilibrium of finite-length, free-ended segments is also presented which predicts a critical value of the pitch beyond which no stable free-ended interfaces exist. Predictions of stability limits for infinite and free-ended equilibria are confirmed experimentally in a Plateau tank with satisfactory agreement. Observations of the bath fluid flow in the vicinity of the free interface suggest a screw-like flow in the creeping flow regime. High-speed imaging was used to capture the instability mechanisms.

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