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Thermocapillary Convection in Liquid Bridges and Annuli

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Thermocapillary convection in two types of cylindrical geometry is investigated in two- and three-dimensional numerical simulations: a liquid bridge heated from the upper wall and an open annulus heated from the outside wall. For the parameter ranges considered, it is found that dynamic free-surface deformations are negligible and do not induce transitions to oscillatory convection in axisymmetric models. Moreover, only steady convection is possible at any Reynolds number (Re) in strictly axisymmetric computations. In our three-dimensional models, the nondeformable free surfaces are either flat or curved as determined by the fluid volume (V) and the Young-Laplace equation. Convection is steady and axisymmetric at sufficiently low values of Re with either nondeformable or deformable surfaces. Transition to oscillatory three-dimensional motions occurs as Re increases beyond a critical value dependent on the aspect ratio, the Prandtl number and V. Good agreement with available experiments is achieved in all cases.

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