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Meniscus effects on the frequency and damping of capillary-gravity waves in a brimful circular cylinder. (English) Zbl 1231.76089

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Summary: We study the effects of a meniscus on the oscillations of a viscous liquid filling a right circular cylindrical container by using the natural viscous complex eigenfunctions of the problem. The free surface of the liquid is assumed to have a pinned contact line. By projecting the governing equations onto an appropriate basis, a nonlinear eigenvalue problem for the complex frequencies is obtained. This is then solved to obtain the modal frequencies as a function of the contact angle θ_c, the Reynolds and Bond numbers Re and Bo and the liquid depth h. At shallow depths, the effect of the meniscus is, in general, to increase the modal frequency and decrease the damping rate with increasing θ_c. At large depths and for higher modes, the damping rate monotonically decreases with increasing θ_c while the frequency attains a maximum in the neighbourhood of 90°. Extensive comparison with experimental and computational results for the $\theta_c = 90°$ case is very good; comparison with the one available experimental result for $\theta_c = 62°$ is also very good.

MSC:

76D45 Capillarity (surface tension) for incompressible viscous fluids
76D33 Waves for incompressible viscous fluids

Cited in **6** Documents

Keywords:

frequency; damping; meniscus effects; circular cylinder; pinned contact line; complex eigenfunctions

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