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Zero-gravity mean free surface curvature of a confined liquid in a radially-vaned container

A variety of increasingly intricate container geometries are under consideration for the passive manipulation of liquids aboard spacecraft where the impact of gravity may be neglected. In this study we examine the mean curvature of a liquid volume confined within a radial array of disconnected vanes of infinite extent. This particular geometry possesses a number of desirable characteristics relevant to waste water treatment aboard spacecraft for life support. It is observed that under certain conditions the slender shape of the free surface approaches an asymptote, which can be predicted analytically using new hybrid boundary conditions proposed herein. This contribution represents possibly the final extension of what has been referred to as the method of de Lazzer et al. (1996). The method enables the integration of the Young-Laplace equation over a domain with its boundaries, including the wetted portion of the solid boundaries, symmetry planes, and circular arcs representing free surfaces at the center plane of the liquid body. Asymptotic solutions at several limits are obtained and the analysis is confirmed with numerical computations.

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