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Size-Dependent Couple Stress Fluid Mechanics: The Influence of Boundary Conditions AREZOO HAJESFANDIARI, ALI HADJESFANDIARI, GARY DARGUSH, University at Buffalo, State University of New York — In size-dependent couple stress fluid mechanics, which involves a length parameter l, the corresponding modified Navier-Stokes equations are $\rho\frac{D\mathbf{v}}{Dt} = -\nabla p + \mu\,\nabla^2\mathbf{v} - \mu l^2\,\nabla^2\nabla^2\mathbf{v}$. The term involving l is of fourth order, which then requires the prescription of additional boundary conditions compared to the classical case. Therefore, the boundary conditions in the size-dependent theory must include specification of either the tangential component of rotations ω on the boundary or the tangential moment-tractions $\mathbf{m}^{(n)}$. Here we concentrate on two-dimensional flows and explore the consequences of prescribing different boundary conditions in size-dependent couple-stresses fluid mechanics by using computational fluid dynamics. We investigate the characteristics of flow for the cavity problem based upon the equation above and the Boussinesq approximation for the Rayleigh-Benard problem. This provides us with interesting, unexpected results for various boundary conditions, when accounting for couple-stresses. These in turn might explain different mechanisms for energy dissipation, as well as for chaotic behaviors of fluid flow.

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