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On the compressible Taylor-Couette problem AVSHALOM MANELA, ITZCHAK FRANKEL, Faculty of Aerospace Engineering, Technion-Israel Institute of Technology, Haifa 32000, Israel — The transition to instability in the Taylor-Couette problem at small Knudsen numbers and arbitrary Mach numbers is studied via a linear temporal stability analysis of the compressible 'slip-flow' problem for a perfect monatomic gas. We focus on the case of stationary outer cylinder and equal wall temperatures. The results indicate that occurrence of instability is limited to small Knudsen numbers owing to the combination of a critical (incompressible) Reynolds number at low Mach numbers and increased dissipation rates at large Mach numbers. Comparison of the linear results with DSMC calculations and existing experimental observations demonstrates that the present analysis correctly predicts the boundaries of the instability domain. We further demonstrate that in the narrow-gap approximation, owing to the reduced effect of compressibility, the neutral curve is well approximated by replacing the incompressible Reynolds number by a Reynolds number based on mean fluid properties. This simple approximation may present a useful alternative in studying the effects of various parameters on the onset of instability in the limit of arbitrarily small Knudsen numbers.

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