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Subsonic Compressible Flow in Two-Sided Lid-Driven Cavity

PALAK SHAH, FARZAD MASHAYEK, University of Illinois at Chicago, GUSTAAF JACOBS, Brown University — This paper presents a numerical study of the laminar, viscous, subsonic compressible flow in a two-dimensional two-sided lid-driven cavity using a multi-domain spectral element method. The flow is driven by steadily moving two opposite walls vertically in opposite directions. The results of the simulations are used to investigate the effects of the cavity aspect ratio, the Reynolds number and the Mach number on the flow. Cases with equal wall temperatures and with unequal wall temperatures are considered. The flow evolution shows that the basic two- dimensional flow obtained is not distinctive. This is particularly true when the temperatures of the two walls are not equal. The increase of this temperature difference changes the steady state flow from a single-vortex to a two-vortex pattern. For cases with equal wall temperatures, at lower Reynolds numbers, the flow pattern consists of two separate co- rotating vortices contiguous to the moving walls. For higher Reynolds numbers, initially a two-vortex flow is formed, which eventually turns into a single elliptical vortex occupying most of the cavity. For a higher aspect ratio, the flow patterns are dissimilar in that the streamlines become more and more elliptic. For aspect ratios as high as 2.5, at high Reynolds numbers, a three-vortex stage is formed. Energy balance studies are conducted at steady state and during flow evolution. The evolution and distribution of heat transfer and work at walls are studied.

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