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Three-dimensional vortex dynamics in oscillatory flow separation[1] MIGUEL CANALS, GENO PAWLAK, Department of Ocean and Resources Engineering, University of Hawaii at Manoa — The three-dimensional (3D) dynamics of coherent vortices and their interactions in an oscillatory flow past an obstacle are examined experimentally. The main focus is in the low Keulegan-Carpenter number range (KC $<$ 5), and for moderate Reynolds numbers (2000 $<$ Re $<$ 10000). This parameter space corresponds to the vortex pairing regime, in which vortex dipoles can propagate away from the boundary and provide a direct mechanism for the transfer of momentum and enstrophy to the outer region. The vortex breakdown mechanisms are elucidated via flow visualizations and digital particle image velocimetry (DPIV). Volumetric dye visualizations reveal complex 3D vortex interactions and explosive vortex breakdown. These visualizations suggest that the initial instability of the spanwise vortices is an elliptical instability of the strained vortex cores. This is confirmed by detailed DPIV measurements which have identified the elliptical instability eigenmode. The periodic features of the flow, including the energetics and enstrophy dynamics, are examined using phase-averaging. The phase-averaged dynamics are then interpreted in light of the results obtained from the time domain observations of the vortex instabilities.

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