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Experimental Investigation of a Vortex Ring Impinging on a Concave Cavity TANVIR AHMED, BYRON ERATH, Clarkson University — The fundamental physical interaction of a vortex ring impinging on a concave hemispherical cavity is investigated, which is a flow scenario that finds wide application in nature and engineering flows. A vortex ring of formation number $F = 2.67$, and Reynolds number $Re = 1450$ is generated using a piston-cylinder arrangement in a water tank. The interaction is investigated for six different hemispherical diameters, where the ratio of vortex ring radius to hemisphere radius (γ) varies as γ =0 (flat plate), 1/4, 1/3, 2/5, 1/2, and 2/3. For γ = 1/4, 1/3, and 2/5, a secondary vortex ring forms and rotates around the primary vortex ring, analogous to flat plate interactions. However, a Widnall-like instability occurs in the secondary ring with the upper ends of the loops subsequently experiencing a head on collision, while the lower ends rotate around the core of the primary ring. This results in ejection of the secondary vorticity away from the hemispherical surface. The escape velocity of the secondary vortex increases with increasing values of γ. For γ = 1/2, the induction of the primary ring with the lip of the hemisphere prior to impact induces edge vorticity on the lip that interacts with, and weakens, the secondary vorticity. The lower ends of the secondary ring subsequently experience head on collision instead of the upper ends. For $\gamma = 2/3$, the primary ring directly impacts on the edge of the hemispherical surface.

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