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Azimuthal Instability of a Vortex Ring in a Liquid CO_2 Drop Rising in the Deep Ocean.[1] LOUIS L. STEYTLER, ARNE J. PEARLSTEIN, Department of Mechanical Science and Engineering, University of Illinois at Urbana-Champaign — Risk analysis for sub-seafloor storage of liquid CO_2 requires assessment of the fate of liquid drops that escape as a result of loss during injection, passage though natural fissures, and seismic activity. Key issues in assessing the fate of escaped CO_2 drops include the rate at which they rise through and dissolve in seawater, and how those rates depend on drop size. At typical depths, the density of liquid CO_2 is slightly less than the density of seawater, and its viscosity is approximately one-tenth that of seawater. For this combination of physical properties, the flow internal to the drop is significantly more complex than the flow external to the drop. We report a three-dimensional numerical simulation of a 6 mm CO_2 drop rising isothermally through seawater, neglecting compressibility effects, mass transfer, and hydrate formation. Starting from rest, a recirculating vortex ring develops internal to the drop, and as the result of a nonaxisymmetric instability, leads to transition from a relatively simple internal flow to a highly complex one. Comparison to results for the classical azimuthal instability of free vortex rings reveals several similarities. By reducing internal mass transfer resistance, the complex flow internal to the drop is expected to enhance dissolution of CO_2 into seawater.

[1]Computations performed using resources of the Argonne Leadership Computing Facility

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