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Modeling rotational instabilities in aluminum reduction cells
DAVID MUNGER, ALAIN VINCENT, University of Montreal — Industrial production aluminum is achieved by means of electrolysis in aluminum reduction cells, in which a shallow electrolytic bath layer floats on top of liquid aluminum. Perturbations of the interface may initiate unstable waves by disturbing the electrolysis current, thus giving rise to a magnetic force through the action of the background magnetic field. Long-waves tend to turn into a rotating wave, whose essential driving mechanism is fairly well understood. However, the flow in a cell is observed to be also dominated by a few large scale vortices whose dimensions and intensity depends on the configuration of the magnetic force due to the background magnetic field. We have extended the stability analysis of interfacial waves to rotating fluids in a hypothetical cylindrical cell. Our model predicts three types of instabilities: (1) rotating waves altered by the global rotation; (2) axisymmetric circular waves; and (3) axisymmetric circular non-oscillatory disturbances. The latter type is expected to be the most unstable. We validate some of the predictions with numerical simulations.

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