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Instability of a particle-laden jet in a confined environment FLORENT P.M. SHARPIN[1], Ecole Polytechnique, JULIEN R. LANDEL, DAMTP, University of Cambridge, C.P. CAULFIELD, BPI & DAMTP, University of Cambridge
— The dynamics of particle-laden jets is relevant to many geophysical events and industrial applications from volcanic eruptions to chemical reactors and oil refinement. We consider experimentally the dynamically rich behavior of a vertical momentum jet, constrained in a narrow gap whose length is two orders of magnitude smaller than the length-scales of the other two dimensions, and constrained to flow through, from below, a bed of small heavy particles. In the regime where the jet has eroded a large triangular region of the particle bed, a dense particle-laden jet develops, as the initially pure jet continually entrains, and carries to some height above the bed, a certain concentration of particles. This coupled particle-laden jet is unstable and oscillates from side to side in the confined environment. A large vortical structure forms as the particle-laden jet tilts sideways, at a well-defined frequency. Using an analogy with turbulent, single-phase fountains, we model the maximum height of rise of the particle-laden jet using a ratio between the single-phase jet source volume flux, and its coupled, particle-laden negative source buoyancy flux, which we determine using a novel non-intrusive technique. We also model the frequency of the particle-laden jet instability using the characteristic travel time of a particle in the jet, which also depends on the reduced gravity of the particle-laden jet.

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