Flow and instabilities of particle-laden fluids

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Particle-laden fluids govern key processes such as sediment transport, gas/oil extraction and storage, or fluidized beds for industrial catalysis. The common point of these applications is the competition between fluid entrainment and particle sedimentation. This coupling can lead to puzzling fluid-escape structures, including fluid focalization and/or the emergence of instabilities. Although apparently innocuous, these structures are among the most threatening hazards, from industrial or offshore drilling incidents to the largest massive extinctions on Earth.

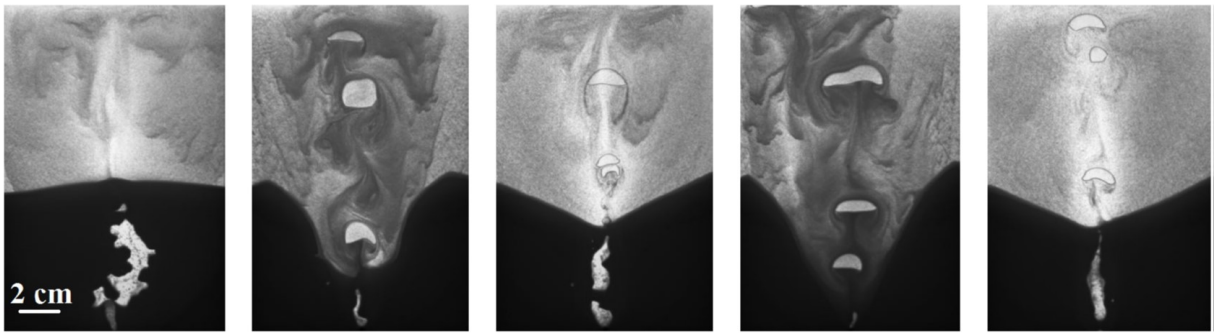

Figure 1. Spontaneous oscillations during air injection in a water-grains mixture. The grains are polystyrene, polydisperse, non-spherical particles of average equivalent diameter $d = 130$ μm [injected flow rate $Q = 0.05$ L/min, cell tilt angle $\alpha = 30^\circ$ respect to the vertical]. From left to right $t = 10$, 210, 420, 490 et 690 s [PhD C. Picard].

At the laboratory scale, we investigate the dynamics of an immersed granular layer submitted to a localized fluid injection. In a given range of parameters and for different experimental configurations, the system exhibits puzzling self-induced oscillations and/or unexpected violent particle resuspension (Figure 1). These curiosities at the laboratory scale may have a crucial impact in geophysical and environmental applications.