Dynamic suspensions by air injection

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Key words Suspension ; Granular matter ; Triphasic flow.

Triphasic flows (grains-liquid-gas) has applications in a wide range of systems. In geophysics, the understanding of the sequestration of gas in oceanic sediments is crucial; in particular, their subsequent release may entail huge cracks [1]. In the industy (petrochemistry, food industry), catalytic gas-fluidized bed reactors have been widely investigated. The objective is to optimize the flow in order to increase the contact surface and mass transfer between gas and liquid phases [2].

Contrary to diphasic flows liquid-grains or gas-grains [3], triphasic cases are less understood due to the complex dynamic of gas through the immersed granular matter [4]. In fact, fundamentally, the three phases and their interaction s play a role on the dynamics of such flow. Different time and length scales will therefore be involved: grains/grains interactions, hydrodynamic coupling between liquid, gas and particles movement, etc. In the particular case where particles are slightly heavier than the liquid, competition between settling and transport is important.

We study experimentally the behavior of an immersed granular layer in a Hele-Shaw cell, when air is injected at the bottom center of the granular bed. The gas initially percolates through the grains (Fig. 1a), then forms bubbles which rise and transport particles in the above liquid (Fig. 1b-1c). The particles settle back on the edges of the cell, deposit and avalanche on the crater formed at the granular bed free surface, and are further entrained by the continuous bubbling at the center (Fig. 1d-1e). We therefore create a dynamic suspension.

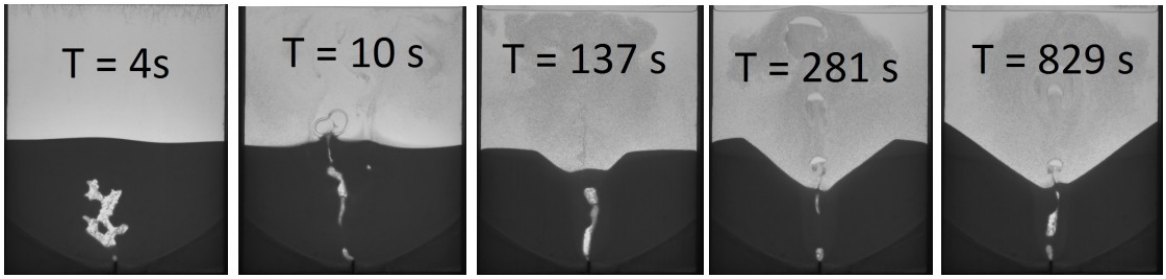

Figure 1 : Temporal evolution of the studied triphasic flow

The study focuses on particles slightly heavier than the surrounding fluid. First, we report the existence of a steady-state, resulting from the balance between particle transport and settling. We quantify so the size of a « dead zone », a part of the granular bed which is not affected by the air flow. A detailed study of the influence of the different parameters (air flow-rate, particle density, cell width…), points out that the bubbles, and especially their characteristic size, are the controlling parameter of this triphasic flow.

References

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