Foam flow in a Hele-Shaw cell with a local constriction

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Liquid foams, such as chocolate mousse and shaving foams are soft materials that we all use in our everyday life. Their multi-scale biphasic structure of gas bubbles within a liquid phase leads to a dual mechanical behaviour: they behave as solids at rest, while they can flow like liquids above a given critical yield stress. Such peculiar rheological properties are at the root of their use in diverse applications, ranging from food, cosmetics and pharmaceutical industries, to oil recovery or soil remediation processes. For those last applications, understanding and controlling the flow of liquid foams in confined heterogeneous media appears of tremendous importance [2].

We have designed a simple experimental set-up that allows the direct observation of the motion and deformation of the elementary components of a two-dimensional liquid foam, the bubbles, when forced to invade a confined medium that mimics a simple model fracture. This set-up is based on a Hele-Shaw cell consisting two glass plates ($50 \times 15 \times 1$ cm^3) separated by gap $G = 1.2$ mm. The cell presents a circular or square defect in the centre with vareous heights from 0 to the size of the gap, thus acting as a permeable obstacle.

The liquid foam is generated in-situ by bubbling filtered pressurized air at a constant flow rate through a niddle in a vertical chamber connected to the cell and filled with a soapy solution. The steady state flow is observed directly using Basler digital camera.

Using standard image correlation we obtain the velocity field. We thus investigate this velocity depending on the obstacle and the foam properties varying the obstacle form and size and foam liquid fracture.

The results suggest the foam velocity to decrease by reaching the obstacle while it is increasing after passing the permeable obstacle forming so-called negative wake [1]. The overshoot obtained downstream the obstacle increases with increasing height of the obstacle and its horizontal size. In contrast, increasing the liquid fracture leads to decrease of this overshoot leading the velocity profile to become potential flow-like.

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References

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