Simulating the flow of aqueous foams in porous media

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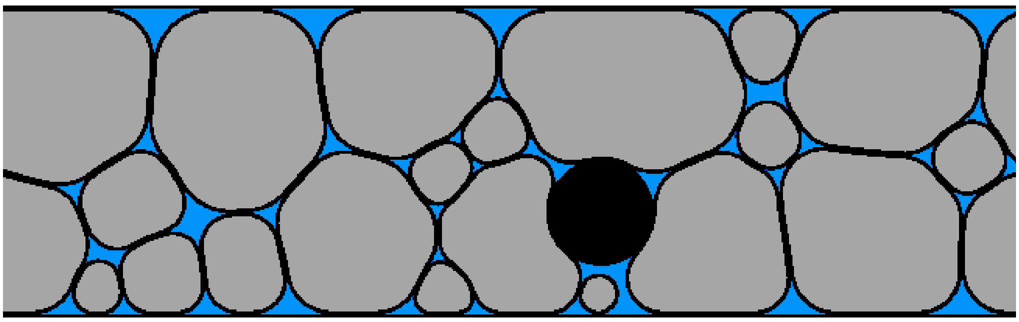
An aqueous foam, consisting of gas bubbles surrounded by a continuous liquid phase, has high interfacial area and low density, and thus finds many industrial applications. A foam is a complex fluid exhibiting both an elastic response at low strains and a yield stress, which depends upon bubble size and liquid fraction, leading to viscous flow.

There is much to be learned about the dynamics of aqueous foams from a two-dimensional (2D) situation, such as a foam between flat parallel glass plates. Major advances in understanding of foam rheology have been triggered by experiments, theory and simulations in 2D (Cantat et al., "Foams: Structure and Dynamics", Oxford University Press, 2013).

This work describes a simulation method that is able to predict the dynamics of 2D foams with liquid fraction intermediate between the oft-used dry and wet limits, while retaining an accurate representation of the bubble shape. It incorporates surface tension forces on the bubble interfaces, and can account for variations in surface tension due to stretching of the interface. Bubble pressures are determined by assuming that the foam is incompressible. In keeping with the 2D nature of the approximation, dissipative forces arise from friction with the bounding glass plates. To keep bubbles apart requires that a disjoining force is applied to nearby interfaces. A force balance applied to each point of a discretised bubble interface then allows the evolution of the foam to be explored.

The talk will illustrate how the method can be used to investigate the rheology of 2D foams. Examples related to the flow of foams in porous media will include flow through constrictions and past obstacles, providing information about in-situ foam generation.



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