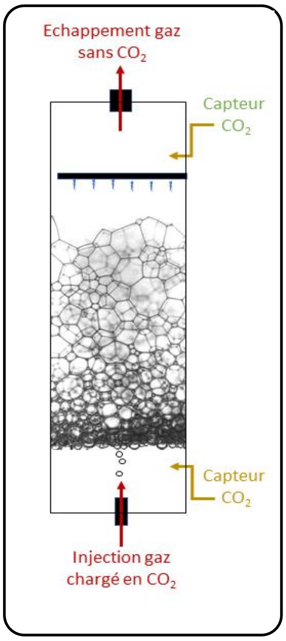
M2 internship offer at LIPhy
CNRS and Université Grenoble Alpes
Grenoble

Dynamics of CO_2 capture by aqueous foams

Whether it is to purify the air of fine particle pollution or to obtain gases, our need for gas filtration and separation is growing rapidly. This need is crucial in the context of global warming, since even if our CO_2 emissions were to become zero today, it will probably also be necessary to capture CO_2 from the atmosphere in an attempt to stem the rise in temperature at the Earth's surface. As CO_2 is present in the atmosphere in concentrations of the order of 0.04%, the volumes of air to be filtered are gigantic, and it is necessary to develop separation processes that are both energy-efficient and fast. Among the various techniques used, the use of membranes, which form a permeable barrier between two media through which the various gaseous compounds are filtered according to their size, diffusivity or solubility in the membranes, is rapidly expanding. However, these membranes clog up easily, which is a huge problem. To circumvent these problems, it has been proposed to use aqueous foams, made up of a myriad of liquid films acting as selective membranes to separate the CO_2 that solubilizes in the liquid phase and the air that remains mainly in the bubbles. CO_2 transfer is correctly understood at the film scale, but much less so at the foam scale, due to the geometric complexity of these materials inherent in the spatial organization of films. In addition, several characteristic times - of solubilization, of bubble life or of diffusion via films - enter into competition. To advance our understanding of this problem, we propose a study of the dynamics of CO_2 transfer within a foam. The proposed approach will be both experimental and theoretical. Experiments will be carried out using an existing laboratory set-up to measure how CO_2 is distributed between the liquid and gas phases. Theoretical analysis will be carried out using effective medium models implemented at LIPhy.



The study configuration envisaged is as follows: a stationary foam column is formed by continuously injecting a flow of air into a volume of previously degassed foaming liquid, as illustrated opposite. At a given point in time, the composition of the injected gas is changed by replacing the air with CO2-laden gas. In order to determine the characteristic time to reach a new stationary state, and how the CO2 is distributed between the liquid and gas phases, several quantities will be monitored over time: the CO2 content above the column, the foam height, the liquid volume fraction along the column, and the CO2 concentration in the liquid phase. These experiments will be carried out for different gas contents and foaming solution compositions.

The trainee, M2 level or equivalent, should have a good knowledge of thermodynamics and soft matter or fluid mechanics. A taste for experimentation and instrumental development is highly desirable. The internship should last a minimum of four months, ideally 6 months, and may be followed by a thesis. The intern will receive a stipend of around 550 euros per month.

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