**Effect of Surfactant on Velocity and Oxygen Mass Transfer of a Single Bubble Rising in a Liquid.**

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**Highlights**

* Effect of contaminant on hydrodynamic of a bubble rising in a liquid.
* Combined effects of polymer and surfactant on oxygen mass transfer.

**1. Introduction**

Dispersion of bubbles in liquid for oxygen transfer found applications in a wide range of fields such as medicine (oxygenation of blood) or environment (wastewater treatment). It is known that presence of surface-active agent in liquid lead to an inhibition of gas-liquid mass transfer [1]. Indeed, they can affect the oxygen mass transfer from a bubble via the modification of the hydrodynamic of the bubble such as its velocity, shape and diameter, but also by affecting directly the diffusion coefficient of oxygen [2]. Although researches about this subject increased, interfacial phenomenon that occurs during the mass transfer is not clearly understood. Surface contamination by surfactant of a bubble rising in a liquid is a time dependent parameter. Indeed, the kinetic of adsorption depends on the diffusion coefficient of the surfactant which is linked to the nature of both surfactant and bulk [3], improvement of the knowledge about contamination kinetic could be useful for a better understanding of interfacial phenomena.

The aim of this study is to highlight the effect of surfactants in different bulks on the bubble hydrodynamic and mass transfer. For that purpose, we studied hydrodynamic of bubbles in different liquids compositions and compared with pure water. In addition, to link this phenomenon with mass transfer, the same solutions has been used and mass transfer of oxygen has been determined by Planar Laser Induced Fluorescence Inhibition (PLIF-I) method [4]. This method has already been used in literature to identify an important decrease of mass transfer when polymer [5] and surfactant [1] are added to water; here the combined effect of each has been investigated.

**2. Methods**

The column where oxygen transfer occurred was filled with the different compositions: pure water, surfactant (SDS and Triton X-100), polymer (polyacrylamide and polyalkylene glycol) and surfactant mixed. Surfactants were characterized by their composition, density, static and dynamic surface tensions. The liquid has been deoxygenized with nitrogen before each experiment. A single bubble was generated with a syringe pump and injected through a stainless steel needle into the column. To excite fluorescence, horizontal laser sheet was generated by a laser (Nd:YAG laser: DANTEC Dynamics Dualpower 200-15, 15Hz, 2$×$200 mJ) . The image of fluorescence in the wake of the bubble were recorded by a Charged Coupled Device camera (CCD camera: DANTEC Dynamics flowsense CM, 12 bits, 15 fps, 2048$×$2048 pixels) located at the bottom of the column and focused on the laser sheet. In order to avoid recording the light provided by the laser sheet, a 570 nm high pass filter was placed in front of the lens. The fluorophore used was ruthenium complex (C36H24Cl2N6Ru;xH2O , Sigma-Aldrich) at a concentration of 70 mg/L. The hydrodynamics properties of bubbles in the column where obtained from the sequences of images recorded by a high speed camera (Photon SA3, 8 bits, 2000 fps, 1024$×$1024 pixels), and images recorded gave access to the velocity, the shape and the diameter of bubble along the column.

**3. Results and discussion**

For each solution prepared, the diameter, the shape, contamination have been determined, along with adimensional numbers (Reynolds, Schmidt, Scherwood). In these last solutions, results obtained from the PLIF-I method allow to quantify the flux of oxygen in the wake of the bubble and thus the diffusion coefficient. The results showed a drastic change in the hydrodynamic parameters of solutions, accompanied by a decrease of amount of oxygen transferred when surfactant are present in the solution. We calculated a division by 20 of the mass transfer coefficient when triton X-100 is added to water at a concentration lower than the CMC. This effect was even more marked when polymer and surfactant were both added to water.

**4. Conclusions**

Our experimental set up allowed us to visualize in the same times changes in hydrodynamics conditions of bubbles rising in liquids and oxygen mass transfer. The effect of both polymer and surfactant have been studied and showed a drastic decrease of the amount of oxygen transferred. This can be explained by changes in hydrodynamic conditions, but others effects can play a role in this diminution. Results highlighted the importance of improving our knowledge about the interface and organization of surfactant in this area for a better understanding of gas-liquid mass transfer phenomenon.

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