Simultaneous 2-Tracer-LIF and PIV for the study of mass transfer around single CO₂-bubbles

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HIGHLIGHTS

• With high speed LIF and PIV experiments the mass transfer and the liquid flow around single ellipsoidal CO₂ bubbles was investigated
• Simultaneous LIF-PIV experiments were carried out to investigate the mass transfer and the liquid flow around single ellipsoidal CO₂ bubbles
• The reflections on the bubble surfaces and their shadows were suppressed with 2T-LIF technique

ABSTRACT

Bubble column reactors are used for different chemical and biological processes in industry. Dispersed gas comes into reaction with the liquid phase through gas-liquid mass transfer. Often mass transfer is the limiting factor for the reaction and its investigation and characterization becomes important for the optimization of a reactor. In the literature, mass transfer experiments use typically two types of reaction systems. In the first, oxygen is dissolved in a sulphite solution, and the oxygen concentration in the liquid is measured by means of a specific fluorescent dye. In the other reaction system, CO₂ gas is dissolved in an aqueous liquid. Here, the pH of water is changing during the reaction and with a pH sensitive fluorescent dye, this change is traceable through the fluorescence intensity. To gain more information about the liquid flow and the mass transfer around a single bubble, in this study three types of measurements are presented. First of all, high-speed LIF measurements of CO₂ transfer from the bubbles to the liquid are analysed. Then high speed PIV measurements were carried out to investigate the flow around the bubbles. At last simultaneous measurements of liquid velocity and pH around single rising ellipsoidal CO₂ bubbles in a round column using PIV and 2-Tracer LIF were implemented. The zig-zagging bubbles of 2-3mm diameter are examined using uranine as fluorescent pH-tracer. Since the generated bubbles in this size regime have a three dimensional rising path, the combined PIV-LIF images were taken before the first inflection point of the bubble path, where bubble motion is still more or less two dimensional. The reflections on the bubble surface and the bubble shadows were reduced by the help of a simultaneously recorded live background.

Fig. 1 Mass transfer behind a CO bubble (left) and the vertical velocity components (right)