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# Interaction between partitioning porous plate and rising bubbles in a trayed bubble column

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ABSTRACT

In a trayed bubble column, the structure of the partitioning plate plays an important role on the bubble behavior. This study examined the effect of the opening ratio and pore size of the plate on the bubble break-up frequency and bubble size distribution. The sieve tray was used as the partitioning plate. The opening ratio was closely related to gas cap development. The stagnation of bubble flow and a gas cap were observed with an opening ratio less than 48.5%. The gas cap increased with decreasing opening ratio and increasing superficial gas velocity. The main effect of the sieve tray could be categorized into the additional drag force and bubble break-up depending on the sieve pore size. When the sieve pore size was smaller than the Sauter diameter of the bubble swarm, the movement of rising bubbles was interrupted by the drag force applied by the surrounding mesh lines. On the other hand, when the sieve pore size was larger than the Sauter diameter, the bubbles were affected by the additional bubble break-up. After the bubbles penetrated the sieve tray, the bubble size distribution shifted to a smaller one and the Sauter diameter decreased.



*Keywords:* Bubble columns; Sieve tray; Opening ratio; Bubble break-up frequency; Bubble size distribution; Sauter diameter

## 1. Introduction

Bubble column reactors are used widely in industrial practices, such as adsorption, fermentation, bio-reactions and coal liquefaction, given the intrinsic advantages of the good mixing ability, high heat transfer efficiency and operation versatility (Kantarci et al., 2005; Ribeiro and Mewes, 2007). In particular, in industrial applications introducing the reactants as a gas phase, the bubble induced mixing improves the mass transfer between reactants and catalysts as well as the reaction efficiency. Therefore, the mass transfer rate and gas hold-up ($\varepsilon_G$) are representatively used to evaluate the efficiency of bubble columns. The gas hold-up is defined as the volume ratio of the gas phase present in the mixture in the reactor.

The gas hold-up is strongly affected by the flow regime, bubble size distribution and liquid circulation velocity. In bubble column reactors, the flow pattern can be categorized into three distinguished flow regimes depending on the superficial gas velocity, which is the volumetric gas flow rate divided by the column cross-sectional area. At a low gas velocity, the homogeneous flow regime is formed and characterized by the small and narrow bubble size distribution with small scale transverse oscillations. In this flow regime, there are weak interactions among the bubbles causing low breakage and coalescence frequencies. As the bubble packing density increases at higher gas velocities, bubble flow loses its stability exhibiting a helical flow pattern and liquid circulation. This heterogeneous flow regime is characterized by large and fast-rising bubbles of which the size distribution is strongly

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