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Fluid Dynamics and Transport Phenomena

Features of the motion of gel particles in a three-phase bubble column under foaming and non-foaming conditions

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Abstract

Features of the motion of gel particles in a three-phase bubble column with non-foaming and foaming gas-liquid systems, determined by using experiments of radioactive particle tracking (RPT), have been compared. The tracer used is a gel particle which resembles typical immobilized biocatalyst. The tracer trajectory is analyzed to extract relevant information for design purposes. The solid velocity field, turbulence parameters, dispersion coefficients, mixing times and flow transitions are determined and compared. The presence of foam significantly affects many quantified parameters, especially within the heterogeneous flow regime. The hydrodynamic stresses are reduced in the presence of foam, especially close to the disengagement. The dispersion coefficients also decrease, and the solid mixing time is only slightly affected by the presence of foam. Gas holdup, inferred both from RPT experiments and from gamma ray scanning, is higher for foaming systems and leads to a shift in the transition gas velocity towards higher values.

Keywords: bubble columns, solid motion, gel beads, foaming, particle tracking, mixing

1 . Introduction

Bioreactor design and scale-up are still challenging issues and a detailed characterization of the phenomena that determine their behavior, especially transport processes and fluid dynamics, is crucial for establishing scaling rules [1,2]. The fate of cell aggregates or immobilized biocatalysts while promoting reaction in a biochemical process is crucial for selecting design variables and operating conditions [3,4]. In this sense, it is important to map the zones of high degree of turbulence to prevent hydrodynamic stress [5].

In the last decades, applications of immobilized enzymes or cells in multiphase reactors have progressively increased. Three-phase bubble columns or fluidized-bed reactors have been frequently