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Solid motion of gel particles in a three phase bubble column examined with Radioactive Particle Tracking: comparison of foaming and non-foaming systems

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The motion of solid particles within industrial multiphase equipment can be extremely complex arising from the interaction between the solid and the fluid phases. Deep understanding of their underlying dynamics is convenient for proper design and operation, and for eventual process intensification. Industrial vessels usually have opaque walls and multiphase systems are inherently opaque. Hence, optical techniques have limited applications and high-energy radiation is more appropriate for obtaining information of the motion of solid particles in such systems. Particularly, radioactive particle tracking (RPT) is an advanced tomographic method that allows recovering the path of a gamma emitter freely moving in a 3D media for prolonged periods of time. This information is used to assess the performance and verify models aimed at simulating the motion of suspended particles. Among other, RPT allows determining velocity fields, turbulence parameters, phase distribution, flow patterns, residence and mixing times.

Industrial fermentations with immobilized biocatalysts are generally carried out in three phase bubble columns, which are gas-liquid-solid multiphase systems with pneumatic agitation. The turbulence can be very harmful for the viability of biologic cultures, although it is essential for homogenizing and transferring oxygen to the cells. In these systems, foam is frequently generated under conditions of high aeration or by the use of mechanical stress protecting agents.

The objective of this work is to use RPT for gathering relevant information on the motion of 4mm calcium alginate spheres pneumatically suspended in a gas-liquid system within a 1.2 m high and 0.1 m inner diameter acrylic column. Liquid and solid were in batch and mixed by the flowing gas phase. The solid inventory represented 10% v/v of the liquid. The solid-liquid mixture height at rest was 0.55m. Gas superficial velocity was varied within the range of 0.01 to 0.13 m/s. Compared to non-foaming systems, considerable damping of the turbulence intensity is found in the presence of foam.

Keywords: Radioactive Particle Tracking, Solid Dispersion, Foaming Systems