A High-Throughput Chaotic Advection Microreactor for Preparation of Uniform and Aggregated BaSO4 Nanoparticles

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Abstract

A high-throughput (105.5 g/h) passive four-stage asymmetric oscillating feedback microreactor using chaotic mixing mechanism was developed to prepare aggregated BaSO4 particles of high primary nanoparticle size uniformity. Three-dimensional unsteady simulations showed that chaotic mixing could be induced by three unique secondary flows (i.e., vortex, recirculation, and oscillation), and the fluid oscillation mechanism was examined in detail. Simulations and Villermaux-Dushman experiments indicate that almost complete mixing down to molecular level can be achieved and the prepared BaSO4 nanoparticles were with narrow primary particle size distribution (PSD) having geometric standard deviation, σg, less than 1.43 when the total volumetric flow rate Qtotal was larger than 10 mL/min. By selecting Qtotal and reactant concentrations, average primary particle size can be controlled from 23 to 109 nm as determined by microscopy. An average size of 26 nm with narrow primary PSD (σg = 1.22) could be achieved at Qtotal of 160 mL/min.

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