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Coupling of CFD with PBM for growth behavior of potassium sulfate in spray fluidized-bed crystallizer

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Abstract: In this work, a computational fluid dynamics (CFD) model coupled with population balance model (PBM) is applied to simulate the evolution of potassium sulphate particle growth process and the liquid-solid two-phase flow behaviors in a spray fluidized-bed crystallizer (SFBC). In order to describe the hydrodynamics of particles and the growth process fully, the kinetics model of particle growth, aggregation and breakage kernels are incorporated into the coupled model by using a user-defined function (UDF). Three particle breakage kernels based on the Kolmogorov turbulence theory (Coulaloglou and Tavlarides), attrition theory (Ghadari and Zhang) and kinetic energy theory (Luo and Svendsen) are considered in this work respectively. The three theories are modified to consider the particle flow behaviors and particle size distributions (PSD) under the same spray velocity. The CFD-PBM model is also used to predict the distributions of relative parameters in the liquid-solid two-phase flow in the SFBC via three breakage kernels. Furthermore, the variations of the solution temperature, particle velocity, crystallizer voidage and particle concentrations are obtained with consideration of particle growth process. The comparison and analysis of the kernels are studied and the simulation results show the difference among these breakage kernels. Meanwhile, the research reveals that the GZ kernel is better agreement with fluidization phenomenon, and it agrees well with experimental datas. This model provides essential information for crystallizer design and optimization.

Key words: population balance modeling, spray fluidized-bed crystallizer, breakage kernels, growth kinetics, sauter mean diameter

INTRODUCTION

The spray fluidized-bed crystallizer (SFBC) is a continuous classifying crystallizer and it has simple structure, low equipment cost and operating cost so that it is widely used in in coating, granulation, catalytic cracking, sedimentation and pharmaceutical industries etc [1]. The SFBC is a kind of crystallization equipment which enables the particles to suspend in the supersaturated solution. A mass of particles are suspended in an upward flow of the supersaturated solution through the crystallizer. As the

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