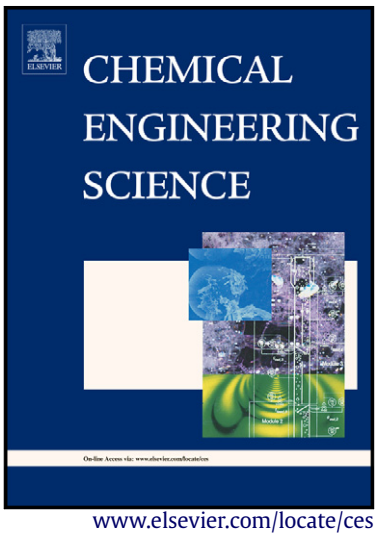

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Design and Optimization of a Multistage Continuous Cooling Mixed Suspension, Mixed Product Removal Crystallizer

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Author Highlights

- Estimation of the Crystallization Kinetics through Population Balance Modelling.
- Novel automated slurry transfer mechanism for MSMPR cascade is described.
- Energy Balance and ratio of operating volumes as a constraint on the Achievable Mean Particle Size in a two stage MSMPR cascade.
- Multi-Objective Optimization and Experimental validation for two stage MSMPR cascade.

Abstract

Continuously operated single and multistage MSMPR crystallizers using intermittent withdrawal through use of an automated pressure supply were developed for the cooling crystallization of Paracetamol from an aqueous isopropanol mixture. The onset of steady state was detected through analysis of the solid phase by means of Focused Beam Reflectance Measurement (FBRM). Simple extraction of the growth and nucleation parameters from the single stage reactor operating at steady state was performed though use of the population balance model. The kinetic data was then used with the two stage MSMPR models to predict the performance of the cascade under various operating conditions. A diagram of the mean particle size vs. total residence time in the MSMPR Cascade was obtained by incorporating the energy balance as a constraint. This affords a means to determine whether a desired product specification can be achieved in the chosen configuration. A multi-objective optimization is proposed to determine a Pareto optimal with respect to multiple attributes of the particle size distribution attained from the two stage MSMPR cascade. The optimal conditions were implemented experimentally and the crystal size distributions (CSDs) at steady state were compared to those predicted by the model.

1 Introduction

Crystallization is a significant separation and purification technique used in the food and pharmaceutical industries. The purity of the product obtained from crystallization is the most concerning aspect, however, control of the attributes of the product particle size distribution are also significant as they can improve downstream processes such as filtration and drying (Barrett et al., 2005). Therefore knowledge of the operating conditions required to generate product with a specific size and shape is fundamental during process development (Zhang et al., 2012; Mullin, 2001; Jones, 2002).