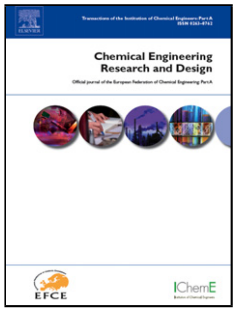

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MODELLING OF THE SPRAY DRYING PROCESS FOR PARTICLE DESIGN

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ABSTRACT

Spray drying is widely applied in many industries, such as the pharmaceutical, food, detergents, polymers, to convert liquids in solid particles. However, it still requires continuous innovation in order to provide more sophisticated particles, which are difficult to design by using only empirical approaches. In this context, a steady-state mathematical model for a co-current spray dryer is developed to give a more phenomenological insight in the production of inhalable particles. The model includes mass, energy and momentum balances for both particulate and gaseous phases. Particularly, and as a model inhalable compound, ciprofloxacin hydrochloride (CIP) aqueous solutions are studied. Several experimental data, obtained in a Mini-Spray Dryer B-290 BÜCHI, were available. In addition, droplet size measurements were carried out by using laser diffraction. The effect of the binary nozzle operating conditions on the mean droplet size was analysed and a correlation to predict the mean Sauter diameter was established. The experimental data are used to fit and validate the proposed model. The validated model is used to perform parametric studies in order to evaluate the effect of the main process variables on the final product properties (e.g., particle size and density, powder moisture content) and to track key powder attributes for pulmonary administration.

KEYWORDS

Spray drying; Modelling; Atomization; Inhalable particles.

1. INTRODUCTION

Within the process industry, it is common to find unitary operations involving particulate systems, such as drying, granulation, grinding, mixing, crystallization, size classification, etc. They are part of a wide range of industries, from fertilizers and food production to pharmaceutical and mineral processing (Balliu, 2005; Christofides et al., 2007). Although about 60% of the chemical industry produces products in the form of particulate solids (Boukouvala et al., 2013; Christofides et al., 2008), these processes still operate with less efficiency than those that handle gases and liquids and, therefore, with little control of the product attributes because there are only few laws that can govern and describe their behaviour (Bell, 2005; Dobry et al., 2009). Recognized this lack of understanding, there is currently a large research activity worldwide, although concentrated in a