

A Study of Particle Histories during Spray Drying Using Computational Fluid Dynamic Simulations

C. Anandharamakrishnan^a, J. Gimbut^{a,b}, A. G. F. Stapley^{a*} & C. D. Rielly^a

^aDepartment of Chemical Engineering , Loughborough University , Loughborough, Leicestershire, UK

^bFaculty of Civil Engineering & Earth Resources, Universiti Malaysia Pahang, Gambang, Kuantan, Pahang

ABSTRACT

Computational fluid dynamics (CFD) models for short-form and tall-form spray dryers have been developed, assuming constant rate drying and including particle tracking using the source-in-cell method. The predictions from these models have been validated against published experimental data and other simulations. This study differs from previous work in that particle time histories for velocity, temperature, and residence time and their impact positions on walls during spray drying have been extracted from the simulations. Due to wet-bulb protection effects, particle temperatures are often substantially different from gas temperatures, which is important, because the particle temperature–time history has the most direct impact on product quality. The CFD simulation of an existing tall-form spray dryer indicated that more than 60% of the particles impacted on the cylindrical wall and this may adversely affect product quality, because solids may adhere to the wall for appreciable times, dry out, and lose their wet-bulb protection. The model also predicts differences between the particle primary residence time distributions (RTD) and the gas phase RTD. This study indicates that a short-form dryer with a bottom outlet is more suitable for drying of heat-sensitive products, such as proteins, due to the low amounts of recirculated gas and hence shorter residence time of the particles.

KEYWORDS: Impact positions, Particle velocity and temperature, Residence time, Spray drying

DOI: 10.1080/07373931003787918