1 Introduction

Particle technology may be described as being the study of materials dispersed within a continuous fluid. The particles may be solid, but they can also be oil droplets in water, water droplets in air, etc. So, by a particle we mean any dispersed material within a fluid. In many cases deformable particles have a slightly different behaviour to rigid ones, but the starting point for the description of deformable particles is that of the rigid, and simpler, case. Hence, particle technology includes the understanding of raindrops, oil emulsions, powders, slurries, etc., and just about every industrial process uses the subject at some stage. For example, in petrol production the catalytic cracking of petroleum is achieved in fluidised beds of catalyst particles (Chapter 7). An understanding of fluidisation relies upon knowledge of particle characterisation and fluid flow through porous media (Chapters 2 and 3). The petroleum processing is performed in the vapour phase, not the liquid, hence the fluidised beds require appropriate gas cleaning equipment for recycling and retention of the catalyst particles (Chapter 14). The catalyst is stored and conveyed into the system (Chapters 10 and 9) and, of course, due care must be exercised over powder hazards (Chapter 15). So, even in the case of an obviously liquid product, petroleum spirit, we encounter a significant proportion of material covered in this book.

An even greater reliance on particle technology is provided by the increasing trend towards high value batch processing in the chemical and pharmaceutical industries. A prime example is the production of a tablet. In many cases a reactant is provided in a solid form and product recovery involves nucleation and then crystallization of the product. These two processes are not covered here, but the interested reader is directed towards other works [J.W. Mullen, 1997, Crystallization, Butterworth-Heinemann, 3rd edition; R.J. Davey and J. Garside, 2001, From molecules to crystallizers, Oxford Chemistry Primers, No. 86]. Most of the remaining aspects of product recovery are covered in this work. The crystals may be settled, to increase the slurry concentration going on to a filter, or filtering centrifuge; the resulting cake will need washing free of reaction products and unreacted feed material and mechanically dried, to minimise the amount of thermal energy required to complete the drying. After thermal drying (not covered here), there is likely to be a need for product storage, crushing and classification, solid/solid mixing, conveying and agglomeration for the purpose of forming the tablet. Any one of these processes may be the cause of a process bottleneck, or throughput limitation, and the intention of this book is to provide a sound understanding of the underlying principles behind these operations to enable reliable operation and appropriate decisions to be drawn.

The Reynolds number

Is a measure of the amount of turbulence within a system. It is numerically the ratio of the inertial to viscous forces. Flow Reynolds number for a fluid through a circular pipe is:

$$\mathrm{Re} = \frac{du\rho}{\mu}$$

see the Nomenclature for definitions. Values above 2000 are usually taken to indicate very significant turbulence.