Chapter 2
Particle Size, Size Distributions and Shape

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Abstract: Only for spheres, the size of a particle can be represented by a single parameter, being e.g., its diameter. For the description of a particle of any other shape more parameters are required. Many different descriptors exist. They can be directly related to visual or microscopic measurement, such as length or breadth, or they are based on the concept of equivalent sphere, yielding the diameter of a sphere that shows the same behavior as the particle or group of particles under consideration. Measurement of particle size by different principles may lead to different results for the same group of non-spherical particles. Examples of equivalent sphere diameters are equivalent sieve (or near-mesh) diameter, Stokes’ diameter and volume diameter. Usually, the particles in a particulate product do not have the same size but a distribution of sizes. Here too, there are different possibilities for quantitative description. One example is a size distribution, based on number, volume or mass of the particles. Other possibilities are a mean size, a single or a small number of descriptors in the middle or at either side of the distribution, or parameters of a model-distribution. The choice of descriptors for particle size and size distribution should be made such that they give the best discrimination for the quality of the particulate product with respect to given properties or for characterization of a production process. If these properties also depend on particle shape, shape and shape distribution should be characterized in addition to size. This can be done in qualitative terms, such as fibers or flakes, or in quantitative terms, such as elongation, roundness, angularity, surface rugosity, percentages of given model shapes, or fractal dimension. Finally, the porosity of particles may play a role in their behavior. This chapter describes some of the many possibilities that exist.
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2.1 Particle Size

In the ideal world of particle characterization, all particles would be homogeneous spheres. Moreover, they would have uniform properties such as density, chemical composition, color, and opacity. Then, all size measurement methods would yield the same size for a particle, being its diameter, and the same particle size distribution (PSD) for a collection of particles, regardless of the principle applied in the technique. It will be clear that such particles would constitute the ideal standard reference material for particle size measurement methods. It will also be clear that this world would be rather dull.

In the real world, most particles are not spherical, but have different shapes and often rough surfaces. Materials of different chemical composition have different properties (e.g., density, conductivity, refractive index) and, even when the bulk

![Fig. 2.1 Vertical (l) and horizontal (r) projection of a particle in most stable resting position, together with some Feret and Martin diameters and chord lengths](image)

Good practice requires:

- good data on PSD, shape, surface and porosity of product
- known relationship between performance and PSD
- adequate choice of PSD parameter(s)
- the reasoning for this choice.