Number and volume-based distribution in particle size analysis

Particle size controls a vast array of sample properties in many industries. As a result, the analysis of particle size and shape is pivotal in ensuring product quality and performance. Understanding the distribution of particle sizes provides valuable insights into material behavior and performance characteristics. Knowing how these particle size distributions are measured and reported is critical to understanding their impact.

At ImageProVision, we recognize the importance of generating quality, relevant data to each application to provide measurable and inciteful guidance. With regards to the measurement of particle size, there are several techniques available that can accurately measure a distribution of particles in the micron size range. These techniques include both Laser Diffraction and Microscopic Image Analysis, to name a few. The challenge associated with these comparative techniques is that they each measure different physical properties of the particles being examined, leading to differences in the resulting Distributions.

The comparison between these techniques is that one provides a volumetric based distribution, and the other a number-based distribution. For Laser diffraction the analysis method provides a volumetric size distribution, reporting results as spheres of equivalent volume.

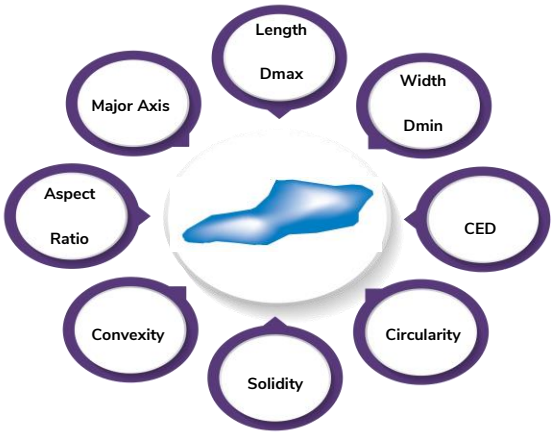


Figure 1 Particle sizes expressed as the diameter of an equivalent sphere. These diameters often appear very different to the particle dimensions observed under a microscope.

This is known as equivalent sphere theory, a theory that describes all the different properties of particles that can be related to a particle of equivalent sphere (Figure 1). In contrast, when using a microscope to measure the size of a particle the measurement is performed on a particle-by-particle basis, this type of measurement is considered a number-based distribution. The primary difference between these two results is the contribution each particle makes to the overall distribution, in volume, there is a cubic relationship as compared to number where there is a linear relationship of each particles contribution.

Let us consider an illustrative example (Figure 2): a sample comprising spherical particles ranging from 1µm to 10µm in diameter. While the number distribution histogram depicts an equal number of particles in each size class, the volume distribution, while being an entirely valid way of representing the data, highlights a disproportionate influence of larger particles.

Volume distributions offer valuable insights into the presence and characteristics of larger particles, crucial for applications such as content uniformity control and the development of topical dosage forms.

ImageProVision leverages cutting-edge technologies in image analysis to derive accurate number distributions, essential for detecting subtle size differences between samples. These differences, often imperceptible in volume distributions, can significantly impact product performance, especially in processes like granulation.

Furthermore, number distributions play a vital role in applications where fine particles significantly influence material behaviour, such as moisture sorption and stability assessments. By focusing on the number of particles within specific size ranges, we gain valuable

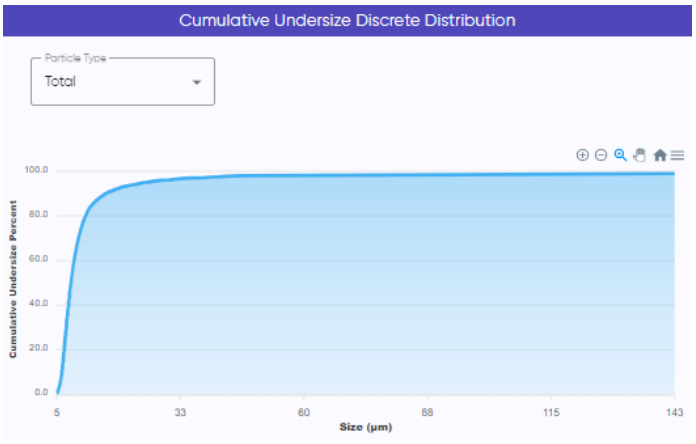


Figure 2(a). Cumulative undersize distributions of batches of Sitagliptin presented as volume distributions.

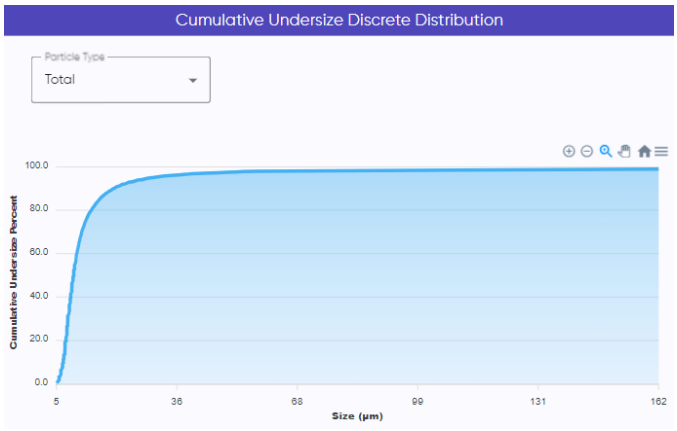


Figure 2(b). Cumulative undersize distributions of batches of Sitagliptin presented as number distributions.

In summary, particle size analysis, whether through volume or number distributions, serves as a cornerstone in ensuring product quality, performance, and consistency across various industrial applications. At our company, we are committed to leveraging the latest advancements in particle size measurement to drive innovation, enhance product quality, and meet the evolving needs of our customers.

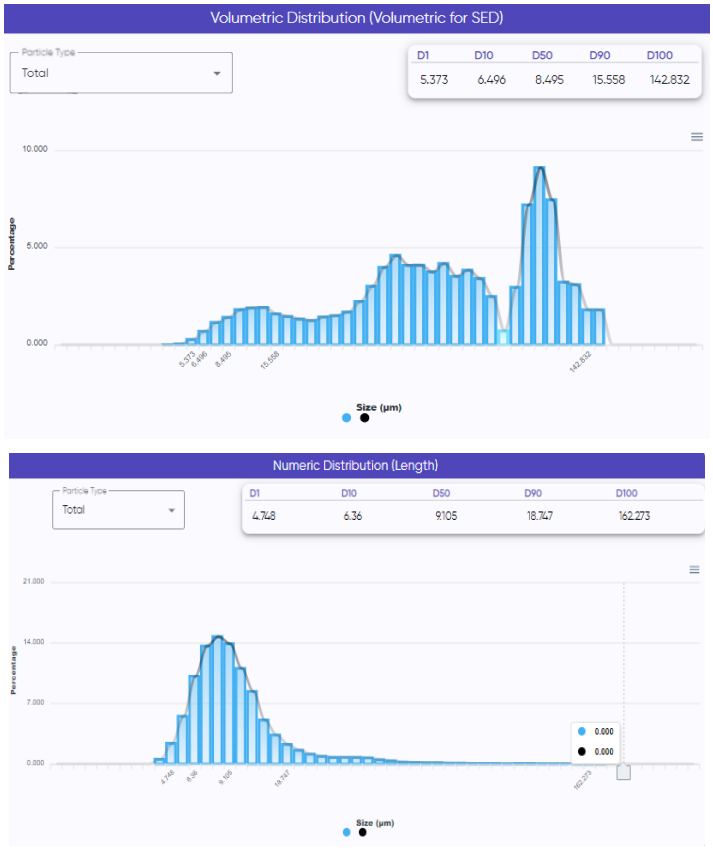


Figure 3. Volume and number distributions for a sample of Sitagliptin. Visual evidence (see insert) suggests that the sample dispersion mainly consists of many small primary particles with a small number of larger agglomerates. The volume distribution shows that the small numbers of agglomerates have the highest intensity in the frequency distribution. The number distribution gives a different perspective and confirms that the number of agglomerates is small. These data were acquired using the ipvPClass (particle size and shape Analyser) and present in two size parameters derived from image analysis, the volumetric spherical equivalent diameter and maximum Feret diameter.

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