



Standard Practice for Calculation of Mean Sizes/Diameters and Standard Deviations of Particle Size Distributions¹

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1. Scope

1.1 The purpose of this practice is to present procedures for calculating mean sizes and standard deviations of size distributions given as histogram data (see Practice E1617). The particle size is assumed to be the diameter of an equivalent sphere, for example, equivalent (area/surface/volume/perimeter) diameter.

1.2 The mean sizes/diameters are defined according to the Moment-Ratio (M-R) definition system.^{2,3,4}

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:⁵

E1617 Practice for Reporting Particle Size Characterization Data

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

¹ This practice is under the jurisdiction of ASTM Committee E56 on Nanotechnology and is the direct responsibility of Subcommittee E56.02 on Physical and Chemical Characterization.

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² Alderliesten, M., “Mean Particle Diameters. Part I: Evaluation of Definition Systems,” *Particle and Particle Systems Characterization*, Vol 7, 1990, pp. 233–241.

³ Alderliesten, M., “Mean Particle Diameters. From Statistical Definition to Physical Understanding,” *Journal of Biopharmaceutical Statistics*, Vol 15, 2005, pp. 295–325.

⁴ Mugele, R.A., and Evans, H.D., “Droplet Size Distribution in Sprays,” *Journal of Industrial and Engineering Chemistry*, Vol 43, 1951, pp. 1317–1324.

⁵ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3.1.1 *diameter distribution, n*—the distribution by diameter of particles as a function of their size.

3.1.2 *equivalent diameter, n*—diameter of a circle or sphere which behaves like the observed particle relative to or deduced from a chosen property.

3.1.3 *geometric standard deviation, n*—exponential of the standard deviation of the distribution of log-transformed particle sizes.

3.1.4 *histogram, n*—a diagram of rectangular bars proportional in area to the frequency of particles within the particle size intervals of the bars.

3.1.5 *lognormal distribution, n*—a distribution of particle size, whose logarithm has a normal distribution; the left tail of a lognormal distribution has a steep slope on a linear size scale, whereas the right tail decreases gradually.

3.1.6 *mean particle size/diameter, n*—size or diameter of a hypothetical particle such that a population of particles having that size/diameter has, for a purpose involved, properties which are equal to those of a population of particles with different sizes/diameters and having that size/diameter as a mean size/diameter.

3.1.7 *moment of a distribution, n*—a moment is the mean value of a power of the particle sizes (the 3rd moment is proportional to the mean volume of the particles).

3.1.8 *normal distribution, n*—a distribution which is also known as Gaussian distribution and as bell-shaped curve because the graph of its probability density resembles a bell.

3.1.9 *number distribution, n*—the distribution by number of particles as a function of their size.

3.1.10 *order of mean diameter, n*—the sum of the subscripts p and q of the mean diameter $\bar{D}_{p,q}$.

3.1.11 *particle, n*—a discrete piece of matter.

3.1.12 *particle diameter/size, n*—some consistent measure of the spatial extent of a particle (see *equivalent diameter*).

3.1.13 *particle size distribution, n*—a description of the size and frequency of particles in a population.

3.1.14 *population, n*—a set of particles concerning which statistical inferences are to be drawn, based on a representative sample taken from the population.