



## Designation: F 751 – 83 (Reapproved 1997)

AMERICAN SOCIETY FOR TESTING AND MATERIALS  
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# Standard Test Method for Measuring Particle Size of Wide-Size Range Dry Toners<sup>1</sup>

This standard is issued under the fixed designation F 751; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method covers a dual-aperture particle size analysis using an electronic sensing zone apparatus. Dry inks, toners, etc., are covered. Particles as small as 1.0-μm diameter and as large as 80-μm diameter in a single powder system can be analyzed.

1.2 This test method is for particulate systems having a size range greater than 20 to 1, therefore requiring two apertures. For applications where particle size difference is between 1.4 μm and 80 μm and having a 20 to 1 or less size range, the simpler procedure found in Test Method F 577 should be used.

1.3 *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:

E 161 Specification for Precision Electroformed Sieves (Square-Opening Series)<sup>2</sup>

F 577 Test Method for Particle Size Measurement of Dry Toners<sup>3</sup>

## 3. Descriptions of Terms Specific to This Standard

3.1 *number size distribution*, is measured and is characteristically represented as a cumulative number percent curve (see Fig. 1).

3.2 *volume size distribution*, is mathematically calculated and is characteristically represented as a cumulative volume percent curve (see Fig. 1).

3.3 *median particle size*, (50 % oversize or undersize) is a convenient value for the central tendency of a size distribution curve. For a distribution derived by number of particles, it is called the number median size. If volume is used to derive the distribution, it is referred to as the volume median size.

3.4 *channel size class or interval*— a subgroup that has

been obtained by dividing the range of particle sizes into an arbitrary number of channels. Most instruments have divided the channels to give intervals that are on a geometric progression using a factor of  $\sqrt[3]{2}$  of a particle diameter.

## 4. Summary of Test Method

4.1 This technique **(1)**<sup>4</sup> determines the number and size of particles suspended in an electrolyte by causing them to flow through a small orifice on both sides of which are immersed electrodes. Voltage pulses, whose amplitudes are proportional to the particle volumes, are generated by changes in resistance as the particles pass through the orifice. These pulses are amplified, sized, and counted, yielding size distribution data for the suspended phase.

4.2 This test method covers the particle size range covered by combining the data from two apertures of different sizes. A typical particle size range would be 1.0 to 80 μm, using a 50-μm and a 200-μm aperture combination.

## 5. Significance and Use

5.1 This test is useful in determining particle size characteristics of dry toners used in copying machines in cases where the particulate system exceeds a 20 to 1 particulate diameter range. It is a practiced method for use in both quality control and research of toner particle size.

## 6. Apparatus

6.1 *Electrical Sensing Zone Instrument* **(2)**<sup>5</sup>, having at least 16 size channels and aperture tubes of the following nominal sizes: 50 μm, 70 μm, 100 μm, 140 μm, and 200 μm.

6.2 *Ultrasonic Dispersing Probes*, or alternative equipment suitable for dispersing the dry toner in an aqueous electrolyte.

### 6.3 *Scalping Screen or Sieve*:

6.3.1 *Three-Inch Diameter Precision Electroformed Sieve*<sup>6</sup> with 32-μm openings in accordance with Specification E 161.

6.3.2 *Twill Square Weave Nitex Monofilament Nylon Screen*<sup>7</sup>, with 30-μm openings. The nylon screen can be

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 14.02.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 15.09.

<sup>4</sup> The **boldface** numbers in parentheses refer to the list of references at the end of this test method.

<sup>5</sup> The counters from Coulter Electronics, Hialeah, FL, and Partical Data, Elmhurst, IL, have been found satisfactory.

<sup>6</sup> Available from Buckbee Mears Co., St. Paul, MN.

<sup>7</sup> Available from Tetko Inc., Elmsford, NY.

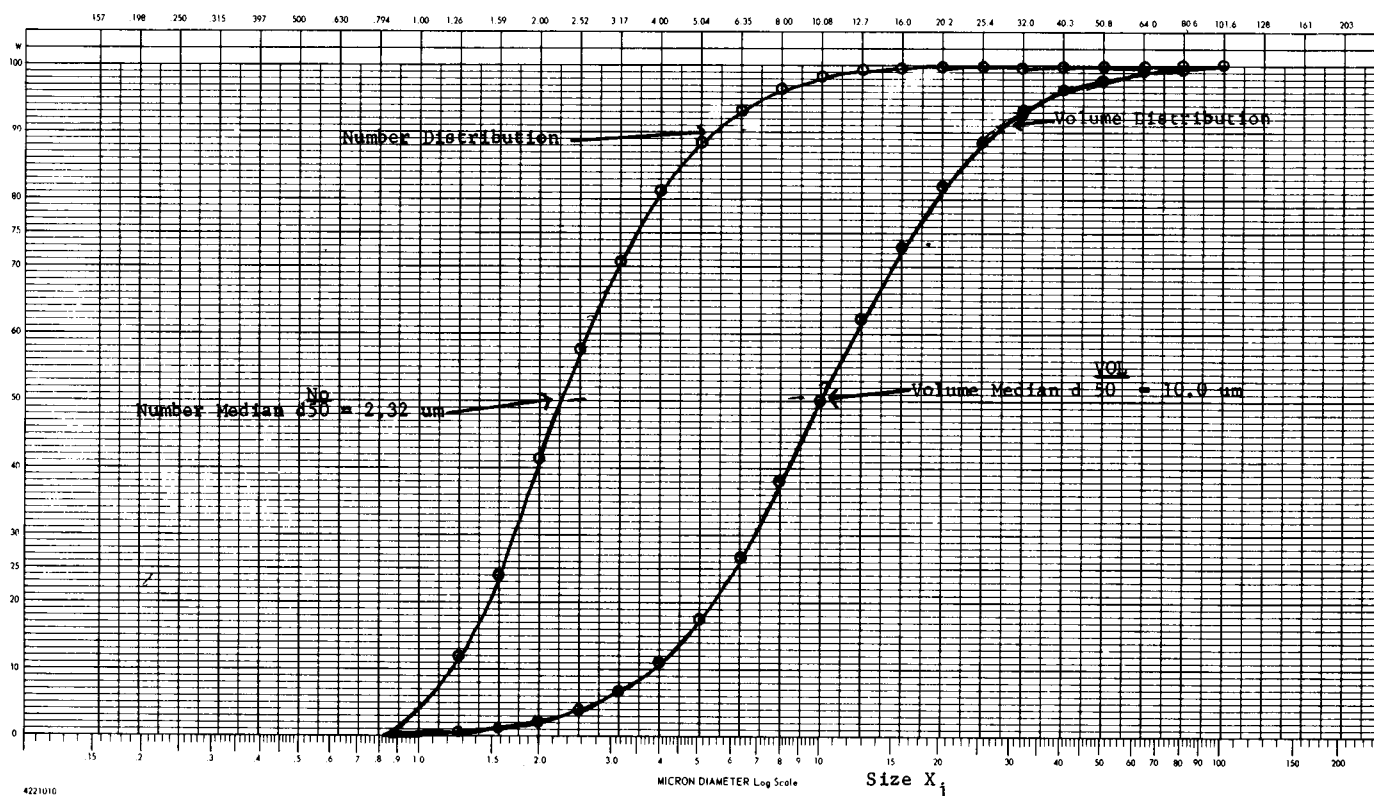


FIG. 1 Toner Particle Size Distribution

mounted on a 1½-in. long by 3-in. diameter PVC pipe with a rubber band.

## 7. Reagents and Materials

7.1 *Electrolyte*—Four weight percent aqueous sodium pyrophosphate or 1 weight % sodium chloride in water. The electrolyte shall be adequately filtered to remove almost all particle contaminants greater than 1  $\mu\text{m}$ . Some aqueous electrolytes such as 1 % sodium chloride electrolytes are commercially available.<sup>8</sup>

7.2 *Surfactant*<sup>9</sup>—A nonionic surface active agent suitable for keeping toner particles separated while in suspension.

7.3 Near monosized spherical particles for calibration standards.<sup>10</sup>

## 8. Cautions

8.1 The largest particles in any particulate system are always the lowest in number, therefore carrying the greatest statistical variation. This inherent deviation may be reduced with this method, at the operators option, by increasing the counting time or by taking more repeat counts.

<sup>8</sup> Aqueous filtered saline solutions are available from Curtin Matheson Scientific, Houston, TX, and J. T. Baker Co., Phillipsburg, NJ.

<sup>9</sup> Triton X-100 available from Rohm and Haas, Philadelphia, PA, diluted to 0.05 weight % and filtered has been found to be acceptable. This and other nonionic surfactants can also be obtained from Curtin Matheson Scientific. These have already been diluted in the proper concentration and adequately filtered to remove fine particles.

<sup>10</sup> Available from Coulter Electronics, Hialeah, FL; Dow Chemicals, Indianapolis, IN; Duke Scientific, Palo Alto, CA; and Particle Information, Grants Pass, OR.

## 9. Sampling

9.1 Sample the powder when flowing (1).

9.2 Sample the entire powder flow over small intervals of time. This is preferable to continuous withdrawal of a small fraction of the flow.

NOTE 1—Often the processes used to produce dry toner and the semicohesive, electrostatic nature of the fine material can make it prohibitively difficult to follow these important general rules for powder sampling.

NOTE 2—These rules are especially important for free-flowing powders of broad-size distribution, which tend to segregate.

NOTE 3—In the case of toner, because of its semicohesive nature and relatively narrow distribution, in contrast to many powders generated from mineral processing, the problems of segregation are frequently not as severe.

9.3 A further positive aspect is that electrostatic imaging requires material that produces uniform, stable, and acceptable copy quality, one copy after the other. In general, the usage rate is in the range from 10 to 100 mg per copy, depending on the original document and the electrostatic conditions. Each copy, consequently, contains a small sampling of the bulk toner.

9.4 The above considerations tend to permit a practical assessment of quality by the measurement of a number of small samples taken from various sections of nonmoving powder beds and containers. These samples may be obtained by probes, also known as “thieves,” for which many designs exist. In fact, this method is often preferable to more elaborate techniques, like sample splitters, which have moving parts. Such devices are difficult to maintain, and may have places where the thermally sensitive powder is fused by shear to form