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## Standard Test Methods for Specific Gravity of Coating Powders<sup>1</sup>

This standard is issued under the fixed designation D5965; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 These test methods cover three procedures for determining the specific gravity (see definition) of coating powders, as follows:

TEST METHOD A—For Testing Coating Powders, Excluding Metallics

TEST METHOD B—For Tests Requiring Greater Precision than Test Method A, Including Metallics, Using Helium Pycnometry

TEST METHOD C—For Theoretical Calculation Based on Raw Material Specific Gravities

1.2 Test Method A can be used as a less expensive method with reduced accuracy for determining the specific gravity of coating powders, excluding metallics.

1.3 The ideal gas law forms the basis for all calculations used in the Test Method B determination of density of coating powders.

1.4 Test Method B includes procedures that provided acceptable results for samples analyzed during round robin testing.

1.5 Test Method B uses SI units as standard. State all numerical values in terms of SI units unless specific instrumentation software reports surface area using alternate units. Many instruments report density as  $\text{g/cm}^3$ , instead of using SI units ( $\text{kg/m}^3$ ).

1.6 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.7 *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.*

<sup>1</sup> These test methods are under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and are the direct responsibility of Subcommittee D01.51 on Powder Coatings.

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### 2. Referenced Documents

2.1 *ASTM Standards*:<sup>2</sup>

D3924 Specification for Environment for Conditioning and Testing Paint, Varnish, Lacquer, and Related Materials

D5382 Guide to Evaluation of Optical Properties of Powder Coatings

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

### 3. Terminology

3.1 *Definitions*:

3.1.1 Definitions 3.1.1 and 3.1.3 are from Guide D5382.

3.1.2 *coating powder, n*—finely divided particles of resin, either thermoplastic or thermosetting, generally incorporating pigments, fillers, and additives and remaining finely divided during storage under suitable conditions, which, after fusing and possibly curing, give a continuous film.

3.1.3 *meniscus, n*—curved upper surface of a liquid column that is concave when the containing walls are wetted by the liquid.

3.1.4 *powder coating, n*—coatings which are protective or decorative, or both, formed by the application of a coating powder to a substrate and fused into continuous films by the application of heat or radiant energy.

3.1.5 *pycnometer, n*—instrument designed to measure the volume of solid materials using Archimedes' principle of fluid displacement. The displaced fluid is a helium gas.

3.1.6 *specific gravity*—(1) strict definition: the density of a substance relative to that of water; (2) practical, as used in this test method—The numerical value of the density when the latter is expressed in grams per millilitre.

<sup>2</sup> 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.

#### 4. Significance and Use

4.1 Test Method A is a less expensive method of determining specific gravity of coating powders, excluding metallics, that produced less precise results than Test Method B.

4.2 Test Method B provides better precision at higher cost and includes metallics, although different models produced different grand averages for each of the three samples tested.

4.3 Test Method C is commonly used by the powder coating industry to estimate the coverage of a powder coating at a given thickness, using the theoretical specific gravity calculated from those of the raw materials.

#### 5. Reagents

5.1 *Purity*—Wetting vehicles should be of reagent grades.

5.2 *Helium*—Shall be understood to mean high purity of commercial grade.

#### 6. Conditioning

6.1 These tests should be standardized at  $23 \pm 2^\circ\text{C}$  ( $73.5 \pm 3.5^\circ\text{F}$ ) and relative humidity of  $50 \pm 5\%$  for the two methods in compliance with Specification **D3924**.

### TEST METHOD A—FOR TESTING POWDER COATINGS, EXCLUDING METALLICS

#### 7. Apparatus and Materials

7.1 *Volumetric Flask*—Calibrated narrow-necked glass type, having a 50-mL capacity.

7.2 *Balance*—A calibrated laboratory balance having a  $\pm 0.001$  g-accuracy. A less accurate balance can be used with a relative effect on the results.

7.3 *Coating Powder*—Weighed to 15 g, within a  $\pm 0.01$  g-accuracy.

7.4 *Immersion Liquid*—Hexane was found to be a good wetting vehicle for the epoxy and polyester coatings used in the round robin for the testing of repeatability and reproducibility.

7.5 *Glass Funnel*—Designed to fit within the neck of the volumetric flask.

7.6 *Polished Round-Bottom Glass Rods*—For dispersing powder.

7.7 *Squeeze Bottle*—Suitable for containing and dispensing wetting vehicle.

#### 8. Hazards

8.1 Exercise care in handling all wetting vehicles. Make sure that personal equipment includes protective gloves, glasses, and clothing. Perform test method using wetting vehicles in a solvent hood.

#### 9. Standardization

9.1 Weigh the empty, clean volumetric flask. Record this weight as *WF*.

9.2 The density of the wetting vehicle, recorded as *DL*, can be determined by adding exactly 50 mL of wetting vehicle to

the previously weighed flask and reweighing. Record this weight as *WFL*. Calculate the density of the wetting vehicle (*DL*) as follows:

$$DL = \frac{(WFL - WF)}{50 \text{ mL}} \quad (1)$$

#### 10. Procedure

10.1 Weigh the 50-mL volumetric flask. Record this weight as *WF*. Add 15 g of powder to the clean, dry, weighed flask and accurately reweigh. Record this weight as *WFP*. Add enough wetting vehicle to cover the powder and gently swirl until the powder is completely wet.

10.2 The removal of entrapped air has a significant effect on the accuracy of the results. Care should be taken to insure wetting out of the powder is complete. When necessary, stir the powder with a polished round-bottom glass rod until completely covered by the wetting vehicle. Wash the rod with wetting vehicle, adding the washings to the flask without exceeding the 50-mL calibration mark.

10.3 Add additional wetting vehicle up to the 50-mL mark. Make sure that the bottom of the meniscus is aligned at eye level with the line on the front and back of the flask neck. This addition of wetting vehicle can be done with a squeeze bottle in a manner to wash any residual powder from the neck of the flask. Reweigh and record this weight as *WFPL*.

10.4 Multiple volumetric flasks can be used in rotation to reduce cleaning and complete drying time.

10.5 **Immediately** clean the flask after each test to increase the ease with which this is accomplished. Each flask shall be completely clean and dry before proceeding to the next test.

#### 11. Calculation

11.1 Calculate the density of the powder (*DP*) as follows:

$$DP = \frac{WFP - WF}{50 \text{ mL} - \frac{WFPL - WFP}{DL}} = \frac{\text{numerator}}{\text{denominator}} \quad (2)$$

where:

*WFP* = weight of flask and powder,  
*WF* = weight of flask,  
*WFPL* = weight of flask, powder, and wetting vehicle,  
*DL* = density of wetting vehicle, and  
*DP* = specific gravity of powder.

11.2 An example, using hexane, would be as follows:

$$DP = \frac{50.545 \text{ g} - 36.581 \text{ g}}{50 \text{ mL} - \frac{77.200 \text{ g} - 50.545 \text{ g}}{0.663 \text{ g/mL}}} = \frac{13.964}{9.796} = 1.42 \text{ specific gravity} \quad (3)$$

where:

*WFP* = 50.545 g,  
*WF* = 36.581 g,  
*WFPL* = 77.200 g,  
*DL* = 0.663 g/mL, and  
*DP* = unknown.