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Standard Test Methods for Density of Coating Powders[1]

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 (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 These standard test methods cover three procedures for determining the density of coating powders, as follows:

1.2 Test Method A, for testing coating powders, excluding metallics, is a method that uses readily available laboratory equipment (for example, analytical balance, volumetric flask, etc.).

1.3 Test Method B requires the use of a pycnometer.

1.4 Test Method C is a method that calculates the density of a powder based upon the formula ingredients and their amounts and densities.

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

1.6 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D3924 Specification for Standard Environment for Conditioning and Testing Paint, Varnish, Lacquer, and Related Materials (Withdrawn 2016)[3]

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

3. Terminology

3.1 *Definitions:*

3.1.1 *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.

3.1.2 *density, n*—the mass per unit volume of a material, usually expressed in g/cm^3.

3.1.2.1 *Discussion*—In this standard, a volumetric flask capacity is expressed—by convention—in mL. However, convention also states density in terms of mass per cm^3. Since 1 mL = 1 cm^3, terms will be interchanged—by convention—but will not affect any of the calculations.

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 *wetting liquid, n*—an organic solvent used to wet-out the powder and displace the air that is trapped between the powder particles.

4. Significance and Use

4.1 Test Method A is a straight-forward method using readily available laboratory equipment and glassware. Test Method A may only be used with powder that does not contain metallic pigments.

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 may be used when the formulation is known, and the density of each raw material is available.

[1] 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] 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] The last approved version of this historical standard is referenced on www.astm.org.

5. Reagents

5.1 *Wetting liquid*—May be a reagent grade solvent or a solvent blend, such as kerosene.

5.2 *Helium*—Must be high purity, commercial grade.

6. Conditioning

6.1 These tests should be standardized at 23 ± 2°C (73.5 ± 3.5°F) and relative humidity of 50 ± 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 at least 50-mL capacity.

7.2 *Balance*—A calibrated laboratory balance having at least ±0.01 g-accuracy.

7.3 *Coating Powder*—Weighed to approximately 15 g, within at least ±0.01 g-accuracy.

7.4 *Wetting Liquid*—Hexane (reagent grade) or a solvent blend such as kerosene has been found to be a good wetting vehicle for the epoxy and polyester powder coatings.

NOTE 1—Wetting liquids must not swell or dissolve the powder.

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

7.6 *Polished Round-Bottom Glass Rods*—For mixing powder to displace the air.

7.7 *Squeeze Bottle*—Suitable for containing and dispensing wetting liquid (for example, hexane, kerosene).

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. Procedure

9.1 Weigh the volumetric flask to at least the nearest 0.01 g. Record this mass as F_{empty}.

9.2 Add approximately 15 g of powder to the empty flask and reweigh. Record this mass as $F_{with\ powder}$ to at least the nearest 0.01 g.

9.3 Add just enough wetting liquid to cover the powder. Gently swirl until the powder is completely wet by the wetting liquid.

9.3.1 Displacing all entrapped air is mandatory. Care should be taken to ensure wetting-out of the powder is complete. When necessary, carefully stir the powder with a polished round-bottom glass rod until the powder is completely covered by the wetting liquid. Rinse the rod with wetting vehicle, being sure that all material is washed into the flask *without exceeding the volume mark.*

9.4 Add additional liquid up to the 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 volumetric 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.

9.5 Reweigh the flask, which now contains powder and wetting liquid, and record this mass as $F_{powder+hexane}$.

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

9.5.2 Clean the flask thoroughly after each test.

10. Calculation

10.1 *Density of Wetting Liquid:*

10.1.1 When using reagent grade wetting liquid (for example, hexane), use the density value supplied by the manufacturer.

10.1.2 When using a wetting liquid that is a blend of solvents (for example, kerosene), the density must be measured.

10.1.2.1 To measure the density of the wetting liquid, weigh a volumetric flask with a capacity of at least 50 mL. Record this mass to the nearest 0.01 g as F_{empty}. Fill the flask to the mL mark and reweigh the flask. Record this mass as $F_{wetting\ liquid}$. The density of the wetting liquid is determined as follows:

$$Density_{\text{wetting liquid}} = \frac{F_{\text{wetting liquid}} - F_{\text{empty}}}{\text{Volume of flask}}$$

For example, if a 50 mL volumetric flask is used, and if

$F_{wetting\ liquid}$ = 77.923 g
F_{empty} = 36.581 g
$Density_{wetting\ liquid}$ = (77.923 – 36.581) / 50 cm^3 = 0.827 g/cm^3

10.2 Calculate the density of the powder as follows:

$$Density_{\text{powder}} = [F_{\text{with powder}} - F_{\text{empty}}] / \left[\text{Flask volume} - \left(\frac{F_{\text{powder+wetting liquid}} - F_{\text{with powder}}}{Density_{\text{wetting liquid}}}\right)\right]$$

where:

$Density_{powder}$ = density of the powder, expressed as g/cm^3
$F_{with\ powder}$ = mass of the volumetric flask with powder added
F_{empty} = mass of the empty volumetric flask
$F_{powder+wetting\ vehicle}$ = mass of the volumetric flask, including the mass of the powder and the wetting vehicle
$Density_{wetting\ vehicle}$ = the density of the reagent grade wetting vehicle, or the determined density (mentioned in 10.1.2.1)

10.2.1 An example, using hexane, and using a 50 mL volumetric flask, would be as follows:

$$Density_{\text{powder}} = (50.545\ \text{g} - 36.581\ \text{g}) / \left[50\ \text{mL} - \left(\frac{77.200\ \text{g} - 50.545\ \text{g}}{0.663\ \text{g/cm}^3}\right)\right]$$

$$Density_{\text{powder}} = 1.425\ \text{g/cm}^3$$

where:

$F_{with\ powder}$ = 50.545 g