Standard Test Method for
Porosity of Paint Film by Mineral Oil Absorption[1]

This standard is issued under the fixed designation D6583; 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 is applicable to air-dry architectural coatings of any type, both solvent and water-borne, and of any color, dark as well as light. It cannot be used with films that are dissolved or excessively softened by mineral oil, but practical examples of such films will be encountered rarely, if ever.

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

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:*[2]

D1475 Test Method For Density of Liquid Coatings, Inks, and Related Products

D2369 Test Method for Volatile Content of Coatings

D3258 Test Method for Porosity of White or Near White Paint Films by Staining

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

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

3. Terminology

3.1 *Definitions:*

3.1.1 *porosity, n*—presence of numerous minute voids in a cured material; that is, the fraction of air by volume in the dry film.

4. Summary of Test Method

4.1 The test paint is applied to a preweighed nonporous panel, air dried, then reweighed to obtain the weight of the film.

4.2 Mineral oil is applied to the surface of the paint film, allowed to absorb for a fixed period of time, and the excess removed in a specified manner. The test panel is then reweighed to determine the amount of mineral oil absorbed.

4.3 Porosity is calculated from the weight ratio of absorbed oil to dry paint film and from previously determined values of non-volatile and density for the whole paint.

5. Significance and Use

5.1 The porosity of a paint film is closely related to the important practical characteristics of stain resistance, abrasion resistance, durability, and the hold-out of any paint subsequently applied.

5.2 This test provides a precise means for evaluating and comparing the quality of paint films, insofar as it pertains to porosity as determined on a coating applied to a nonporous substrate. Porosity measured using this test method may *not* be an accurate predictor of coating porosity when the coating is applied to substrate of higher absorption characteristics.

5.3 Unlike current Test Method D3258 Porosity of Paint Films, which is effective only with light colored paints, this test method is equally effective with paints of any color, both dark and light. Also unlike Test Method D3258, its results are not influenced by the hiding characteristics of the paint film.

6. Apparatus and Materials

6.1 *Bird Type Film Applicator,* 150-mm wide with a clearance of 150 μm.

6.2 *Bird Type Film Applicator,* 150-mm wide with a clearance of 100 μm.

6.3 *Vacuum Drawdown Plate.*

6.4 *Test Panel.*[3]

6.5 *Mineral Oil,* specific gravity 0.8200 to 0.8350; viscosity 6.5 to 7.8 cSt at 40°C.

6.6 *Absorbent Wipers.*

7. Procedure

7.1 Weigh each test panel to the nearest milligram. Record as W_p.

7.2 Place the test panel on the vacuum plate and apply the paint under test with the 150-μm clearance drawdown blade. Remove the test panel from the vacuum plate and air dry as 48 h under standard conditions of 23 ± 2°C and 50 ± 5 % relative humidity.

7.3 Weigh the coated test panel to the nearest milligram. Record this weight as W_{p+f}.

7.4 Place the coated test panel on the vacuum plate and apply the mineral oil with the 100-μm clearance drawdown blade making sure the entire surface of the coating is covered by the oil.

7.5 After 3 min, wipe off excess mineral oil with the absorbent wipers. Hold the test panel at an angle to a light source to ascertain from its sheen if all mineral oil is removed from the test panel. Repeat wiping, if necessary, until the film has no sheen. Failure to remove this excess will produce erroneous results. Results are invalid if paint film is removed during this process.

7.6 Weigh the test panel from 7.5 to the nearest milligram and record as W_o.

7.7 Determine the density D of the paint in g/mL and the density d of the saturant in g/mL, in accordance with Test Method D1475.

7.8 Determine the nonvolatile by weight N of the paint, in accordance with Test Method D2369.

8. Calculation

8.1 *Weight of Applied Paint Film:*

8.1.1 Calculate the weight of the applied paint film as follows:

$$W_f = W_{p+f} - W_p \tag{1}$$

where:

W_f = paint film, g,
W_{p+f} = test panel and paint film, g, and
W_p = test panel, g.

8.2 *Weight of Mineral Oil Absorbed:*

8.2.1 Calculate the weight of the mineral oil m absorbed by the paint film as follows:

$$W_m = W_o - W_{p+f} \tag{2}$$

where:

W_m = mineral oil absorbed by the paint film, g,
W_o = oiled test paint, g, and
W_{p+f} = test panel and paint film, g.

8.3 *Weight Ratio of absorbed Oil to Dry Paint Film:*

8.3.1 Calculate the ratio of absorbed oil to dry paint film R as follows:

$$R = W_m / W_f \tag{3}$$

where:

R = weight ratio of absorbed oil to dry paint film,
W_m = mineral oil absorbed by the paint film, g, and
W_f = paint film, g.

8.4 *Porosity:*

8.4.1 Calculate porosity P as follows:

$$P = \frac{CRND}{CRND + d\,(C + ND - D)} \times 100 \tag{4}$$

where:

C = constant of:
    1.00 for water-based systems, and
    0.78 for solvent-based systems.

NOTE 1—The constant C is to adjust the calculation for the difference in density of the solvent (water in water-based systems and a generic solvent in solvent-based systems).

P = porosity of paint film, expressed as a percentage,
R = ratio by weight of absorbed oil to dry paint film,
N = nonvolatile by weight of the whole paint,
D = density of the whole paint, g/mL, and
d = density of the saturant, g/mL.

9. Report

9.1 Report the porosity of the paint film as determined in 8.4.1 to 1 decimal place.

10. Precision and Bias[4]

10.1 The precision of this test method is based on an interlaboratory study of D6583, Test Method for Porosity of Paint Film by Mineral Oil Absorption, conducted in 2010. Each of four laboratories tested four paints for porosity, in order to determine the intralaboratory and interlaboratory precision. Laboratories reported triplicate test results, each result being an individual determination. Practice E691 was followed for the design and analysis of the data; the details are given in Research Report: RR:D01-1173.

10.1.1 *Repeatability Limit (r)*—Two test results obtained within one laboratory shall be judged not equivalent if they differ by more than the "*r*" value for that material; "*r*" is the interval representing the critical difference between two test results for the same material, obtained by the same operator using the same equipment on the same day in the same laboratory.

10.1.1.1 Repeatability limits are listed in Table 1.

TABLE 1 Porosity (Fraction of Air by Volume in the Dry Paint Film

Material	Average[A] X	Repeatability Standard Deviation s_r	Reproducibility Standard Deviation S_R	Repeatabiliby Limit r	Reproducibility Limit R
A	27.75	5.28	11.26	14.79	31.52
B	26.13	3.16	6.97	8.86	19.53
C	5.90	1.65	4.61	4.62	12.92
D	7.93	2.08	6.20	5.83	17.36

[A] The average of the laboratories' calculated averages.

10.1.2 *Reproducibility Limit (R)*—Two test results shall be judged not equivalent if they differ by more than the "*R*" value for that material; "*R*" is the interval representing the critical difference between two test results for the same material, obtained by different operators using different equipment in different laboratories.

10.1.2.1 Reproducibility limits are listed in Table 1.

10.1.3 The above terms (repeatability limit and reproducibility limit) are used as specified in Practice E177.

10.1.4 Any judgment in accordance with statements 10.1.1 and 10.1.2 would normally have an approximate 95 % probability of being correct, however the precision statistics obtained in this ILS must not be treated as exact mathematical quantities which are applicable to all circumstances and uses. The limited number of laboratories reporting results guarantees that there will be times when differences greater than predicted by the ILS results will arise, sometimes with considerably greater or smaller frequency than the 95 % probability limit would imply. Consider the repeatability limit and the reproducibility limit would imply. Consider the repeatability limit

and the reproducibility limit as general guides, and the associated probability of 95 % as only a rough indicator of what can be expected.

10.2 *Bias*—At the time of the study, there was no accepted reference material suitable for determining the bias for the procedure in this test method, therefore no statement on bias can be made.

10.3 The precision statement was determined through statistical examination of 47 results, from four laboratories, on four paints, which are described as:

Sample A: 59 PVC latex paint using flat grade TiO_2

Sample B: 59 PVC latex paint using combination of opaque polymer and flat grade TiO_2

Sample C: 59 PVC latex paint using enamel grade TiO_2

Sample D: 59 PVC latex paint using combination of opaque polymer and enamel grade TiO_2

11. Keywords

11.1 film porosity; porosity; resistance–penetration (into paint films)