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Standard Practice for Assessing the Solvent Resistance of Organic Coatings Using Solvent Rubs[1]

This standard is issued under the fixed designation D5402; 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 practice describes a solvent rub technique for assessing the solvent resistance of an organic coating that chemically changes during the curing process. This technique can be used in the laboratory, in the field, or in the fabricating shop. Test Method D4752 is the preferred method for ethyl silicate zinc-rich primers.

1.2 This practice does not specify the solvent, number of double rubs, or expected test results.

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

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.* Consult the ~~supplier's Material~~ supplier's Safety Data Sheet for specific hazard information relating to the solvent used.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D235 Specification for Mineral Spirits (Petroleum Spirits) (Hydrocarbon Dry Cleaning Solvent)
D523 Test Method for Specular Gloss
D740 Specification for Methyl Ethyl Ketone
D843 Specification for Nitration Grade Xylene
D3363 Test Method for Film Hardness by Pencil Test
D4138 Practices for Measurement of Dry Film Thickness of Protective Coating Systems by Destructive, Cross-Sectioning Means
D4752 Practice for Measuring MEK Resistance of Ethyl Silicate (Inorganic) Zinc-Rich Primers by Solvent Rub
D7091 Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *double rub, n*—the act of rubbing a cloth in one complete forward and back motion over a coated surface.

4. Significance and Use

4.1 Coatings that chemically change during the curing process, such as epoxies, vinyl esters, polyesters, alkyds and urethanes, become more resistant to solvents as they cure. These coatings should reach specific levels of solvent resistance prior to being topcoated and prior to placing in service; the levels of solvent resistance necessary vary with the type of coating and the intended service. Rubbing with a cloth saturated with the appropriate solvent is one way to determine when a specific level of solvent resistance is reached. However, the level of solvent resistance by itself does not indicate full cure and some coatings become solvent resistant before they become sufficiently cured for service.

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[1] This practice is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.46 on Industrial Protective 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~~standard's Document Summary page on the ASTM website.

4.2 The time required to reach a specific level of solvent resistance can be influenced by temperature, film thickness, air movement and, for water-borne or water-reactive coatings, humidity.

4.3 The test ~~solvent's~~solvent's effect upon the coating varies with coating type and solvent used. The coating manufacturer may specify the solvent, the number of double rubs, and the specific test results needed.

5. Materials and Equipment

5.1 *Solvent:*
5.1.1 *Methyl Ethyl Ketone (MEK),* conforming to Specification D740, or
5.1.2 *Mineral Spirits,* conforming to Specification D235, or
5.1.3 *Xylene,* conforming to Specification D843, or
5.1.4 *Other Solvents,* as specified by the coating manufacturer or user.

5.2 *100 % Cotton, Shop Cloth or Cheesecloth.* Cheesecloth is for coil coatings, mesh grade 28 by 24. Approximately 300 by 300 mm (12 by 12 in.) and contrasting in color to the coating being evaluated, or other mutually agreed upon cloth.

5.3 *Proper Safety Equipment,* as determined from the solvent MSDS, for example, solvent resistant gloves, respirator.

6. Procedure

Method A (Standard Method)

6.1 If the testing is being performed in a laboratory setting, before actually testing the specimens, perform a sufficient number of double rubs with the index finger covered with a cotton cloth on a laboratory balance such that 1000 to 2000 g of force is constantly being applied. This is the amount of pressure the operator will apply when testing the specimens, and will be considered as being moderate pressure.

6.2 Select areas on the coated surface at least ~~150-mm (6-in.)~~100-mm (4-in.) long on which to run the tests. Clean the surface with tap water to remove any loose material and allow to dry.

6.3 Measure the dry-film thickness of the coating in the selected areas in accordance with Test Methods D4138 or Practice D7091. Mark a ~~150-~~100- by 25-mm ~~(6-~~(4- by 1-in.) rectangular test area on the undamaged, cleaned surface using a pencil or other suitable solvent resistant marker.

6.4 Fold the cotton cloth into a pad of double thickness and saturate it to a dripping wet condition with the specified solvent. Do not allow more than 10 s to elapse before proceeding to the next steps.

6.5 Place the properly protected index finger into the center of the pad while holding excess cloth with the thumb and remaining fingers of the same hand. With the index finger at a 45° angle to the test surface, rub the rectangular test area with moderate pressure first away from the operator and then back towards the operator. Use the amount of pressure determined in 6.1. One forward and back motion is one double rub, and complete at the rate of approximately 1/s.

6.6 Continue rubbing the test area for a total of 25 double rubs. Take care to stay within the rectangular test area.

6.7 If additional solvent rubs are specified, reposition the finger on an unused clean portion of the cloth and re-saturate the cloth with the selected solvent to a dripping wet condition. Do not allow more than 10 s to elapse before continuing the double rub procedure on the marked test area for an additional 25 double rubs. Repeat this step until reaching the specified test criteria, such as, until the substrate becomes visible, or until a predetermined number of double rubs have been performed. If multiple specimens are being tested in a laboratory, it may be useful to occasionally check the pressure exerted on a balance with a dry cotton cloth between specimens.

NOTE 1—If multiple specimens are being tested and fatigue sets in making it difficult to maintain the 1000 to 2000 g force, stop testing (after completing a specimen) until fatigue is gone.

6.8 If the film has not been removed down to the substrate, immediately inspect the middle ~~125~~75 mm ~~(5~~(3 in.) of the rubbed area, disregarding 13 mm (½ in.) at each end, for fingernail hardness and visual changes in appearance, comparing the rubbed area with an adjacent unrubbed area. Gloss and hardness will tend to return to initial values as the recovery time increases. The following methods may be used to evaluate the solvent-rubbed area: gloss may be measured in accordance with Test Method D523; pencil hardness with Test Method D3363; film thickness of the rubbed area by the same method used in 6.3 (allow up to 24 h for the coating to recover before measuring film thickness).

NOTE 2—It may be difficult to measure film thickness and gloss in the narrow solvent-rubbed area of the panel.

Method B (Coil ~~Coater's~~Coater's Method)

6.9 This Method is similar to Method A except with the following changes:

6.9.1 For testing in a laboratory setting, us a balance to check the pressure applied with a finger using the procedure in 6.1. Note the amount of pressure required to apply 2000 to 3000 g of force. This will be considered to be moderate to heavy pressure. Use cheesecloth as stated in 5.2.

6.9.2 Use the same procedure as in 6.2 except select an area 200 mm (8 in.) long.
6.9.3 Use the same procedure as in 6.3 except mark off an area 200 mm (8 in.) long.
6.9.4 Use the same procedure in 6.4.
6.9.5 Use the procedure in 6.5 except rub at the rate of 100 double rubs per min.
6.9.6 Use the procedure in 6.6.
6.9.7 Use the procedure in 6.7 except for the following note:

NOTE 3—If fatigue sets in, making it difficult to maintain the 2000 to 3000 g force, stop testing until fatigue is gone.

6.9.8 Use the procedure in 6.8.

NOTE 4—It is known that some operators have used cotton swabs or an object of consistent weight (such as a ball peen hammer) to perform solvent double rubs. It was determined in an interlaboratory study that these alternative methods produce results that are more variable than results obtained when using either method A or B. The results can be found in Appendix X2.

7. Report

7.1 Report, as a minimum, the following information:
7.1.1 Description of cloth used,
7.1.2 Solvent used,
7.1.3 Number of double rubs,
7.1.4 Film thickness before rubbing, and
7.1.5 If additional measurements are made (gloss, hardness, etc.) note the time between the completion of the double rubs and the test.

7.2 Additional information, such as temperature, humidity, weather conditions. Elapsed time between coating applications and conducting the test can affect test results and should be reported whenever possible.

7.3 Appendix X2 contains a "Solvent Double Rub Test" form that may be helpful in reporting test results.

8. Keywords

8.1 coating; curing characteristics; double rub method; drying or curing; paint; recoat time; service time; solvent resistance; solvent rub method

APPENDIXES

(Nonmandatory Information)

X1. INTERLABORATORY TESTING

X1.1 An interlaboratory study in which five laboratories participated was performed to compare alternative methods of performing solvent double rub testing.

X1.2 The interlaboratory study utilized four different methods, using methyl ethyl ketone as the solvent (MEK).

X1.2.1 Method 1 was the standard method (Method A) in accordance with Practice D5402.

X1.2.2 Method 2 was a modified version of Practice D5402 in which a double rubs were performed with double-ended cotton swab with a cardboard shaft. One end of the cotton swab was dipped into solvent and 13 double rubs were performed. Then the other end was dipped, and 12 double rubs were performed (25 rubs per double-ended swab.) The swab was discarded, and another 25 double rubs were performed with a fresh swab. Enough pressure was applied to the shaft of the swab to bend it, but not to break it.

X1.2.3 Method 3 was a modified version of Practice D5402 in which a double rubs were performed with a 2-lb ball peen hammer. The cotton cloth was fastened to the ball end of the hammer with a wire. It was dipped in solvent every 25 rubs. The cloth was not repositioned each time.

X1.2.4 Method 4 was the coil ~~coater's~~coater's method (Method B) in accordance with Practice D5402.