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StandardPractice for Conducting Tests on Sealants Using Artificial Weathering Apparatus[1]

This standard is issued under the fixed designation C1442; 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 covers three types of laboratory weathering exposure procedures for evaluating the effect of actinic radiation, heat, and moisture on sealants.

1.2 The exposure sources used in the three types of artificial weathering devices are the filtered xenon arc, fluorescent ultraviolet lamps, and open flame carbon arc based on Practices G155, G154, and G152, respectively.

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

1.4 The ISO standard related to this Practice is ISO 11431. Significant differences exist between the procedures. The ISO specimens are exposed through glass and are elongated prior to examination for loss of adhesion or cohesion, or both, following exposure.

1.5 *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]

C717 Terminology of Building Seals and Sealants

G113 Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials

G141 Guide for Addressing Variability in Exposure Testing of Nonmetallic Materials

G147 Practice for Conditioning and Handling of Nonmetallic Materials for Natural and Artificial Weathering Tests

G151 Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources

G152 Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

G154 Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

G155 Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials

2.2 *ISO Standard:*

ISO 11431 Building Construction—Sealants: Determination of Adhesion/Cohesion Properties After Exposure to Heat and Artificial Light Through Glass and to Moisture[3]

3. Terminology

3.1 *Definitions*—Definitions of the following terms are found in Terminology C717: *compound, cure, sealant, substrate*. Definitions of the following terms are found in Terminology G113: *actinic radiation, control material, file specimen, fluorescent ultraviolet lamps, irradiance, open flame carbon arc, radiant exposure, sample, solar radiation-ultraviolet, solar radiation-visible, spectral power distribution, xenon arc*.

4. Summary of Practice

4.1 The test sealant may be applied to a variety of types of substrates or tested as a free film. The configuration depends on the properties to be evaluated following exposure. At least four replicates of each sealant being tested are required. After curing, one replicate of each sealant being tested is retained as an unexposed file specimen and three replicates are exposed to actinic radiation, heat, and moisture. At the end of the exposure period, the test sealant is examined for property change in comparison with the unexposed file specimen and the performance is compared with that of an exposed control material, if used.

4.2 It is recommended that a similar material of known performance under use conditions (a control) be exposed simultaneously with the test specimen for evaluation of the performance of the test materials relative to that of the control under the same laboratory exposure conditions. It is preferable

[1] This practice is under the jurisdiction of ASTM Committee C24 on Building Seals and Sealants and is the direct responsibility of Subcommittee C24.40 on Weathering.

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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] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

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to use two control materials, one with relatively poor durability and the other with good durability.

5. Significance and Use

5.1 This practice determines the effects of actinic radiation, elevated temperature, and moisture on sealants and their constituents under controlled laboratory artificial weather test conditions.

5.2 When conducting exposures in devices which use laboratory light sources, it is important to consider *(1)* how well the artificial test conditions will reproduce property changes and failure modes caused by end-use environments on the sealant being tested and *(2)* the stability ranking of sealants. Refer to Practice G151 for full cautionary guidance regarding laboratory weathering.

5.3 Because of differences in the spectral power distributions of the exposure sources (xenon arc, fluorescent UV lamps, and open flame carbon arc), as well as other conditions used in the three types of laboratory weathering tests, including temperature, type and amount of moisture, and test cycles, these three procedures may not result in the same performance ranking or types of failure modes of sealants. Further, different exposure durations may be required for testing the weathering performance of sealants by the three types of exposures. Comparisons should not be made of the relative stability of sealants exposed in the different types of apparatus.

5.4 Variations in results may be expected when operating conditions are varied within the accepted limits of this practice. Therefore, all test results using this practice must be accompanied by a report of the specific operating conditions as required in Section 10. Refer to Practice G151 for detailed information on the caveats applicable to use of results obtained according to this practice.

5.5 No laboratory exposure test can be specified as a total simulation of actual use conditions in outdoor environments. The relative durability of materials in actual use conditions can vary in different locations because of differences in UV radiation, time of wetness, relative humidity, temperature, pollutants, and other factors. Results obtained from these laboratory accelerated exposures can be considered as representative of actual use exposures only when the degree of rank correlation has been established for the specific materials being tested and when the failure mode is the same. Exposure of a similar material of known outdoor performance, a control, along with the test specimens provides for evaluation in terms of relative durability under the test conditions, which also greatly improves the agreement in test results among different laboratories.

5.6 The acceleration factor relating the exposure time in a laboratory accelerated test to exposure time outdoors required to produce equivalent degradation is material dependent and can be significantly different for each material and for different formulations of the same material. Therefore, the acceleration factor determined for one material cannot be assumed to be applicable to other materials.

5.7 Results of this procedure will depend on the care that is taken to operate the equipment according to Practices G152, G154, and G155. Significant factors include regulation of the line voltage, freedom from salt or other deposits from water, temperature control, humidity control, where applicable, condition and age of the burners and filters in xenon arc equipment, and age of lamps in fluorescent UV equipment.

NOTE 1—Additional information on sources of variability and on strategies for addressing variability in the design, execution and data analysis of laboratory accelerated exposure tests is found in Guide G141.

6. Test Specimens

6.1 The size and configuration of the specimens are determined by the specifications of the test method used to evaluate the effect of exposure on the specimens. Where practical, it is recommended that specimens be sized to fit the sample holders supplied with the apparatus.

6.2 Some common specimen configurations may include slab, tensile bar, H-block aymar samples, patties, sheets, drawdowns, preformed joint sealants, prevulcanized elastomeric joint materials, beads, channels, and so forth.

6.3 Specimens configured for movement during exposure to artificial weathering conditions also may be used.

6.4 Follow the procedures described in Practice G147 for identification and handling of specimens prior to, during and after exposure.

6.5 When destructive tests are used to evaluate weathering stability, ensure that sufficient unexposed file specimens are retained so that the property of interest can be determined on unexposed file specimens each time exposed materials are evaluated.

7. Apparatus

7.1 *Test Chamber*—Choice of apparatus and exposure conditions selected shall be by mutual agreement among the interested parties. Because the different types of exposures may produce different test results, they cannot be used interchangeably without supporting data that demonstrates equivalency of the procedures for the materials tested. The procedures shall be as described in 7.2, 7.3, and 7.4, which are based on test procedures in ASTM and ISO standards and on parameters used in round robin tests on sealants.

7.1.1 The operational fluctuations are allowable deviations from the specified set points for irradiance, temperature and relative humidity during equilibrium operation. They do not imply that the user is allowed to program a set point higher or lower than that specified. If the operational fluctuations are greater than the maximum allowable after the equipment has stabilized, discontinue the test and correct the cause of the problem before continuing.

7.2 *Procedure for Exposure in Xenon Arc Light Apparatus*—Unless otherwise specified, use the following operating conditions and see Practices G151 and G155 for requirements that are not given below:

7.2.1 The xenon arc shall be used with daylight type filters to simulate direct exposure to solar radiation and conform with the spectral power distribution in Practice G155.

7.2.2 The irradiance shall be set at a level not less than 0.35 nor greater than 0.51 W/(m^2 · nm) at 340 nm. The maximum

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allowable operational fluctuation is ±0.02 W/(m^2 · nm). For equivalent broadband irradiance levels and maximum allowable operational fluctuations at 300–400 nm and 300–800 nm, consult the manufacturer of the apparatus.

7.2.2.1 The irradiance level of 0.51 W/(m^2 · nm) at 340 nm is preferred for reasons given in Appendix X1.1. However, to accommodate users who are required to operate the machine at 0.35 W/(m^2 · nm) at 340 nm for other tests carried out simultaneously, the lower irradiance level is an option. The test duration is specified in terms of radiant exposure and the time is adjusted according to the formula in Annex A1.2 to obtain the same radiant exposure at different irradiance levels. See Appendix X2 for discussion on effect of variation in irradiance level.

7.2.3 The default exposure cycle shall be 102 min light only followed by a wet period of 18 min light with wetting either by water spray on the front surface or immersion in water. The water spray temperature is uncontrolled, but is typically 21 ± 5°C. It may be lower if ambient water temperature is low and a holding tank is not used to store purified water. The recirculated immersion water temperature is typically 40 ± 5°C during the test.

NOTE 2—For sealants in which moisture has a significant effect on weathering, the two types of wetting may produce different test results due to differences in the water temperature and because water spray and immersion in water are different kinds of moisture exposures.

7.2.4 The exposure cycle of 2 h light only followed by 2 h light plus wetting either by water spray on the front surface or immersion in water can be used by agreement between concerned parties.

NOTE 3—The test cycle in 7.2.3 has been used by historical convention and may not adequately simulate the effects of outdoor exposure of sealants. Other cycles can be used by mutual agreement of all concerned parties. The cycle specified in 7.2.4, which provides more thorough wetting than the cycle in 7.2.3, was evaluated in ruggedness tests on sealants.

7.2.5 The uninsulated black panel temperature (BPT) shall be set at 70°C with a maximum allowable operational fluctuation of ±2.5°C during the dry period of exposure to the radiation. For the equivalent insulated black panel temperature (black standard temperature, BST), consult the manufacturer of the apparatus.

7.2.6 In equipment that provides for adjustment of the chamber air temperature, the latter shall be set at 48°C with a maximum allowable operational fluctuation of ±2°C.

7.2.7 In xenon arc apparatus that allows for control of relative humidity, it shall be set at 50 % during the dry period of exposure to light. The maximum allowable operational fluctuation is ±5 %.

7.3 *Procedure for Exposure in Fluorescent UV Apparatus*—Unless otherwise specified, use the following operating conditions and see Practices G151 and G154 for requirements that are not given below:

7.3.1 Use fluorescent UVA-340 lamps that comply with the spectral power distribution specifications in Practice G154.

7.3.2 In apparatus with irradiance control, irradiance shall be set at 0.89 W/(m^2 · nm) at 340 nm.

NOTE 4—The irradiance setting is an attempt to provide irradiance similar to that measured in the fluorescent UV apparatus without irradiance control, when operated at a temperature of 60°C. In previous editions of C1442, the irradiance set point was 0.77 W/(m^2 · nm) at 340 nm. Due to an error in calibration by one manufacturer, the actual irradiance was 0.89 W/(m^2 · nm) when the specific manufacturer's equipment was set at 0.77 W/(m^2 · nm). Therefore, the correct setting for the recalibrated equipment is 0.89 W/(m^2 · nm). However, for users of equipment made by other manufacturers that had been correctly calibrated, running at the new set point will result in a change in the actual irradiance of the test. If in doubt, users should consult the manufacturer of their device for clarification. There can be differences in test results when using different irradiance levels. Refer to Appendix X2 for information regarding the effect of irradiance.

7.3.3 Seal any holes larger than 2 mm in specimens and any opening larger than 1 mm around irregularly shaped specimens to prevent loss of water vapor. Attach porous specimens to a solid backing, such as aluminum, that can act as a vapor barrier.

7.3.4 For specimens that are less than 20 mm thick, including support dimensions, the exposure cycle shall be 8 h UV at an uninsulated black panel temperature set at 60°C followed by 4 h wetting by condensation at an uninsulated black panel temperature set at 50°C. The maximum allowable operational temperature fluctuation is ±2.5°C.

7.3.5 For specimens that are more than 20 mm thick, including support dimensions, the exposure cycle shall be 5 h UV only at an uninsulated black panel temperature set at 60°C followed by 1 h UV plus wetting by water spray on the front surface. The water temperature shall be less than 40°C. The maximum allowable operational temperature fluctuation is ±2.5°C.

NOTE 5—Wetting by condensation is not applicable to specimens having a thickness greater than 20 mm because of inadequate heat transfer.

7.3.6 Initiate exposure at the beginning of the UV period.

7.4 *Procedure for Exposure in Open Flame Carbon Arc Apparatus*—Unless otherwise specified, use the following operating conditions and see Practices G151 and G152 for requirements that are not given below.

7.4.1 The open flame carbon arc shall be used with daylight type filters and conform with the spectral power distribution specifications in Practice G152.

7.4.2 The default exposure cycle shall be 102 minutes light only followed a wet period of 18 minutes light plus water spray on the front surface. The water spray temperature is typically 21 ± 5°C, but may be lower if ambient water temperature is low and a holding tank is not used to store purified water.

7.4.3 The exposure cycle of 2 h light only followed by 2 h light plus water spray on the front surface can be used by agreement between concerned parties.

7.4.4 The uninsulated black panel temperature shall be set at 70°C with a maximum allowable operational fluctuation of ±2.5°C during the dry period of exposure to the radiation.

7.4.5 In equipment that provides for adjustment of the chamber air temperature, the latter shall be set at 48°C with a maximum allowable operational fluctuation of ±2°C.

7.4.6 Relative humidity shall be set at 50 % during the dry period of exposure to light. The maximum allowable operational fluctuation is ±5 %.

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