

Test Method for Colorfastness to Oxides of Nitrogen in the Atmosphere under High Humidities

1. Purpose and Scope

1.1 This test method is used to determine the resistance of the color of textiles to the action of oxides of nitrogen in the atmosphere at elevated temperatures with relative humidities above 85%.

1.2 On certain fibers, dyes do not readily fade at humidities below 85%. Testing at higher humidities is required to produce color changes that predict service fading under warm, humid conditions (see 11.1).

2. Principle

2.1 A test specimen and a swatch of control ribbon are simultaneously exposed to oxides of nitrogen in an atmosphere which is maintained at $87.5 \pm 2.5\%$ RH and a temperature of $40 \pm 1^\circ\text{C}$ ($104 \pm 2^\circ\text{F}$) until the control ribbon shows a color change corresponding to that of a standard of fading. The cycles are repeated until the specimen shows a definite color change or for a prescribed number of cycles.

3. Terminology

3.1 **colorfastness**, n.—the resistance of a material to change in any of its color characteristics, to transfer of its colorant(s) to adjacent materials or both, as a result of the exposure of the material to any environment that might be encountered during the processing, testing, storage or use of the material.

4. Safety Precautions

NOTE: These safety precautions are for information purposes only. They are ancillary to the testing procedures and are not intended to be all inclusive. It is the user's responsibility to use safe and proper techniques in handling materials in this test method. Manufacturers MUST be consulted for specific details such as material safety data sheets and other manufacturer's recommendations. All OSHA standards and rules must also be consulted and followed.

4.1 Oxides of nitrogen in high concentrations are injurious to health and must be exhausted to the atmosphere or trapped in water and neutralized with a 10% solution of sodium hydroxide or sodium bicarbonate. The maximum concentration in a work area must not exceed 500 pphm.

4.2 Chain or clamp the gas cylinder to a wall or other suitable support so that it cannot fall or be knocked down.

4.3 Exposure to chemicals used in this procedure must be controlled at or below levels set by governmental authorities (e.g., Occupational Safety and Health Administration's [OSHA] permissible exposure limits [PEL] as found in 29 CFR 1910.1000; see web site: www.osha.gov for latest version). In addition, the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs) comprised of time weighted averages (TLV-TWA), short term exposure limits (TLV-STEL) and ceiling limits (TLV-C) are recommended as a general guide for air contaminant exposure which should be met (see 11.2).

5. Apparatus and Materials

5.1 Exposure chamber suitable for containing oxides of nitrogen (NO_2) and maintaining a constant elevated temperature and relative humidity (see 11.3).

5.2 Control Ribbon No. 1 (see 11.4).

5.3 Standard of Fading (Ribbon No. 1) (see 11.4).

5.4 Gray Scale for Color Change (AATCC EP1) (see 11.5).

5.5 Oxides of nitrogen supply tank (see 11.6).

6. Test Specimens

6.1 Cut each specimen at least 60×60 mm. For subsequent color comparison, the unexposed sample should be kept in an airtight container away from light to avoid further shade changes.

6.2 If the test involves laundered or drycleaned material, launder or dry-clean material for both the control and test specimens. For the preparation of specimens for testing after laundering or drycleaning, follow the procedures prescribed in AATCC TM61, Test Method for Colorfastness to Laundering: Accelerated, and/or AATCC TM132, Test Method for Colorfastness to Drycleaning.

7. Procedure

7.1 Suspend the test specimens and a swatch of Control Ribbon No. 1 in the exposure chamber which is maintained at $87.5 \pm 2.5\%$ RH and a temperature of $40 \pm 1^\circ\text{C}$ ($104 \pm 2^\circ\text{F}$). NO_2 concentrations must range from 400-600 pphm which

should produce a cycle of fade within 5-15 h of exposure.

7.2 Examine the Control Ribbon No. 1 periodically until its color corresponds to that of the Standard of Fading when compared in daylight ranging from average to slightly bluish north skylight or equivalent artificial light. This constitutes one cycle.

7.3 Remove those specimens which exhibit a noticeable color change at the end of one cycle. One cycle will generally produce a measurable color change in specimens which are sensitive to oxides of nitrogen.

7.4 Suspend an unexposed swatch of Control Ribbon No. 1 for each additional cycle of fade until the required number of cycles have been completed.

7.5 Optional Aftertreatment

7.5.1 Specimens exposed to oxides of nitrogen might continue to change color after removal from the test chamber. The color may be stabilized by plunging the specimens into a buffered urea solution (see 11.7) for 5 min. They should then be squeezed, thoroughly rinsed in clean water and dried in air at a temperature not above 60°C (140°F). CAUTION: Do not treat any specimen with the urea solution that must be returned to the test chamber for additional exposure.

8. Evaluation

8.1 At the end of each cycle, immediately compare those specimens which are removed from the exposure chamber with the preserved originals from which they are drawn.

8.2 Rate the effect on color of test specimens after any specified number of cycles by reference to the Gray Scale for Color Change (AATCC EP1), or using AATCC EP7, Instrumental Assessment of the Change in Color of a Test Specimen, and record the numerical rating that corresponds to the appropriate one on the Gray Scale. Report the number of cycles run.

9. Report

9.1 Report the numerical grade for the change in color of the test specimen, the number of cycles run, the temperature and relative humidity at which the test was performed.

10. Precision and Bias

10.1 *Precision*. Precision for this test method has not been established. Until a precision statement is generated for this method, use standard statistical techniques in making any comparisons of test results for either *within-laboratory* or *between-laboratory* averages.

10.2 *Bias*. Colorfastness to oxides of nitrogen in the atmosphere under high humidities can be defined only in terms of a test method. There is no independent method for determining the true values. As a means of estimating these properties, the method has no known bias.

11. Notes

11.1 **Humidity for Testing**. The fading of dyes by oxides of nitrogen on some fibers such as nylon and acetate is altered greatly by relatively small variations in relative humidity at high humidities. Therefore closely control temperature and relative humidity.

11.2 Available from Publications Office, ACGIH, Kemper Woods Center, 1330 Kemper Meadow Dr., Cincinnati OH 45240; tel: +1.513.742.2020; web site: www.acgih.org.

11.3 **Exposure Chamber**. The oxides of nitrogen chamber for elevated temperatures and relative humidities above 85% should be made of stainless steel which has been coated on the inside with a resistant coating. It must maintain the conditions of $87.5 \pm 2.5\%$ RH, $40 \pm 1^\circ\text{C}$ ($104 \pm 2^\circ\text{F}$) temperature and contain an NO_2 concentration between 400-600 ppm.

11.3.1 Blueprints of a suitable apparatus are available from AATCC, P.O. Box 12215, Research Triangle Park NC 27709; tel: +1.919.549.8141; fax: +1.919.549.8933; e-mail: ordering@aatcc.org; web site: www.aatcc.org.

11.4 **Test Control and Standard of Fading**.

11.4.1 Historically, the test control fabric,

Control Ribbon No. 1, was a dyeing of 0.4% C.I. Disperse Blue 3 (Celliton Blue FFRN) on cellulose acetate satin. Lot 21 uses 0.4% Disperse Violet 1 on cellulose acetate stain since its fading characteristics are well known and it yields more color change after the testing cycle than previous test control lots dyed with Disperse Blue 3.

11.4.2 Since different lots and sources of both the dyestuff and undyed fabric will produce variations in both the original shade and its fading rate, it is therefore necessary to accurately establish a new standard of fading for each dyed lot of control fabric ribbon so that comparable tests results can be obtained when using different lots of the control and their respective standards of fading. In conducting tests, only the standard of fading applicable to that lot of control fabric ribbon may be used.

11.4.3 The standard of fading for the original lot of control fabric ribbon was made with vat dyes on cellulose acetate satin. For subsequent lots of the fabric ribbon, it was found for the standard of fading that the use of direct dyes on viscose satin for the standard of fading provided a better shade match.

11.4.4 Both the Control Ribbon No. 1 and the Standard of Fading must be kept in suitable containers or enclosures to protect them from possible exposure and color change to oxides of nitrogen and other contaminants which might be present in the atmosphere during transportation and storage.

11.4.5 The Control Ribbon is also sensitive to other atmospheric contaminants such as ozone. Its fading rate will vary considerably at different humidities and temperatures and its use in natural or end-use testing as a measure of exposures to oxides of nitrogen is not recommended. The color change produced on the control will reflect the combined effects of the atmospheric contaminants present and temperature-humidity variations, not just the effects of exposure to oxides of nitrogen.

11.4.6 A sealed unit of Test Control Fabric

comprising 2.47 cm wide Control Ribbon No. 1 with a specific lot number indicated; and a specimen of the Standard of Fading for that lot of control ribbon is available as CR & SF No. 1 from Testfabrics Inc., 415 Delaware Ave., P.O. Box 3026, W. Pittston PA 18643; tel: +1.570.603.0432; fax: +1.570.603.0433; e-mail: info@testfabrics.com; web site: www.testfabrics.com.

11.5 Available from AATCC, P.O. Box 12215, Research Triangle Park NC 27709; tel: +1.919.549.8141; fax: +1.919.549.8933; e-mail: ordering@aatcc.org; web site: www.aatcc.org.

11.6 Use bottled gas which contains approximately 1% NO_2 in nitrogen in cylinders equipped with the proper reducing valves.

11.7 **Urea Aftertreatment**.

11.7.1 The use of this treatment is completely optional. Experience has shown that color change after removal of specimens from the exposure chamber is negligible. The urea treatment itself will often cause a color change in specimens. Therefore, if this procedure is used, it is essential that both the exposed and unexposed control specimens be treated in an identical manner.

11.7.2 Urea Solution: 10 g of urea ($\text{NH}_2 \cdot \text{CO} \cdot \text{NH}_2$) per liter of water buffered to pH7 by addition of 0.4 g of sodium dihydrogen orthophosphate ($\text{NaH}_2\text{PO}_4 \cdot 2\text{H}_2\text{O}$) and 2.5 g of disodium hydrogen orthophosphate ($\text{Na}_2\text{HPO}_4 \cdot 12\text{H}_2\text{O}$) and 0.1 g or less of a rapid wetting surface active agent; for example, sodium dioctyl sulfosuccinate.

12. History

12.1 Reaffirmed 2020.

12.2 Revised 2015. Reaffirmed 2013, 2006, 2001, 1992, 1987. Editorially Revised 2019, 2010, 2008, 2004, 1995, 1989. Editorially Revised and Reaffirmed 1997, 1986.

12.3 Developed in 1985 by AATCC Committee RA33. Technically equivalent to ISO 105-G04.