

Test Method for Colorfastness to Burnt Gas Fumes

1. Purpose and Scope

1.1 This test method is intended for assessing the resistance of the color of textiles of all kinds and in all forms when exposed to atmospheric oxides of nitrogen as derived from the combustion of natural gas. Exceptions are noted in 11.8.1.

1.2 This test method may be used for rating colorfastness of dyes by applying the dye to textiles by a specified procedure and at a specified depth of color and testing the dyed textiles.

2. Principle

2.1 A specimen of the textile and the test control fabric are exposed simultaneously to oxides of nitrogen from burnt gas fumes until the control shows a change in color corresponding to that of the standard of fading. The change in color of the specimen is assessed with the standard gray scale for assessing change in color. If no color change is observed in the specimen after one exposure period or cycle, exposure may be continued, for either a specified number of periods or for the number of periods required to produce a specified amount of color change in the specimen.

3. Terminology

3.1 **burnt gas fumes**, n.—atmospheric oxides of nitrogen as derived from the combustion of illuminating or heating gas.

3.2 **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. The precautions 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 Good laboratory practices should

be followed. Wear safety glasses in all laboratory areas.

4.2 All chemicals should be handled with care.

4.3 Stoddard solvent is a combustible liquid and presents a moderate hazard. It should not be used near an open flame, and fabric saturated with this solvent should be dried in an adequately ventilated laboratory hood. Use chemical goggles or face shield, impervious gloves and an impervious apron when handling Stoddard solvent.

4.4 Perchloroethylene is toxic by inhalation, by repeated contact with skin and by ingestion; it MUST be used only in a well vented atmosphere. Toxicology studies with laboratory animals have shown evidence of cancer in rats and mice exposed to perchloroethylene vapors at 100-400 ppm concentrations for prolonged times. Fabric saturated with this solvent should be dried in an adequately ventilated laboratory hood. Use chemical goggles or face shield, impervious gloves and an impervious apron when handling perchloroethylene.

4.5 An eyewash/safety shower should be located nearby and an organic vapor respirator should be readily available for emergency use.

4.6 In previous versions of this test, recommendations were made for the use of a wire screen placed above the burner to decrease the test time. During recent studies it was found that the improper application of the steel screen may increase the generation of residual unburnt gas and, thereby, cause the potential for an explosion. The manufacturers of the devices are recommending against the use of this screen due to potential safety issues (see 11.6.1).

4.7 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 11.1).

5. Apparatus, Materials and Reagents

5.1 Exposure chamber (see 11.2).

5.2 Control Ribbon No. 1 (see 11.3).

5.3 Standard of Fading (Ribbon No. 1) (see 11.3).

5.4 Gray Scale for Color Change (AATCC EP1) (see 11.9).

5.5 Natural gas (see 11.6).

5.6 Urea solution (see 11.10).

5.7 Mineral spirits.

5.8 Perchloroethylene.

5.9 Trichloroethylene.

5.10 1993 AATCC Standard Reference Detergent WOB (see 11.9).

6. Test Specimens

6.1 Use test specimens that measure approximately 5.0 × 10.0 cm. If pressing is necessary to remove wrinkles, iron the specimens between two layers of closely woven cotton cloth or press them with a steam press (see 11.4).

6.1.1 For fastness to oxides of nitrogen in storage or use, test a specimen of the original fabric.

6.1.2 For fastness to oxides of nitrogen after drycleaning, immerse one specimen in cold mineral spirits for 10 min, then squeeze the solvent out and dry the specimen in air. One specimen is immersed in cold perchloroethylene for 10 min, squeezed and allowed to dry in the air. Trichloroethylene may be substituted for perchloroethylene. Prepare a drycleaned only specimen for comparison with the tested drycleaned specimen.

6.1.3 For fastness to oxides of nitrogen after washing (see 11.5), unless a specific wash test is specified, wash the test specimen in a detergent solution containing 5 g of 1993 AATCC Standard Reference Detergent WOB per liter of water of approximately zero hardness for 10 min at 41 ± 3°C, rinse it in warm water and dry it in air. Prepare a washed only specimen to compare with the tested washed specimen.

7. Procedure

7.1 Suspend the test specimens and a piece of the Control Ribbon freely in the test chamber so that they are not in contact with each other and do not come into direct contact with any hot metallic surface. Light the gas burner and adjust the flame and ventilating equipment so that the temperature in the chamber does not exceed 60°C (see 11.7 and 11.8). Leave the specimens to remain in the chamber until the control sample changes color to correspond to the color of the

Standard of Fading when compared in daylight (ranging from average to slightly bluish north sky light) or equivalent artificial illumination.

7.2 Then remove the test specimens from the test chamber and immediately assess the change in color of each by use of the Gray Scale for Color Change.

7.3 Specimens exposed to oxides of nitrogen may continue to change color after removal from the test chamber. Optionally, another or more detailed visual or instrumental examination may be done. If this is to be done, without delay, plunge the test and control specimens and pieces of the original test and control fabric into buffered urea solution (see 11.10) for 5 min. Then squeeze out the specimens and pieces and thoroughly rinse them. Dry the specimens in air at a temperature not above 60°C.

7.4 After the first cycle, any specimens which do not show a color change and which are not treated with the buffered urea solution may be returned to the test chamber along with a fresh piece of the test control and the test continued until the second test control shows a change in color corresponding to that of the Standard of Fading.

7.5 Cycles may be repeated for either a specified number of cycles or until the specimens show a specified amount of color change.

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 were drawn.

8.2 Rate the effect on color of test specimens after any specified number of cycles by reference to AATCC EP1, Gray Scale for Color Change, 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 (see 11.11).

9. Report

9.1 Report the grade for each specimen and the number of cycles, to which it was exposed. Report the average temperature employed and, if humidity was increased, report the method used.

10. Precision and Bias

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

10.2 *Bias.* Burnt gas fumes can be defined only in terms of a test method. There is no independent method for determining the true value. As a means of estimating this property, the method has no known bias.

11. Notes

11.1 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.

11.2 Exposure Chamber.

11.2.1 The exposure chamber may be of variable construction but must provide an enclosure in which test specimens can be exposed in an atmosphere of air which has passed over and contains the byproducts of combustion from a lighted gas burner. The apparatus should be equipped with a suitable means of supporting the test specimens so that there is a free circulation of the atmosphere around the specimens and so that only a minimum amount of the specimen at the point of its suspension is in direct contact with any hot metallic surface. Either a motor driven fan to move the air around in the test chamber or a motor driven rotating specimen rack should be used in order to insure as nearly as is possible that all specimens are exposed to the same conditions of gas concentration, temperature and humidity. Adjustable vents or dampers in the top of the unit together with the height of the flame of the gas burner are used to regulate the temperature of the exposure chamber, but temperature and humidity will vary with that of the room in which the exposure chamber is being operated.

11.2.2 Several forms of suitable apparatus are illustrated in the *American Dyestuff Reporter*, July 22, 1940, pp368-369. Blueprints of a suitable apparatus can be purchased 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.

11.3 Test Control and Standard of Fading.

11.3.1 Historically, the control ribbon was a dyeing of 0.4% C.I. Disperse Blue 3 on cellulose acetate satin. Lot 21 uses 0.4% Disperse Violet 1 on cellulose acetate satin 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.

11.3.2 Pieces of the original lot of control ribbon were hung in air in three separate places in southern New Jersey for six months. It was assumed that the atmosphere in these places contained an average content of oxides of nitrogen. At the end of the exposure period, samples from the three locations were assembled and compared with the original material. All had changed about equally, being decidedly duller and redder than the original. The faded shade was then matched with vat dyes on cellulose acetate satin and this became the original standard of fading for that lot of control fabric. This produced a standard of fading which was more permanent than the exposed pieces of the control fabric which would have continued to change with even very small amounts of oxides of nitrogen.

11.3.3 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 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 ribbon may be used.

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

11.3.5 Both the Control Ribbon 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.

11.3.6 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 exposure 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.

11.3.7 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.

11.4 Heat by Ironing.

11.4.1 When an acetate fabric is pressed with an iron which is hot enough to remove all wrinkles, there is danger of sealing the surface of the fabric which would increase the resistance to gas fading. This technique is not conducive to accurate test results and should be avoided on fabrics of this type.

11.5 Drycleaning and Washing Test Specimens.

11.5.1 All the inhibitors available at present are soluble to some extent in water and therefore tend to be removed by washing. These inhibitors are in general not soluble in the ordinary drycleaning solvents, and fabrics treated with suitable inhibitors should withstand several drycleanings without losing their resistance to gas fading (if the drycleaning operation does not include spotting or sponging with water). The inhibitors also tend to lose their efficiency if the fabrics come into frequent contact with perspiration.

11.6 Gas.

11.6.1 Illuminating gas furnished by the gas companies in Massachusetts, Connecticut, Rhode Island, New York, New Jersey, Pennsylvania and Delaware has been used in this work, including both natural and manufactured gas. The results were essentially the same in all cases. Any gas burner may be used, and either a luminous (yellow) or a blue-green flame is suitable, though the latter