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Instrumental Assessment of the Change in Color of a Test Specimen

Developed in 1995 by AATCC Committee RA36; reaffirmed 1996, 2003, 2009; revised and reaffirmed 1998; revised 2015. Technically equivalent to ISO 105-A05.

1. Scope

1.1 This evaluation procedure is intended as an alternative to the visual method of AATCC Evaluation Procedure (EP) 1, Gray Scale for Color Change (see 9.1), for assessing the change in color of a test specimen (see 9.2). It is applicable to any test method referring to Gray Scales except those which involve treatment with solutions containing fluorescent whitening agents (FWA).

2. Principle

2.1 The color of the specimen which has been submitted to the colorfastness test and the color of an identical untreated specimen are measured instrumentally. The CIELAB coordinates for lightness L^* , chroma C^*_{ab} , and hue h_{ab} are determined for both specimens as defined in CIE 15.2. The CIELAB differences ΔL^* , ΔC^*_{ab} , and ΔH^*_{ab} are calculated and converted to a gray scale grade by means of a series of equations.

3. Terminology

3.1 **color change**, n.—a change in color of any kind whether in lightness, hue or chroma or any combination of these, discernible by comparing the test specimen with a corresponding untested specimen.

3.2 **gray scale grade**, n.—for color change, (GSc), the numerical value that is assigned to the change in color of a test specimen as compared to an original or untreated specimen.

4. Apparatus

4.1 Spectrophotometer or colorimeter meeting any one of the geometric definitions described in CIE publication 15.2, subclause 1.4 (see 9.3).

5. Test and Reference Specimens

5.1 Choose a representative sample of material, which has been subjected to a colorfastness test, of adequate size to fit the sample holder of the instrument used. Back this specimen with enough thicknesses of the original material to make

the specimen opaque. (Opacity, or at least consistency, is required for accurate measurement.) Backing a single layer of the material with a white material that contains no FWAs is a permitted alternative provided both the reference specimen (original material) and test specimen are backed in an identical manner.

5.2 Form a layer of the reference specimen (original material) consisting of the same number of thicknesses as that prepared in 5.1.

6. Procedure

6.1 Measure the color of the reference specimen and calculate the CIELAB L^* , C^*_{ab} , and h_{ab} values using the data for the 10° observer and for illuminant D₆₅ (see 9.4).

6.2 Measure the color of the test specimen which has been subjected to the colorfastness test and make the same colorimetric calculations as done for the reference specimen. Then make the calculations as described below in Section 7.

7. Calculations

7.1 The subscript 'M' is used to represent a function of the mean of the test and reference specimen. The subscript 'K' is used to represent chroma corrected hue functions. The subscript 'F' is used to represent the special gray scale color difference and separate this ΔE from others in normal use. The subscript 'T' is for the test specimen and the subscript 'R' is for the reference specimen.

7.2 Calculate ΔE_F using the equations:

$$\begin{aligned}\Delta E_F &= [(\Delta L^*)^2 + (\Delta C^*_F)^2 + (\Delta H^*_F)^2]^{1/2} \\ \Delta H^*_F &= \Delta H^*_K / [1 + (10 \cdot C_M / 1000)^2] \\ \Delta C^*_F &= \Delta C^*_K / [1 + (20 \cdot C_M / 1000)^2] \\ \Delta H^*_K &= \Delta H^*_{ab} - D \\ \Delta C^*_K &= \Delta C^*_{ab} - D \\ D &= (\Delta C^*_{ab} \cdot C_M \cdot e^{-x}) / 100 \\ x &= [(h_M - 280) / 30]^2\end{aligned}$$

if

$$|h_M - 280| \leq 180$$

or

$$x = [(360 - |h_M - 280|) / 30]^2$$

if

$$\begin{aligned}|h_M - 280| &> 180 \\ C_M &= (C^*_{abT} + C^*_{abR}) / 2 \\ h_M &= (h_{abT} + h_{abR}) / 2\end{aligned}$$

if

$$|h_{abT} - h_{abR}| \leq 180$$

or

$$h_M = (h_{abT} + h_{abR}) / 2 + 180$$

if

$$|h_{abT} - h_{abR}| > 180$$

and

$$|h_{abT} + h_{abR}| < 360$$

or

$$h_M = (h_{abT} + h_{abR}) / 2 - 180$$

if

$$|h_{abT} - h_{abR}| > 180$$

and

$$|h_{abT} + h_{abR}| \geq 360$$

L^*_{Ts} , C^*_{abTs} , h_{abT} = CIELAB lightness, chroma and hue of Test specimen (see 9.5)

L^*_{Rs} , C^*_{abRs} , h_{abR} = CIELAB lightness, chroma and hue of Reference specimen (see 10.5)

$$\Delta L^* = L^*_T - L^*_R$$

$$\Delta C^*_{ab} = C^*_{abT} - C^*_{abR}$$

$$\text{sign of } \Delta H^*_{ab} = \text{sign of } (h_{abT} - h_{abR})$$

$$\Delta H^*_{ab} = [(\Delta E^*_{ab})^2 - (\Delta L^*)^2 - (\Delta C^*_{ab})^2]^{1/2}$$

$$\Delta E^*_{ab} = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$$

7.3 Calculate the gray scale grade for color change (GSc) according to Table I or according to the function in 7.3.1.

7.3.1 Function.

$$\text{GSc} = 5 - \Delta E_F / 1.7$$

when

$$(\Delta E_F \leq 3.4)$$

$$\text{GSc} = 5 - \text{Log} (\Delta E_F / 0.85) / \text{Log} (2)$$

when

$$(\Delta E_F > 3.4)$$

The function produces continuous decimal values of grade compared to the step values that are obtained from the table.

8. Report

8.1 The report should contain, as a minimum, the following information:

8.1.1 The Gray Scale Grade(s) [GSc value(s)] for change in color of the specimen(s); follow the directions and report as directed in the appropriate test method.

8.1.2 The number and date of this procedure; i.e., AATCC EP7: 2009;

8.1.3 All details necessary for the identification of the sample(s) tested;

8.1.4 Which of the optional CIE geometry types was used;

8.1.5 Identification of the spectrophoto-

Table I—Gray Scale Color Change Step Values

ΔE_F	GSc
< 0.40	5
≥ 0.40	4-5
≥ 1.25	4
≥ 2.10	3-4
≥ 2.95	3
≥ 4.10	2-3
≥ 5.80	2
≥ 8.20	1-2
≥ 11.60	1