Test Method for Compatibility of Basic Dyes for Acrylic Fibers

Developed in 1974 by AATCC Committee RA87; reaffirmed 1976, 1977, 1980, 1989, 2009, 2013; revised 1984, 2019; editorially revised 1985, 1988, 2008, 2010; editorially revised and reaffirmed 1987, 1994, 1999, 2004. Technically equivalent to ISO 105-Z03.

Foreword

This test method is based on one first proposed by the Society of Dyers and Colourists (see 12.1). The standard dyes were chosen because: (a) they form two series encompassing the compatibility behavior of nearly all basic dyes recommended for acrylic fibers; (b) the dyes in each series are spaced to produce approximately equal visual effects; and (c) the corresponding standard dyes from both scales are compatible.

1. Purpose and Scope

1.1 In the dyeing of acrylic fibers with basic dyes, the classic parameters—e.g., the time of half-dyeing—of individual dyes do not give a true indication of their dyeing behavior in admixture with other basic dyes.

1.1.1 Since basic dyes show virtually no migration in acrylic fibers under normal dyeing conditions, compatibility is of major importance in selecting dye combinations with optimum level dyeing behavior.

1.2 This test method determines the compatibility of a basic dye when applied to acrylics.

2. Principle

2.1 Compatibility of a basic dye is assessed by determining its dyeing behavior in combination with each of the standard dyes in a yellow or blue scale—whichever shows the greatest difference in hue from that of the dye under test.

2.2 The dye is assigned a grade from 1 through 5 corresponding to the standard dye with which it gives on-tone dyeings throughout the sequence (half-steps, < 1, or > 5 may also be assigned).

3. Terminology

3.1 **basic dye,** n.—a dye that dissociates in an aqueous medium to give a positively-charged ion (cation) with affinity for fibers containing acidic groups.

3.2 **compatibility,** n.—*in textile dyeing*, propensity of individual dye components in a combination shade to exhaust at similar rates, resulting in a buildup of shade that is constant, or nearly constant, in hue throughout the dyeing process.

3.3 **grade**, n.—the number assigned to a test specimen resulting from comparison to a scale.

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 and a single- use dust respirator while handling powder dyes.

4.2 All chemicals should be handled with care.

4.3 Use chemical goggles or face shield, impervious gloves and an impervious apron during handling of concentrated acetic acid.

4.4 An eyewash/safety shower should be located nearby and an organic vapor respiratory with full facepiece should be readily available for emergency use.

4.5 The basic dyes listed in this method belong to the following classes:

C.I. Basic Orange 42—Azo-methineazo
C.I. Basic Yellow 29—Methine
C.I. Basic Yellow 28—Monoazo
C.I. Basic Yellow 15—Monoazo
C.I. Basic Orange 48—Azo
C.I. Basic Blue 69—Methine
C.I. Basic Blue 45—Anthraquinone
C.I. Basic Blue 47—Anthraquinone
C.I. Basic Blue 22—Anthraquinone
C.I. Basic Blue 77—Triarylmethane

4.6 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 12.2).

5. Uses and Limitations

5.1 The test is valid only under the conditions defined. Compatibility may be affected by the presence of anionic substances—e.g., anionic surfactants or anionic dyes—in the dyebath.

5.2 The yellow and blue standard dyes of compatibility grade 2.0 are not fully compatible when applied in combination. The differences observed are exaggerated if wet-spun acrylic fibers are used.

5.3 The test is one for compatibility and not a measure of the extent to which incompatibility may lead to unlevelness when combinations of basic dyes are applied to acrylic fibers.

5.4 Although some of the specified dyes are not in current commercial production, the set of 10 dyes (50 g each), is available for purchase by laboratories interested in performing this method (see 12.3).

6. Apparatus, Reagents and Materials

6.1 Acrylic fiber, 30 samples (pieces of skeins) of equal weight.

6.2 Dyeing apparatus, for dyeing at a 40:1 liquor:goods ratio at the required constant temperature.

6.3 Standard dyes, 5, yellow or blue (see Table I and 12.3).

6.3.1 Use the dye scale (yellow or blue) that shows the greatest difference

Table I—Standard Dye Scales

C.I. Basic Dye	% owf	Compatibility Grade
Yellow		
Orange 42	0.45	1.0
Yellow 29 (200%)	0.25	2.0
Yellow 28 (200%)	0.15	3.0
Yellow 15	0.75	4.0
Orange 48	0.65	5.0
Blue		
Blue 69	0.55	1.0
Blue 45	2.7	2.0
Blue 47 (200%)	0.6	3.0
Blue 77	0.6	4.0
Blue 22 (200%)	1.2	5.0

Note: Dye strength is 100% unless otherwise noted (see 12.6).
The percentages given produce dyeings approximately one half of 1/1 standard depth on many acrylic fibers (see 12.4).

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in hue from that of the dye under test (e.g., to evaluate a blue dye, use the yellow standard dye scale).

6.4 Acetic acid (glacial).

6.5 Sodium acetate crystals ($CH_3COONa \cdot 3H_2O$).

6.6 Deionized or distilled water, which does not change significantly in pH on boiling.

7. Specimens

7.1 A specimen of the dye under test is required for each of 5 dyebaths. The % owf is selected to give dyeings approximately one half of 1/1 standard depth on the pretreated acrylic fiber (see 12.4).

8. Procedure

8.1 Pretreat the acrylic fiber for 10 min at approximately 95°C (203°F) in a solution containing 1% (owf) acetic acid (glacial) and 1% (owf) $CH_3COONa \cdot 3H_2O$ (to give pH 4.5 ± 0.2) at a liquor: goods ratio of 40:1.

8.2 Lightly squeeze the pretreated fiber and keep it wet, ready for use.

8.3 Set 5 dyebaths, one for each of the standard dyes in the selected scale, at 95°C (203°F), a liquor:goods ratio of 40:1 and a pH value of 4.5 ± 0.2 with:

X% Standard dye (see Table I)

Y% Dye under test (see 7.1)

1% Acetic acid (glacial)

1% $CH_3COONa \cdot 3H_2O$.

8.3.1 These percentages and the liquor:goods ratio refer to the weight of an individual fiber sample, not to the combined weight of the 6 samples required for each series of dyeings.

8.4 Use 6 fiber samples for each dyebath. Enter the first fiber sample into the dyebath at the recommended temperature, for the recommended time (see 12.5). Remove the first sample and replace it with the second. Repeat this dyeing procedure for a total of 5 samples.

8.4.1 Dye the last sample to complete exhaustion in the same dyebath as the first 5.

8.4.2 Rinse and dry each fiber sample immediately after it is removed from the dyebath. Mount the samples in the sequence in which they were dyed.

8.5 Repeat the dyeing procedure for the remaining dyebaths (6 fiber samples in each of 5 baths; 30 fiber samples in total).

Table II—Sample Test Results for a Blue Dye

Compatibility Grade (Yellow Scale)	Appearance of Dyed Samples
1.0	Progressively much bluer
2.0	Progressively bluer
3.0	On-tone
4.0	Progressively yellower
5.0	Progressively much yellower

The compatibility grade of the blue dye is 3.0.

9. Evaluation

9.1 Visually assess each dyed fiber sample. For each dyebath, report whether the 6 dyeings are progressively bluer, progressively yellower, or consistently on-tone.

9.1 Assign a compatibility grade to the dye under test.

9.2.1 If one of the dyebaths produced consistently on-tone dyeings, the grade is the number associated with that bath (see Table I). A typical example of the results obtained in assessing a blue dye is shown in Table II.

9.2.2 It is possible for the compatibility of a dye to lie between two adjacent standards; e.g., to be 1.5, 2.5, 3.5 or 4.5. In these instances, a series of on-tone dyeings will not be obtained with any of the standard dyes.

9.2.3 If a dye lies outside the scale as defined, assign a grade of < 1, or > 5, whichever is appropriate.

10. Report

10.1 Describe or identify the tested dye.

10.2 Report that sample was tested according to AATCC TM141-2019.

10.3 Report the testing conditions:

10.3.1 Scale used (yellow or blue).

10.3.2 Acrylic fiber description.

10.3.3 Dyeing apparatus, temperature and time.

10.3.4 Test dye and standard dyes % owf.

10.4 Report the test results:

10.4.1 Compatibility grade of the tested dye.

10.4.2 Relevant observations regarding the dyeings.

10.5 Describe any modification(s) of the published method.

11. Precision and Bias

11.1 *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.

11.2 *Bias*. The compatibility of basic dyes for acrylic fibers 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.

12. Notes

12.1 Compatibility Test for Combinations of Basic Dyes in the Dyeing of Acrylic Fibres, *Journal of the Society of Dyers and Colourists*, Vol. 88, June 1972, pp220-222.

12.2 Available from Publications Office, ACGIH, Kemper Woods Center, 1330 Kemper Meadow Dr., Cincinnati OH 45240, USA; +1. 513.742.2020; www.acgih.org.

12.3 Available from AATCC, PO Box 12215, Research Triangle Park NC 27709, USA; +1.919.549.8141; ordering@aatcc.org; www.aatcc.org.

12.4 For ease in visual assessment, use the dyes under test and the standard dyes in a concentration that produces approximately one half of 1/1 standard depth when dyed on most acrylic fibers. If standard depth of the dye being tested is not known, a dyeing concentration of similar depth to the Standard Dye Scales in Table 1 can be used. Additionally, standard depth information may be available from the dye supplier. It should be understood, however, that it is not critical that the compatibility is assessed at standard depth, since identical grades are obtained at other depths and in other ratios of standard and test dye.

12.5 Acrylic fibers can vary widely in their dyeing characteristics. The test is to be conducted in such a manner that all available dye is exhausted in approximately equal portions onto the number of fiber samples used. To accomplish this, it may be necessary to adjust the dyeing temperature within a range of 90-100°C and/or the dyeing time for each sample in the range of 5-10 min. Suggested times and temperatures for some typical fibers are:

Acrilan 16—93°C, 5 min intervals

Acrilan SEF—96°C, 5 min intervals (except for blue C-1 and yellow C-2 standard, use 93°C) Orlon 75—96°C, 10 min intervals (except for C-1 standard, use 5 min)

Creslan—88°C, 5 min intervals

12.6 The strengths of some standard dyes were changed in August 1984. The % owf was adjusted accordingly. For example, C. I. Basic Yellow 29 (200%) at 0.25% replaced C. I. Basic Yellow 29 (100%) at 0.50%.

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