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NATIONAL BUREAU OF STANDARDS
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LIGHT-SENSITIVE PAPER

Direction for Use in Testing Textiles for Colorfastness to Light.

Light-sensitive paper* and booklets of standard faded strips of it are being supplied by the National Bureau of Standards for use in standardizing the dosage of radiant energy when testing textiles for colorfastness to light by exposure in commercial carbon-arc fading lamps. These lamps vary in fading rate from one to another and from time to time. The lack of duplicability in their performance must be taken into consideration in using them.

The paper is from a standardized lot produced in the National Bureau of Standards paper mill. It is colored with the direct azo dye, benzo azurine G, Colour Index No. 502. The paper is in pieces 2-5/8 inches by 2-3/4 inches.

The booklets contain strips of the paper 1-1/4 inches wide which have been faded by exposure in the National Bureau of Standards Master Lamp [1] in the range from about 16 to 32 Standard Fading Hours in steps of 4 hours. Twenty "Standard Fading Hours" of exposure in the master lamp is equivalent in fading action to 20 clock hours of exposure in the well-known Atlas Electric Devices Company's FDA-R Fade-Ometer, based upon the average results of tests in one hundred and thirty of these lamps. It is the exposure required to produce just "appreciable" fading of Lightfastness Standard L4 of the American Association of Textile Chemists and Colorists [2].

The paper and booklets make it possible to translate clock hours of exposure in lamps to "Standard Fading Hours" (SFH) and thus to express the dosage of radiant energy on a common basis. Directions for the use of the papers and booklets and a brief discussion of sources of variations in fading tests follow.

*See page 5 for specific information on Lot Numbers 1554 and 1589 of the light-sensitive paper.

CALIBRATION OF LAMP

The paper may be used to check the performance of lamps from time to time in order to predict the number of clock hours of exposure which will be required to produce fading corresponding to a specified number of Standard Fading Hours. The more frequently such checks are made the greater will be the assurance that the lamp is performing as desired.

The procedure follows: Mount a piece of the paper in a specimen holder of the lamp in the usual way (without backing) and place it in the lamp at the time it is started with a new set of carbons. Expose the paper continuously for 20 hours. Remove it and allow it to stand in the dark at room temperature for at least 2 hours in order for it to cool and to regain its normal moisture from the air. Trim off and discard the unexposed edges as they may affect the judgment of the fading.

Compare the fading of the exposed paper with that of the standard faded strips in the booklet. To do this, hold the booklet in the left hand, allow the pages to flip open one after another, rear cover first, and slip the exposed paper under one standard faded strip after another being careful to have the standard strip superimposed closely upon the exposed paper and the grain, that is the long dimension, or "machine" direction of the two in the same direction. Make the comparison in the light from a daylight fluorescent lamp or equivalent source with illumination of 50 foot candles or more on the papers. The lamp should be parallel to the long edge of the paper and booklet. The incident light should be at an angle of 45° and line of sight perpendicular to the surface of the paper. Avoid touching the surfaces of the exposed paper and the standard strips with the fingers as they are sensitive to moisture and soil easily.

From the comparison, estimate the exposure in Standard Fading Hours which would duplicate the fading of the test piece. Obtain a factor for converting clock hours of exposure in the machine to Standard Fading Hours. For example, if the paper exposed for 20 clock hours faded to an extent considered to fall half way between the 20 and 24 SFH strips in the booklet, i.e., 22 SFH, the factor would be 22/20 or 1.1. Credit textiles exposed in the machine for a given number of clock hours with an exposure in Standard Fading Hours of 1.1 times the clock hours.

If the factor is greater than 1.3, the fading rate of the lamp is considered too high as it may result in anomalous fading. The lamp should then be adjusted to give a slower fading rate.

USE OF PAPER IN TESTING

The lamp calibration outlined in the preceding paragraphs is a suitable basis for timing exposures in routine testing. For more important testing, however, the dosage of radiant energy should be measured with the paper during each test as the fading rate of a lamp may change from day to day and even during a test. The procedure is illustrated by the following directions for control of a 20-hour exposure. For long exposures, a succession of papers will have to be used and the number of Standard Fading Hours shown by them added together to obtain the total exposure. In carrying out such tests the paper should be changed with each change of carbons.

Place the textile specimen and two (or more if desired) pieces of the paper in the lamp at the same time, side by side. Remove one of the papers from the lamp about 4 hours before the estimated end of the test, noting the time. Allow this paper to stand in the dark at room temperature for 2 hours, compare the fading with that of the standard faded strips, and obtain the factor for converting clock hours to SFH as already outlined. Use this factor in calculating the time of exposure for the textile under test. The piece of paper left in the lamp with the textile will have received the same radiant-energy exposure as the textile at the end of the test. The actual exposure in SFH at the end of the test will then be obtained by rating the fading of this paper with the standard faded strips in the booklet. The result can be used as evidence that the test was as desired, or sufficiently near to it, or that the test must be repeated.

FACTORS AFFECTING DUPLICABILITY IN FADING TESTS

The many factors which may affect the duplicability of results in testing textiles for colorfastness to light, make such tests difficult to repeat. Some of the factors which the operator of a fading lamp should keep in mind include: density and spectral distribution of the incident radiant flux, the temperature and relative humidity of the air at the specimen, atmospheric contamination, method of mounting the specimen, and intermittent exposure. These factors affect the fading of the paper as well as textiles but the magnitude of the effects may not only be different for paper and textiles but for different textiles. The relative rates of fading of different textiles and the paper will not necessarily change to the same degree with changes in these conditions.

Given the same current, voltage, other electrical operating conditions, and similar carbons, the radiant flux emitted by the carbon-arc fading lamp is assumed to be reasonably under control with respect to spectral distribution and amount. The light-sensitive paper is intended to correct for moderate variations in amount of radiant flux.

Commercial fading lamps usually provide some control of temperature and relative humidity of the air about the specimens. The method of the American Association of Textile Chemists and Colorists calls for exposure of specimens in filtered air that is humidified and its temperature automatically controlled preferably at 105° F (40° C), but not over 115° F (46° C) [2].

In making preliminary comparisons of faded papers and standard faded strips, it is permissible to breathe on the faded paper momentarily to increase its moisture content. Final comparisons should be made as already indicated, or better after conditioning the paper by exposure to air at 50% relative humidity over night or longer.

The practice in some laboratories of mounting specimens on black or white cardboard or other backing has an effect on the fading especially of thin translucent specimens and therefore should be noted in reporting the results of tests. As already indicated, the light-sensitive paper should be exposed without backing as the SFH scale is based upon its use in this way. For strict control, the paper and textile should be put in the lamp at the same time and in comparable positions, for instance, both in the upper or lower row, and any vacant positions in the lamp should be filled with dummy specimens because of the influence on air currents and reflections.

The paper and some textiles fade more in a given time if exposed intermittently than if exposed continuously, perhaps because of an increase in moisture content while the lamp is shut off and the resulting more rapid fading when it is turned on again. It is therefore desirable to begin tests with the lamp provided with a fresh set of carbons and to avoid shutdowns.

REFLECTANCE OF FADED PAPERS

Although the paper and booklets are designed for simple visual estimation of the fading, photometric measurements may be used. They are used regularly at the National Bureau of Standards in evaluating the faded strips that go into the booklets. A Hunter Multipurpose Reflectometer [3] with large aperture and amber filter [4] is used. The specimens are conditioned by exposure to air having a relative humidity of 50 ± 4% and temperature of 73.5° ± 2° F for not less than 16 hours. The moisture content of the paper at the time of measurement has a definite influence on the reflectance.

AVAILABILITY OF PAPER AND BOOKLETS

During the past several years paper from Lot No. 1554 has been used. The supply is now practically exhausted and paper from Lot No. 1589 has superseded it. Although these lots are duplicate paper-mill runs they differ slightly in the fading in a given time of exposure. For this reason the 1589 paper should be used only with 1589 booklets. When this is done, the indicated number of Standard Fading Hours will be the same as would be obtained with Lot No. 1554 paper and booklets.

Communications regarding the paper should be addressed to the National Bureau of Standards, Textiles Section, 7.2, Washington 25, D. C.

REFERENCES

[1] Light-Sensitive Papers as Controls for Testing Textile Colorfastness and Stability of Materials under Arc Lamp Exposure, by Herbert F. Launer. Journal of Research, National Bureau of Standards, Vol. 41, pages 169-177 (1948). Research Paper RP1916.

[2] 1953 Technical Manual and Year Book of the American Association of Textile Chemists and Colorists, Vol. XXIX. Obtainable from the Secretary AATCC, Lowell Technological Institute, Lowell, Massachusetts.

[3] A Multipurpose Photoelectric Reflectometer, by Richard S. Hunter. Journal of Research, National Bureau of Standards, Vol. 25, page 581 (1940). Research Paper RP1345.

[4] Photoelectric Tristimulus Colorimetry with Three Filters, National Bureau of Standards Circular C429 (1942).

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