Standard Practice for Measuring the Dark Stability of Ink Jet Prints[1]

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1. Scope

1.1 This practice describes an accelerated procedure intended to determine the dark stability of ink jet prints.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D2244 Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates

2.2 *ANSI Standards:*

ANSI/NAPM IT9.9–1990 Stability of Color Photographic Images—Methods for Measuring[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *ink jet media, n*—recording elements used by ink jet printers to receive inks. The substrate may be paper, plastic, canvas, fabric, or other ink receptive material. The substrate may, or may not, be coated with an ink receptive layer(s).

3.1.2 *single accelerated test, n*—dark stability testing at a single set of environmental conditions, for example 50°C and 50 % relative humidity (RH).

4. Summary of Practice

4.1 Printed test samples are covered with a polyethylene terephthalate (PET) sleeve[4] to simulate an album, or with a sample of the same sample type to simulate a stack of prints, and placed in foil-lined bags. Air is forced out of the bags and the bags are sealed. The bags are placed in dark recirculating forced-air environmental chambers at 50°C/50 % RH and 24°C/50 % RH and the color change of the samples is then measured over time.

NOTE 1—The foil bags serve several purposes: they protect the samples, they prevent any outgassing from the samples from contaminating other samples in the test chamber, and they ensure contact of the PET or receiver to the samples.

4.2 The duration of the incubation may vary widely depending on the dark stability of the ink/media.

4.3 During the course of the test, the color changes in the printed samples are periodically evaluated instrumentally. Results are compared to a control incubated at room conditions and to the same specimen prior to incubation. The color change is reported as percent retained optical density and color difference, ΔE.

4.4 The test may be continued for a specific duration of time or until a predetermined color difference has been achieved.

5. Significance and Use

5.1 Dark stability of printed ink jet media for specified periods of time is pertinent to the end use of these materials. While natural aging is the most reliable method of assessing image stability, the length of time required makes this practice impractical for most materials. As a result, accelerated tests often are used. This practice is an accelerated short-term storage practice that simulates long-term storage but at elevated temperature. It provides faster results and is intended to identify problems that may occur over extended time periods. A room condition sample also is tracked to provide practical data. Because testing is done at a single set of conditions, it is not intended to be a long-term predictor as achieved through Arrhenius testing.

NOTE 2—The results from single accelerated tests can lead to inaccurate results. This procedure should be used only for early-screening information in side-by-side comparisons only. Arrhenius testing, which is based on mathematical extrapolation of a series of high temperature tests to room temperature, is a better predictor of a product's stability.[5]

[1] This practice is under the jurisdiction of ASTM Committee F05 on Business Imaging Products and is the direct responsibility of Subcommittee F05.07 on Ink Jet Imaging Products.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

[4] Kodak Image Sleeve Cat. 160–0733.

[5] S. Anderson and D. Kopperl, "Limitations of Accelerated Image Stability Testing," *Journal of Imaging Science and Technology*, 37: 363–373 (1993).

5.1.1 Since the ability of an ink jet print to withstand color changes is a function of temperature and humidity, it is important that dark stability be assessed under the conditions appropriate to the end use application. While ink jet prints may be handled and displayed under a variety of conditions, this test practice is intended to produce the color changes that may occur in ink jet prints upon dark exposure in typical office environments.

5.1.2 The accelerated procedure described in this test practice is intended to provide a means for the rapid evaluation of dark stability under laboratory conditions. Test results are useful for specification acceptance between producer and user, for quality control, and for research and product development.

5.1.3 Color changes are not a linear function of duration of incubation. The preferred method of determining dark stability is to incubate the prints for a number of intervals, and to assess the exposure time required to obtain a specific color difference.

6. Interferences

6.1 It is recognized that the rate of dark fade of ink jet prints will vary because of factors, such as initial color density, the area printed (solid versus half-tone), the substrate, the ink type (dye versus pigment inks), and the coating type and thickness. Consequently, test results must be determined individually for each printed recording element.

6.2 The rate of dye degradation is temperature dependent: at high temperatures, the chemical reactions that lead to dye loss are accelerated; however, at temperatures above 50°C, dot spread may occur resulting in an apparent increase in density.

6.3 While ink jet images may be stored at relative humidities of greater than 50 % in many parts of the world, the combination of high temperatures used for accelerated testing and high humidity may produce effects that would never occur in actual use.

7. Apparatus

7.1 *Recirculating Forced-Air Environmental Chambers, PET and foil-lined bags.* [6]

8. Test Specimen

8.1 The substrate, method of printing, ink, ink laydown, and handling of printed specimens shall be consistent with the anticipated end use of the specimens.

8.2 The test image may be generated with personal computer word processing, drawing/graphics, or page layout software, saved as a print file for each printer/method of printing (contributing its unique ink and ink/receiver interactions that may impact on the image light stability), trial-printed, and evaluated for appropriate ink letdown (purity and amount) and ease of printing and testing. Each print file should have its filename, type, and version identified in the image area and a place for experimental notes, for example, time, printer, environmental conditions, operator. The printer settings and a trial print of each print file version should be archived.

8.3 The recommended test image should consist of color patches printed using print files containing the appropriate printer setup specific for each application. The color patches should be printed at 1.0 density and include each of the primary colors (cyan, magenta, yellow, and black), secondary colors (red, green, and blue), and composite black (cyan plus magenta plus yellow).

8.4 For instrumental evaluation, the color patch must be large enough to cover the specimen port; a minimum size of 1-¼ in.^{2} (35 mm^2) is satisfactory for many instruments.

8.5 Potential variables, such as temperature, relative humidity, must be monitored and controlled to guard against sample induced changes.

9. Conditioning

9.1 It is recommended that samples be conditioned at 25°C and 45 % RH for at least 24 h prior to testing. Specimens should be inspected visually for color uniformity and surface irregularities, which could adversely affect color measurement.

10. Procedure

10.1 Prepare samples in accordance with Section 8

10.2 Take initial readings of density, or L*a*b, or both.

10.3 Cover the samples with a like sample or with PET and place in foil-lined bags. Force air from bag and seal. Place sealed bags in dark, recirculating forced-air environmental chambers at 50°C/50 % RH and 24°C/50 % RH.

10.4 Measure color change of the samples on a periodic basis, for example, 42, 63, 84, 126, 168, 210, 252, 294, 365 days, and so forth.

10.5 Terminate the test after a specific duration of time or when a predetermined color change is achieved. The duration of the test and the magnitude of the predetermined color change may differ significantly depending on the ink/media and the intended usage.

11. Calculation

11.1 ΔE shall be calculated in accordance with Practice D2244. Densities shall be measured in accordance with ANSI/NAPM IT9.9–1996, sections 3.3–3.6. Percent-retained density shall be calculated as follows:

$$\%\ \text{Retained Density} = \frac{\text{Optical Density After Exposure}}{\text{Optical Density Before Exposure}} \times 100 \quad (1)$$

NOTE 3—The type of equipment used for making color measurements, the method, and the color-difference equation used must be stated.

12. Report

12.1 Report the following information:

12.1.1 Specimen identification, including the printer, method of printing, and the media type.

[6] Foil-lined bags, available from Maco Bag Corporation in two sizes: Poly Heat Seal Pouch 7-¼ in.× 15 ⅛ in. (Part #MACO 000041) and Poly Heat Seal Pouch 13 in. × 13 in. (Part #MACO 000042), have been found suitable.

12.1.2 The test results from the instrumental color change evaluation (percent retained optical density and ΔE) of the color patches and the support and the initial and final density and L*a*b values.

12.1.3 Exposure temp, *t*.

12.1.4 Exposure humidity, *h*.

12.1.5 Total exposure time, *d*.