Designation: F2037 – 00 (Reapproved 2011)

Standard Practice for Predicting the Lifetime of Ink Jet Prints Stored in Dark Keeping Conditions in Typical Office Environments[1]

This standard is issued under the fixed designation F2037; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice describes an accelerated procedure intended to predict the lifetime of images stored in dark keeping conditions in typical office environments.

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 IT9.9–1996 Stability of Color Photographic Images—Methods for Measuring[3]

ANSI/PIMA IT9.24–1997 Arrhenius-Type Predictions—Test Method[3]

Limitations of Accelerated Image Stability Testing[4]

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 polyethylene terephthalate (PET) sleeve[5] 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 multiple temperatures at 50 % RH. After a predetermined color change is obtained, the test is terminated and the image life is predicted by ANSI/PIMA IT9.24–1997.

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 test may vary widely depending on the dark stability of the ink/media and the temperature condition.

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.

5. Significance and Use

5.1 The image life of printed ink jet media in dark keeping conditions in typical office environments 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 method impractical for most materials. As a result, accelerated tests often are used. This test practice is an accelerated short-term storage test that simulates long-term storage but at elevated temperatures. A room condition sample is also tracked to provide practical data. By measuring the time needed to obtain a predetermined color change at a variety of

[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.

Current edition approved Oct. 1, 2011. Published March 2012. Originally approved in 2000. Last previous edition approved in 2006 as F2037–00(2006). DOI: 10.1520/F2037-00R11.

[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] S. Anderson and D. Kopperl, *Journal of Imaging Science and Technology*, 37: 363–373 (1993).

[5] Kodak Image Sleeve Cat. 160–0733.

temperature conditions, the image life can be predicted using the Arrhenius method.

NOTE 2—The Arrhenius method is a predictive test based on mathematical extrapolation of high temperature tests to room temperature. In this test, long-term color changes are predicted by performing short-term tests at a series of high temperatures.

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 keeping in typical office environments.

5.1.2 The accelerated procedure described in this test practice is intended to provide a means for predicting the life of an ink jet image under laboratory conditions. Test results are useful for specification acceptance between producer and user, for quality control, and for research and product development.

6. Interferences

6.1 It is recognized that the rate of dark fade of ink jet prints will vary significantly 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 inkjet 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 and 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 24°C and 50 % RH for at least 24 h prior to testing. Specimens should be visually inspected 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 24°C (control sample) and at least four additional temperatures. The temperature range shall be at least 20°C, preferably wider, and the temperature intervals shall be approximately equal. Temperature settings should be as high as possible without causing artifacts, such as dot spread. A recommended starting point is 20°C, 30°C, 40°C, and 50°C. The humidity shall be set at 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 when the 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 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.

11.2 The predicted image life calculated by the Arrhenius method. The calculation shall be performed in accordance with ANSI/NAPM IT9.9–1996.

[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), are suitable.

NOTE 4—While the Arrhenius test is a better predictor of long-term stability than single accelerated tests, the quality of results it produces is affected by many factors such as the number and level of temperatures, length of test, and test humidity. A discussion of certain cautions that must be used to interpret Arrhenius test data may be found in the standard for Limitations of Accelerated Image Stability Testing and in ANSI/PIMA IT9.24 "Arrhenius-Type Predictions—Test Method."

12. Report

12.1 Report the following information:

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

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

12.1.3 Exposure temperature ranges, *t*.

12.1.4 Exposure humidity, *h*.

12.1.5 Predetermined color change used to determine test end point.

12.1.6 Extrapolated time for end point to occur at specified temperature and relative RH.