Designation: D7305 – 08a (Reapproved 2013)

Standard Test Method for Reflection Density of Printed Matter[1]

This standard is issued under the fixed designation D7305; 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 test method describes a procedure for measuring reflection density of printed matter using a reflection densitometer or spectrodensitometer.

1.2 This test method is intended primarily for process colors (yellow, magenta and cyan) and black. With appropriate instrumentation, it may also be used for other colors.

1.3 This test method applies to prints made by any printing process on a flat surface, with reflection density values ranging from just above zero, on the unprinted substrate, through to around 2.5 for very dense prints.

1.4 This test method can be used for prints on paper, film or board but not for those on metal or foil. It can be conducted in the pressroom or laboratory.

1.5 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.6 *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]

E284 Terminology of Appearance

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

2.2 *ANSI Standards:*[3]

CGATS.4-1993 Graphic Technology – Graphic Arts Reflection Densitometry Measurements — Terminology, Equations, Image Elements and Procedures

CGATS.6 Graphic Technology — Specifications for Graphic Arts Printing

CGATS.11-1999 Graphic Technology — Certified Reference Materials for Reflection and Transmission Metrology – Documentation Requirements and Recommended Procedures

PH 2.17 Geometric Conditions for Reflection Density

PH 2.18 Spectral Conditions for the Measurement of Optical Density

2.3 *ISO Standard:*[3]

ISO 15790 Graphic technology and photography — Certified reference materials for reflection and transmission metrology — Documentation and procedures for use, including determination of combined standard uncertainty

2.4 *Other Standard:*[3]

DIN 16536-2:1986 Testing of prints and printing inks in graphic technology — Colour density measurements on on-press or off-press prints

3. Terminology

3.1 Definitions related to appearance are in Terminology E284.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *reflection density, n*—the light-absorbing property of a material, expressed as the logarithm of the reciprocal of the reflectance factor (i.e. higher density indicates more light is absorbed). [$D = \log_{10} (1/R) = -\log_{10} (R)$]

3.2.2 *reflection densitometry, n*—the practice of characterizing the amount of light absorption of materials by measuring reflectance and calculating and reporting reflection density.

3.2.3 *spectrodensitometer, n*—a spectrophotometer with appropriate software to convert the measured reflectance values to reflection density.

3.2.4 *process color, n*—a color having the main attribute of absorbing approximately one-third (1/3) the visible spectrum and transmitting the other two-thirds (2/3).

3.2.5 *dry back, n*—the reduction in density that occurs over time after printing on paper and other absorbent substrates due to ink penetration into the substrate.

3.2.6 *status T, n*—an ISO Reflection Status Density.

[1] This test method is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.56 on Printing Inks.

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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, http://www.ansi.org.

***A Summary of Changes section appears at the end of this standard**

NOTE 1—ISO Reflection Status Density is defined by its Spectral Products (Fig. 1), that is, the wavelength by wavelength combination of a standard influx spectrum (CIE illuminant A) and the filter-modifed efflux spectrum. Originally, these modifiers were defined by combinations of Wratten filters but today, either more durable materials, such as glass are used or the Spectral Products are computed numerically from tables of weights and the spectral reflectance factors measured with a spectrodensitometer.

The status T spectral products are applicable to the measurement of artwork for color separation and graphics arts materials such as ink-on-paper printed sheets, and off-press proofs. Status T was originally defined to closely match the spectral products historically used in evaluating original artwork to be color separated but were later applied, notably in the USA, to the measurement of most other printed graphic arts materials.

The status E spectral products are also applicable to the measurement of graphics arts materials such as ink-on-paper printed sheets, and off-press proofs. They evolved from the wider of the two passband filter specifications of DIN 16536-2:1986 for the Yellow and the Magenta and Cyan spectral products were chosen to match those of Status T. Status E spectral products have been applied, primarily in Europe, to the measurement of graphic arts materials. The narrower passband of the Yellow filter (compared to Status T) produces values that are more similar for all three chromatic inks at typical printing densities.

4. Symbols

4.1 *Symbols*: The following symbols are defined or referred to in this standard.

D reflection density
R reflectance factor

5. Summary of Test Method

5.1 The densitometer or spectrodensitometer is calibrated and set for the desired spectral response and color.

5.2 Multiple reflection density measurements are taken in specified positions on the print in order to determine an average result.

6. Significance and Use

6.1 One of the key properties for printing in the lab or on production equipment is the intensity of the color, color balance and uniformity. This test can be used to ensure that the proper amount of ink is transferred to the substrate by obtaining a target density value, in addition to determining whether the print is uniform by measuring the reflection density over a wide print area. This then allows the use of the print for controlled testing of other appearance properties, such as gloss and color, and performance properties, such as resistance to abrasion and chemicals.

6.2 This test can be used to help achieve consistent color reproduction of printed color on flat surfaces.

6.3 Transfer of density readings from one set of inks to another, or from one substrate to another, carries a high risk of producing a color or tone shift. It is not in the scope of this test

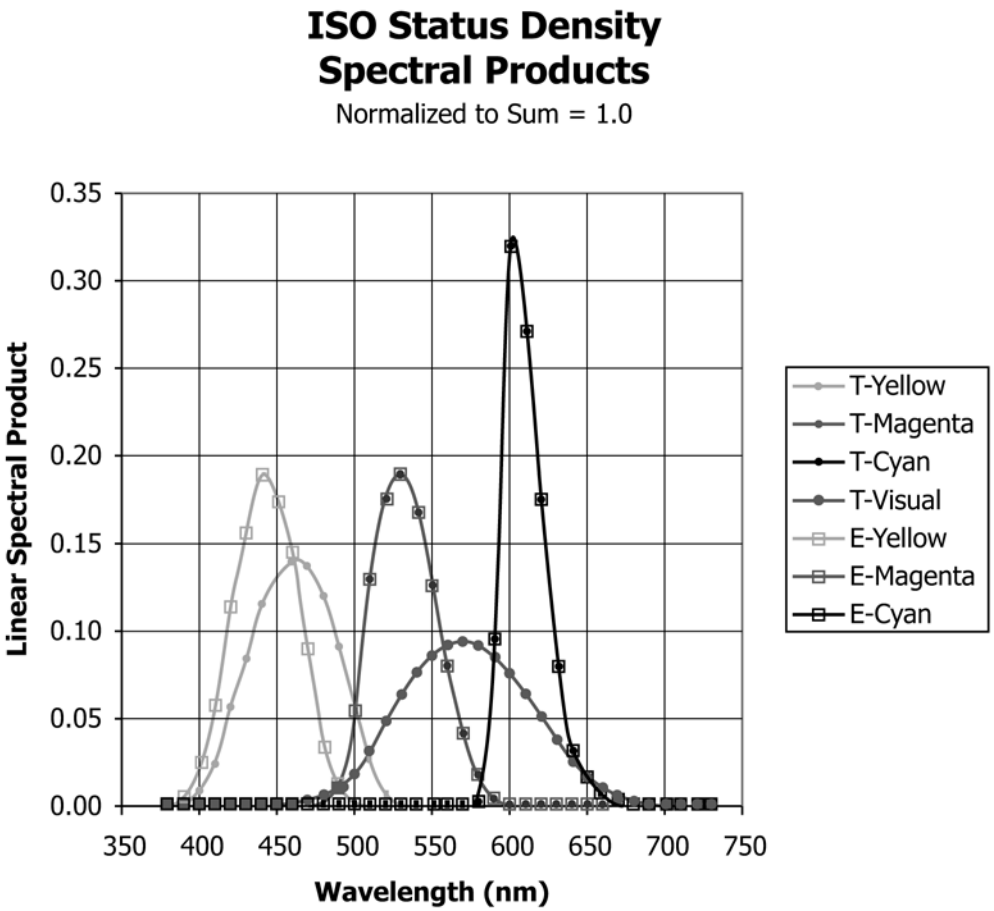

FIG. 1 ISO Status Density Spectral Products

method to use density readings as digital proof of target points for printing process control.

7. Apparatus

7.1 *Densitometer,* of which there are two types.

7.1.1 *Reflection Densitometer* conforming to ANSI Standard PH2.17 with a Status T response that conforms to ANSI Standard PH2.18, and used according to CGATS.4-1993.

7.1.2 *Spectrodensitometer,* with a Status T response that conforms to ANSI Standard PH2.18, calibrated according to the manufacturer's instructions and used according to CGATS.6. A spectrodensitometer that gives spectral output is required for non-process colors.

7.1.3 *Standardization plate and calibration instructions* supplied by the manufacturer.

8. Materials

8.1 *Reference Standards* such as the T-Ref standard.[4]

8.2 *Backing Paper* from the print job is normally used in the printing industry. Matte-black backing paper having a visual reflection density of 1.50 ± 0.20 can be used but may not be appropriate for all applications such as transparent film or paper with low opacity, due to show through.

9. Test Samples

9.1 Test samples may be production prints or prints prepared in the laboratory. Many production prints contain color bars or targets specifically intended for monitoring reflection density. In either case, the area of the specimen to be measured must be large enough to accommodate the aperture of the instrument being used.

9.2 Print areas to be measured must be free of wrinkles, folds, fingerprints and other such defects.

9.3 Prints can be measured at any interval after printing. However, on absorbent substrates the density readings will decrease with time due to dry back until the ink is fully dry.

10. Calibration and Standardization

10.1 Warm up the densitometer or spectrodensitometer according to the time stated in the manufacturer's recommendations. Use the first few readings to establish stable readings on the standardization plate.

10.2 Calibrate the instrument according to the manufacturer's procedure.

10.2.1 Set the instrument to the specific density values established by the manufacturer.

10.3 Further assurance of calibration precision can be obtained by measuring a certified reference material such as the T-Ref standard. Readings that differ from the labelled value on the certified reference material by more than the greater of 0.02 density units or 2 % should be discussed with the densitometer manufacturer in order to determine whether the particular densitometer is performing to its design capability.

11. Procedure

11.1 Select the filter on the densitometer to measure the specific color.

11.1.1 If the test sample is a process color, use the appropriate status T filter.

11.1.2 If the sample is black, gray or white, use the Visual density filter.

11.1.3 If the sample is a non-process color, a spectrodensitometer capable of producing spectral output is used and the reading is recorded at the wavelength giving the highest reading (maximum absorption).

11.2 Set the densitometer to the appropriate mode to measure density.

11.3 Place the backing sheet(s) on a flat surface and the print specimen on top of the backing sheet(s).

11.4 Place the densitometer aperture on the test specimen.

11.5 For laboratory and production prints containing large solids, take five measurements, one in each corner 25 mm from the edge of the test specimen and one in the middle if the color specimen is large enough or five readings representative of the length of the test specimen.

11.6 For production prints containing only color bars or small targets, five measurements can either be taken at the appropriate patches along the color bar or on five sequential prints specimens.

11.7 Calculate the mean and record the reading.

11.8 Use the data recording requirements in Section 12 to characterize reflection density measurement.

12. Report

12.1 Report the following information:

12.1.1 The manufacturer and model number of the densitometer or spectrodensitometer.

12.1.2 The aperture on the measuring head of the instrument.

12.1.3 The spectral response (status T).

12.1.4 The identity of the backing paper used.

12.1.5 Whether the measurement is absolute density or relative density.[5]

12.1.6 The identity of the prints measured and the measurement positions.

12.1.7 The interval after printing.

13. Precision and Bias[6]

13.1 *Precision*—An interlaboratory study of this test method was conducted. Ten laboratories tested five specified areas of triplicate prints of four colors, measuring status T densities. The reflection density of the prints varied from around 0.85 on the yellow to about 1.60 on the black. The test results were

[4] Available from IDEAlliance, 1421 Prince St., Suite 230, Alexandria, VA 22314–2805.

[5] The default measurement is absolute density which includes the density of the substrate. Relative density, which excludes the density of the substrate, can be obtained as a function on most densitometers or by manually measuring the density of unprinted substrate and subtracting this value.

[6] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D01-1141.

analyzed in accordance with Practice E691. Based on the statistical analysis of the results, the following criteria should be used to judge unacceptability of results at the 95 % confidence level:

13.1.1 *Repeatability*—Two results, each the mean of five determinations, obtained by the same operator should be considered suspect if they differ by more than 0.03 density units.

13.1.2 *Reproducibility*—Two results, each the mean of five determinations, obtained by operators in different laboratories should be considered suspect if they differ by more than 0.05 density units.

13.1.3 *Bias*—There are several sources of bias in the assessment of reflection density of prints. A certified reference material (CRM) or materials are required to assess the level of bias for any given instrument. The creation and use of certified reference materials for assessment of printing is documented in ANSI CGATS.11-1999 and ISO 15790. The industry standard reference material in the North American printing industry is the T-Ref standard. The stated uncertainty at the 2× coverage for the T- Ref ranges between ±0.02 and ±0.04 depending on the value of the density with the most common value being ±0.04. An upper limit on the bias can be set as the combination of the uncertainty of the CRM and the instrument reproducibility, taken in quadrature. That is, the square root of the sum of the squares of the uncertainty and the reproducibility. For this standard the upper limit on the bias is 0.064 density units. Direct tests of T-Ref versus one of the instruments used in the round-robin gave bias of between 0.00 and 0.05 density units on the different test targets.

14. Keywords

14.1 process color; reflection densitometer; reflection density; spectrodensitometer

SUMMARY OF CHANGES

Committee D01 has identified the location of selected changes to this standard since the last issue (D7305 - 08) that may impact the use of this standard. (Approved November 1, 2008.)

(1) 6.1 was revised.