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Brightness of pulp, paper, and paperboard (directional reflectance at 457 nm)

1. Scope

1.1 This method is for the determination of the brightness of white, near-white, and naturally colored pulp, paper, and paperboard. Brightness is a commonly used industry term for the numerical value of the reflectance factor of a sample with respect to blue light of specific spectral and geometric characteristics. This method requires an instrument employing 45° illumination and 0° viewing geometry with the illuminating and viewing beams adjusted so that translucent materials are evaluated on an arbitrary but specific scale. The cone of light (see A.3.2 and A.3.5) used by this method is wider than that specified for the CIE Standard 45/0 geometry.

1.2 Brightness and whiteness are not the same measurement. Brightness and whiteness are not interchangeable, and there is no known mathematical relationship between the two values.

1.3 This procedure is applicable to all naturally-colored pulps, and papers and board made therefrom and is suitable for optically brightened pulp and paper. The measurement is not suitable for paper or paperboard containing added coloring matter (such as yellow or green dyestuff) which appreciably absorbs light in that part of the spectrum extending from about 400 to 500 nm. This brightness method is not applicable to colored papers which must be measured either spectrophotometrically or colorimetrically in order to obtain meaningful results (1).

1.4 This method gives:

1.4.1 A procedure for using the test instrument to measure the directional reflectance factor at 457 nm of a sample of paper or paperboard (2-5).

NOTE 1: The effective wavelength of the spectral band is 457 nm. The shape of the function is also important as defined in Appendix A.

1.4.2 A description of a system of preparing, distributing and using reflectance standards by which an instrument can be maintained in continuous agreement, to within specified tolerances, with a master instrument.

1.4.3 A detailed description (Appendix A) of the significant spectral, geometric, and photometric

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characteristics of a master instrument, with a statement of the tolerances which must be met in its construction and maintained during its use.

1.4.4 A procedure described in Appendix C for separating the fluorescent component of brightness from the non-fluorescent component of brightness and measuring it quantitatively.

2. Summary of method

This method provides: (a) a scale for measurement of blue directional reflectance factor, (b) a method for verifying the calibration of each instrument used for reflectance testing so that the user can rely upon the test results, and (c) a means for determining the fluorescent component of brightness.

3. Significance

3.1 Blue-light reflectance measurements were originally designed to provide an indication of the amount of bleaching that has taken place in the manufacture of pulp. The higher the blue-light reflectance, generally the whiter the products will appear. The method provides a simple single-number index useful for comparing similar white materials; however, colored materials are better identified by using a standardized three-dimensional color space, see TAPPI T 524 "Color of Paper and Paperboard (45°/0° geometry)."

3.2 Because the instrument geometry of this method is different from that of TAPPI T 525 "Diffuse Brightness of Pulp (d/0)" and ISO 2470 "Measurement of Diffuse Blue Reflectance Factor (ISO Brightness)," there is no simple relationship between the two brightness scales (9,10).

4. Reflectance scale and standards

4.1 *Reflectance scale:* The standard brightness scale is based on the reflectance of magnesium oxide of 100.0%. This scale is rigorously maintained utilizing instrumental methods not dependent upon unstable physical standards such as magnesium oxide (6).

4.2 *Calibration Standards:* Sets of paper tabs and polished white opal glass standards¹ with calibration values based on the master instrument. Sets of at least five pads of paper of different reflectance levels and two opal glass standards shall be provided.

4.3 Calibration Standards are to be provided by a calibration laboratory meeting the requirements of Section 5.3 of TAPPI T 1211 sp-01 "Acceptance Procedures for Calibration Laboratories."

5. Apparatus

5.1 *Brightness tester,* a test instrument which embodies the geometric, photometric and spectral characteristics specified in Appendix A and in such adjustment that its calibration is correct to within the tolerances specified in 6.1.

NOTE 2: Agreement of the test instrument with the master instrument on one or two levels of standards is not sufficient proof that readings on the test instrument will agree with the master instrument throughout the range of application of this method. The test instrument will be in proper calibration if it reads all standards within ± 0.3 point of their assigned values.

5.2 *Standards,* a set of five pads of paper tabs and two opal glass standards as described in 4.2 and Appendix B.

5.3 *Backing weight,* 1-kg weight with flat bottom.

6. Calibration

6.1 *Obtain reflectance standards¹* at monthly intervals and calibrate the test instrument with them as soon as they are received. If the instrument readings on the standards differ from their assigned value by more than ± 0.3 point, adjust the instrument in accordance with the manufacturer's instructions so that the readings agree with the assigned

¹ Names of suppliers of testing equipment and materials for this method may be found on the Test Equipment Suppliers list, available as part of the CD or printed set of Standards, or on the TAPPI website general Standards page.

values to within 0.3 point.

6.2 Check the test instrument readings at least monthly against the assigned values of all the standards. A check should be made with the opal glass standard at least daily. The frequency of these checks will depend on the amount of use of the instrument and the accuracy required. Care should be exercised that the paper standards do not become soiled through frequent use.

6.3 At intervals of one to three years, depending upon the conditions and frequency of use, the test instrument should be carefully inspected, tested, and adjusted to ensure that its geometric and spectral characteristics fall within prescribed limits, and that its photometric system is within the specified tolerances.

7. Test specimens

7.1 Sample preparation—paper and paperboard

7.1.1 Sample the material to be tested in accordance with TAPPI T 400 “Sampling and Accepting a Single Lot of Paper, Paperboard, Containerboard, or Related Product.” From each test unit cut a representative portion of the paper or board into seven or more tabs at least 30 mm longer and 20 mm wider than the specimen aperture [nominally 51 mm (2 in.) by 38 mm (1½ in.) with the short dimension parallel to the machine direction]. Avoiding any water mark, dirt, or blemish, assemble the tabs in a pad with the felt (top) sides up. Use the top tab as a cover only; mark it near one corner to identify the sample and the top side. More than seven specimen tabs may be required for thin or transparent samples to ensure that the pad is completely opaque. (Only a few tabs will be required for paperboard.) The number of tabs in the pad should be such that the measured reflectance is not changed by doubling its thickness.

7.1.2 Do not touch test areas of the specimen with the fingers. Protect the test areas from contamination, excessive heat, or intense light.

7.2 Sample preparation—pulp. Prepare sheets from pulp samples in accordance with TAPPI T 218 “Forming Handsheets for Reflectance Tests of Pulp (Büchner Funnel Procedure)” or TAPPI T 272 “Forming Handsheets for Reflectance Testing of Pulp (Sheet Machine Procedure).”

8. Procedure

8.1 Without touching the test areas with the fingers, remove the protective cover tab and place it at the back of the pad. Place the pad over the specimen aperture of the instrument with the machine direction of the paper parallel to the plane determined by the axes of the incident and reflected rays of light and with the top side in contact with the instrument. If an orientation (“upstream/downstream”) effect is suspected (as in the case of some lightweight coated grades), rotate the pad 180° and observe the reading. If the difference between upstream and downstream brightness exceeds 0.3, clearly record in the report the reading for each orientation.

8.2 Place the 1-kg backing weight on the pad. Measure and record the reflectance reading to 0.1 unit.

8.3 Move the lower tab to the back of the pad and measure the second tab. Repeat this procedure until five tabs have been measured.

9. Report

Report the average brightness of the sample to one decimal place, together with the minimum and maximum readings. State clearly and conspicuously any deviations from the standard procedure, and note any unusual features or characteristics of the sample.

10. Precision

10.1 The following estimates of repeatability and reproducibility were taken from the CTS Interlaboratory Program for Paper and Paperboard in 1996 and 1997. Only labs using instruments conforming to this method were selected. For each sample, 55 to 61 laboratories are included in the statistics. Each estimate is based on eight determinations per sample.