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Accelerated light aging of printing and writing paper by xenon-arc exposure apparatus

1. Scope

1.1. This standard practice describes a laboratory procedure for the exposure of printing and writing paper to xenon-arc light at elevated levels of light flux to permit accelerated aging of that type of paper.

1.2. This standard practice specifies the sample preparation and conditions of exposure required to obtain information on the relative stability of paper with regard to change in optical properties brought about by exposure of such paper to light.

1.3. This standard practice provides qualitative guidelines regarding paper stability. It does not define the life expectancy for a given paper to reach a specified set of optical properties.

1.4. This standard practice uses high-intensity broadband light sources that may not be suitable for the evaluation of light stability of papers that contain peroxide bleached mechanical pulp (1).

2. Summary

2.1. In this standard practice, light from a xenon-arc lamp that makes use of filters to simulate natural daylight that has passed through window glass shines on a paper surface with light flux that is substantially greater than in normal indoor conditions of paper exposure. The light flux shines in a controlled manner and for a specified period of time. The light flux causes photochemical reactions in the paper that may change its reflectance (brightness) and color. Comparing initial and final levels of these parameters against different criteria, provides a measure of optical stability.

3. Significance

3.1. This standard practice will find use by parties concerned with the relative optical stability of various printing and writing papers.

3.2. The practice will provide manufacturers, paper users and other interested parties with guidelines to determine quantified rankings of paper stability that identify papers that are stable, moderately stable and unstable when exposed to light over periods of time.

3.3. The stability rankings may be used for definition of the stability of paper to light, but will not define specific periods of life expectancy of a given paper.

Approved by the Standard Specific Interest Group for this Test Method



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4. Applicable standards

4.1. TAPPI Test Methods:

TAPPI T 400 "Sampling and Accepting a Single Lot of Paper, Paperboard, Containerboard, or Related Product"
TAPPI T 412 "Moisture in Pulp, Paper, and Paperboard"
TAPPI T 402 "Standard Conditioning and Testing Atmosphere for Paper, Board, Pulp Handsheets and Related Products"
TAPPI T 452 "Brightness of pulp, paper, and paperboard (directional reflectance at 457 nm)"
TAPPI T 254 "Cupriethylenediamene disperse viscosity of pulp (falling ball method)"
TAPPI T 524 "Color of paper and paperboard (45°/0° geometry)"
TAPPI T 1200 "Interlaboratory Evaluation of Test Methods to Determine TAPPI Repeatability and Reproducibility."
TAPPI T 1212 "Light sources for evaluating papers including those containing fluorescent whitening agents"
TAPPI T 1213 "Optical measurement terminology (related to appearance evaluation of paper)"

4.2. ASTM Standards:

D 1968 "Standard Terminology Relating to Paper and Paper Products"
G 113 "Terminology relating to natural and artificial weathering tests of nonmetallic materials"
G 151 "Standard practice for exposing nonmetallic materials in accelerated test devices that use laboratory light sources"
G 155 "Standard practice for operating xenon arc light apparatus for exposure of nonmetallic materials."

5. Apparatus – test chamber

5.1. Provide a test chamber that utilizes a sealed "long-arc" xenon lamp to illuminate the test samples. The lamp selection shall be according to ASTM Standard G 155, as per Table 2 of that document.

5.2. Use a glass filtration system in front of the lamp to simulate natural daylight that has passed through window glass. This is to cut off almost all of the very short wavelength (nominally that which is below 320 nm) that occurs when daylight passes through window glass. Provide the glass filtration system as defined in ASTM Standard G 155.

5.3. Provide a cooling system with the test chamber such that a temperature at the paper surface is maintained at greater than 20°C and less than 30°C for all paper types. Air may be used as a cooling medium, but is not mandated so long as humidity of about 0.007 kg water/kg of dry air is maintained in the atmosphere above the paper surface and that a supply of oxygen, approximately equivalent to that which is found in standard air, is present at the paper surface. Apart from the oxygen, the remainder of the gas present shall be inert.

5.4. The test chamber shall be designed such that it can be operated with ventilation so as to assure that it is free of ozone gas.

6. Test chamber operation and calibration

6.1. Control the intensity [irradiance (E)] of the xenon arc lamp to $765 \text{ W/m}^2 \pm 75 \text{ W/m}^2$ as measured in the 290-800 μm wavelength range.

6.2. Recalibrate the instrument with sufficient frequency to ensure continual preservation of both the light spectrum and the light intensity. For recalibration frequency recommendations, refer to the manufacturer's instructions of the particular instrument in use.

6.3. Arrange the configuration of the test chamber so as to assure uniformity of light intensity (irradiance) across the paper sample area in a way that provides $\leq 10\%$ deviation from target intensity for the entire sample.

6.4. Check the temperature at the paper surface with sufficient frequency to ensure that it is between 20°C and 30°C throughout the test. Make these measurements with a properly calibrated optical pyrometer.