INTERNATIONAL STANDARD

ISO 18946

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Imaging materials — Reflection colour photographic prints — Method for testing humidity fastness

Matériaux pour l'image — Tirages photographiques en couleurs par réflexion — Méthode d'essai de la solidité à l'humidité

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 18946 was prepared by Technical Committee ISO/TC 42, *Photography*.

Introduction

This International Standard addresses the methods and procedures for testing the humidity fastness of reflection colour photographic prints. Low and high humidity exposure are covered. This is of particular relevance to dye-based ink-jet prints or dye diffusion process prints[10][11][12][13][14][15][16].

Some types of colour photographic print suffer from changes in image appearance when exposed to a high relative humidity environment. The observed changes relate to colour, tone and loss of sharpness caused by horizontal and vertical diffusion of colorants as a result of exposure to elevated humidity.

The elevated humidity can arise from:

a) exposure to high relative humidity of the environment of the display area or storage space;

b) trapped moisture as a result of stacking prints, or inserting them into albums, in a high relative humidity environment;

c) trapped moisture as a result of stacking prints, or inserting them into albums, before sufficient dry time has elapsed.

Therefore, humidity based on meteorological data and users' behaviour was considered in determining the appropriate test conditions for the humidity fastness test. The test method stipulated in this International Standard is validated for case a).

Image deterioration of dye-based prints caused by high humidity is often detectable by the following characteristics.

— Blur (sharpness loss), change of colour and/or tone is observed.

— The deterioration is observed in higher humidity, commonly over 80 %RH or over 90 %RH.

— The deterioration can occur in a relatively short time, even within one or two weeks.

— Higher density images, or images that contain more secondary or mixed colours, are generally more affected. The largest change is usually observed at the boundary of different colours, or with images that have contrasting background colours. The size of the higher density area also affects the deterioration because the solvent and water of the ink diffuses to the adjacent lower density area when the higher density area is small.

It is important to take into account these characteristics when determining the appropriate test chart and test conditions.

It has also been observed that low relative humidities can accelerate the yellowing of certain types of inkjet papers. Indoor low humidities are common in colder climates as a result of heating air drawn in from the outdoors with very low dew points, and also in hot, dry climates in combination with air conditioning. In addition to D_{min} yellowing, very low humidities have also been shown to cause physical degradation to image-receiving layers; this phenomenon is outside the scope of this International Standard.

This International Standard makes use of a checkerboard pattern that allows assessment of humidity-induced blur by means of a relatively simple colorimetric measurement[11].

Imaging materials — Reflection colour photographic prints — Method for testing humidity fastness

1 Scope

This International Standard describes test methods for evaluating reflection colour photographic prints with regard to changes in image appearance resulting from exposure to both low and high relative humidity.

The observed changes relate to colour, tone and loss of sharpness caused by horizontal and vertical diffusion of colorants from exposure to elevated humidity levels. Other humidity-related factors, such as mould and mildew growth, and physical damage, such as curl, cockle, cracking or delamination due to humidity cycling, are outside the scope of this test method.

Although the method and procedures described in this International Standard can be used to test any colour hardcopy technology, it is particularly appropriate to systems where the colorants are applied by a mechanism involving the diffusion of colorant into image-receiving layers, for example inkjet or dye diffusion processes, and to certain types of inkjet media that are susceptible to D_{min} yellowing.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 18913, *Imaging materials — Permanence — Vocabulary*

ISO 18931, *Imaging materials — Recommendations for humidity measurement and control*

ISO 18941, *Imaging materials — Colour reflection prints — Test method for ozone gas fading stability*

ISO 13655, *Graphic technology — Spectral measurement and colorimetric computation for graphic arts images*

ISO 11664-4, *Colorimetry — Part 4: CIE 1976 L*a*b* Colour space*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 18913 and the following apply.

3.1
operational control point
set point for equilibrium conditions measured at one or more sensor locations in an exposure device

NOTE Adapted from ASTM G113.

3.2
operational fluctuations
positive and negative deviations from the setting of the sensor at the operational control set point during equilibrium conditions in a laboratory accelerated weathering device

NOTE 1 Operational fluctuations are the result of unavoidable machine variables and do not include measurement uncertainty. Operational fluctuations apply only at the location of the control sensor and do not imply uniformity of conditions throughout the test chamber.

NOTE 2 Adapted from ASTM G113.

3.3
operational uniformity
range around the operational control point for measured parameters within the intended exposure area, within the limits of the intended operational range

NOTE Adapted from ASTM G113.

3.4
uncertainty (of measurement)
parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could be reasonably attributed to the measurement

NOTE 1 The parameter might be, for example, a standard deviation (or a given multiple of it), or the half-width of an interval having a stated confidence level.

NOTE 2 Uncertainty of measurement comprises, in general, many components. Some of these components can be evaluated from statistical distribution of the results of series of measurements and can be characterized by experimental standard deviations. The other components, which can also be characterized by standard deviations, are evaluated from assumed probability distributions based on experience or other information.

NOTE 3 It is understood that the result of the measurement is the best estimate of the value of the measurement and that all components of uncertainty, including those arising from systematic effects, such as components associated with corrections and reference standards, contribute to the dispersion.

NOTE 4 Adapted from ISO/IEC Guide 98-3:2008, 2.2.3.

4 Requirements

This International Standard specifies a set of recommended test methods with associated requirements for permitted reporting. Data from these tests shall not be used to make life expectancy claims, such as time-based print lifetime claims, either comparative or absolute. Conversion of data obtained from these methods for the purpose of making public statements regarding product life shall be in accordance with the applicable International Standards for specification of print life.

The test methods in this International Standard might be useful as stand-alone test methods for comparison of the stability of image materials with respect to one specific failure mode. Data from the test methods of this International Standard may be used in stand-alone reporting of the absolute or comparative stability of image materials with respect to the specific failure mode dealt with in this International Standard, when reported in compliance with the reporting requirements of this International Standard. Caution shall be exercised when comparing test results for different materials. Comparisons shall be limited to test cases that use equipment with matching specifications and matching test conditions.

5 Outline of test procedure

The checkerboard pattern[11] shown in Figure 1 shall be printed at (23 ± 2) °C and in an environment of (50 ± 10) %RH.

The test samples shall be conditioned, positioned with unrestricted airflow, for (24 ± 2) h at (23 ± 2) °C and (50 ± 5) %RH.

The printed samples shall be exposed to high humidity or low humidity as specified in Clause 7.

The colour patches shall be measured using CIELAB colorimetry before and after the humidity exposures. $\overline{\Delta E^*_{\mathrm{ab}}}$ for the patches of the checkerboard pattern shall be calculated.

This International Standard stipulates three test methods: A, B, and C.

Method A demonstrates the degree of the deterioration ($\overline{\Delta E}$ of the printed image) quantitatively in a fixed humidity condition, i.e. 25 °C and 85 %RH, for a given period of time. Four weeks is the recommended duration. One, two or eight week durations can be used. Method A is most useful for research and development of

printing systems or printing materials where the humidity fastness of many samples can be screened and closely compared.

Method B demonstrates the limitations of printing systems and materials by analysing data from tests at various levels of humidity, i.e. 25 °C for two weeks at three or more humidity levels chosen from 60, 65, 70, 75, 80, 85, 90 and 95 %RH, and showing where each sample starts to deteriorate. Method B is especially useful for communicating with end users who will be able to recognize the high humidity limitations for each product tested.

Method C demonstrates the propensity of the image-receiving layer or underlying substrate to yellow upon exposure to low relative humidities, i.e. 25 °C at 20 %RH for up to six months[18].

The test procedures are summarized in Table 1.

Table 1 — Summary of test procedures

Steps		Procedures and test conditions
Sample preparation	Test target	Checkerboard pattern shown in Figure 1
	Temperature and RH	(23 ± 2) °C and (50 ± 10) %RH
Sample conditioning	Temperature and RH	(23 ± 2) °C and (50 ± 5) %RH
	Duration	(24 ± 2) h, unrestricted airflow
Measurement	Method	CIE colorimetry conforming to measurement condition M0 of ISO 13655
	Parameter	$\overline{\Delta E^*_{ab}}$ of 84 patches in Figure 1 before and after the humidity exposure
Humidity exposure	Method A	25 °C and 85 %RH Recommended duration of 4 weeks One, two or eight week durations can be used
	Method B	25 °C for two weeks at three or more humidity levels chosen from 60, 65, 70, 75, 80, 85, 90 and 95 %RH
	Method C	25 °C at 20 %RH for up to six months
Measurement	Method	CIE colorimetry conforming to measurement condition M0 of ISO 13655
	Parameter	$\overline{\Delta E^*_{ab}}$ of 84 patches in Figure 1 before and after the humidity exposure
Report	Methods A and C	Measured deterioration at a fixed humidity
	Method B	Highest limit humidity without significant deterioration

6 Sample preparation

6.1 General

The checkerboard pattern shown in Figure 1 shall be printed at (23 ± 2) °C and (50 ± 10) %RH.

The test samples shall be conditioned for (24 ± 2) h at (23 ± 2) °C and (50 ± 5) %RH before humidity exposure, positioned with unrestricted airflow.

The sample holding environment shall be ozone-free [≤2 nl/l[1)] average ozone concentration over any 24 h period] for ozone-sensitive samples, as determined in accordance with ISO 18941. A material that is not sensitive to ozone shall have demonstrated no measurable D_{min} or printed patch colour change at ambient

1) 1 nl/l = 1ppb (1 ×10−9). Although the notation “ppb” (parts per billion) is widely used in the measurement and reporting of trace amounts of pollutants in the atmosphere, it is not used in International Standards because it is language-dependent.

ozone exposure levels and measurement condition temperature and humidity, over time periods consistent with measurement and test-staging time periods.

At least two replicate prints are required for each test case. Replicates shall be located for testing in different regions of the test chamber volume.

It is recommended that reference samples be included in every exposure test to track consistency of the test procedures as well as unintended changes of test conditions[9].

6.2 Test target

The checkerboard test pattern (see Figure 1) shall be used as the test target. This test file is contained in the Humidity Print Stability Digital Test File collection and is available at http://www.i3a.org/resources/#iso. The standard Humidity Print Stability Digital Test File shall be downloaded and maintained in the tiff file format. No lossy image or file compression shall be applied to the target file. The digital file resolution shall be maintained as 600 dpi. The Humidity Print Stability Digital Test File is encoded in sRGB, defined as per IEC 61966-2-1, and uses the tiff format with the sRGB ICC profile embedded. After downloading, the Humidity Print Stability Digital Test File shall be retained in that format and encoding with the ICC profile retained.

NOTE Other file formats that retain the state of exactly unchanged pixel encoding values, no lossy compression, embedded sRGB ICC profile, and 600 dpi, can be treated as equivalent to the tiff format for internal use in a test environment.

This test pattern contains all of the cyclic combinations of Y, M, C, R, G, B, white and black as a checkerboard pattern. Rows 1, 7, 13 and 14 consist of solid-fill colour patches, which are used to evaluate changes in colour quality. Rows 2 to 6 and 8 to 12 consist of colour patches with a fine checkerboard pattern of interleaved colour squares which manifest colour changes that correlate well with loss of line quality caused by lateral migration of colorants.

This test target was created to measure both colour and tone change and blur of the checkerboard pattern. The change in the CIELAB colorimetric value of each patch in Figure 1 caused by humidity exposure shall be measured as specified in Clause 8.

It is recommended that a printed reference be kept in a freezer after conditioning and that it be used for the additional visual evaluation, comparing it to the humidity-exposed samples. The freezer should comply with the cold storage conditions given in ISO 18920, ensuring in particular that the humidity is less than 50 %RH. The measurement of the colorimetric value of CIELAB of the checkerboard pattern is not always accurate in detecting line profile change as it cannot detect image sharpness loss if there is no colorimetric change in the checkerboard pattern.

Figure 1 — Test target for humidity fastness test

6.3 Printer driver setting

When making prints for the humidity test, the manufacturer's recommended printer driver settings for each applicable medium should be used. Other printer driver settings may be used depending on the objectives of the test. The driver setting used shall be reported.

The standard target file shall be used, with no density or colour adjustment, when preparing the test samples.

6.4 Printing conditions

The test samples shall be printed in accordance with the manufacturer's recommended procedures for each printing system. The temperature and humidity for printing shall be (23 ± 2) °C and (50 ± 10) %RH.

6.5 Sample conditioning

The printed samples shall be conditioned for (24 ± 2) h at (23 ± 2) °C and (50 ± 5) %RH before humidity exposure, positioned with unrestricted airflow. This is not mandatory for traditional chromogenic prints and electrophotographic prints. These prints shall be prepared within one month of the starting time of the test.

Although it is common to condition printed samples for two weeks before the image stability test, this test method stipulates a shorter conditioning time. This better replicates actual user practice and accounts for the