DRAFT INTERNATIONAL STANDARD

ISO/DIS 5630-7

ISO/TC **6**/SC **2**

Secretariat: **SIS**

Voting begins on:
2013-08-23

Voting terminates on:
2013-11-23

Paper and board — Accelerated ageing —

Part 7:
Exposure to light

Papier et carton — Vieillissement accéléré —

Partie 7: Exposition à la lumière

ICS: 85.060

Reference number
ISO/DIS 5630-7:2013(E)

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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 5630-7 was prepared by Technical Committee ISO/TC 6, *Paper, board and pulps*, Subcommittee SC 2, *Test methods and quality specifications for paper and board*.

ISO 5630 consists of the following parts, under the general title *Paper and board — Accelerated ageing*:

— *Part 1: Dry heat treatment at 105 degrees C*

— *Part 3: Moist heat treatment at 80 degrees C and 65 % relative humidity*

— *Part 4: Dry heat treatment at 120 or 150 degrees C*

— *Part 5: Exposure to elevated temperature at 100 degrees Celsius*

— *Part 6: Exposure to atmospheric pollution (nitrogen dioxide)*

— *Part 7: Exposure to light*

Exposure of paper or board to a hostile environment, such as some type of radiation, elevated temperature, or chemical pollutant over a period of hours or days may provide information concerning the natural changes that may occur in the material over a period of years.

This test method for accelerated ageing by exposure of paper to an elevated light flux has its origins in the extensive ASTM[1] research program which developed experimental procedures and studied a range of printing and writing papers. The light irradiance specified in this part of ISO 5630 is much lower than that recommended by the ASTM study which is considered too high and requires expensive and hazardous equipment.

To get a full understanding of the stability of paper to long term natural ageing effects, a combination of test methods for accelerated ageing should be used. Application of accelerated ageing tests assumes that the changes that occur under harsher than normal conditions have a strong positive correlation with those occurring under 'normal' conditions.

Paper and board — Accelerated ageing — Part 7: Exposure to light

1 Scope

This part of ISO 5630 specifies a method for accelerating the ageing of paper and board through exposure to an elevated light irradiance and for assessing the effect of ageing on optical properties for the purpose of predicting stability to long term natural ageing that occurs due to exposure to light. It is applicable to all types of paper and board whose surface is white or near white.

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 186, *Paper and board – Sampling to determine average quality*

ISO 187, *Paper, board and pulps – Standard atmosphere for conditioning and testing and procedure for monitoring the atmosphere and conditioning of samples*

ISO 2470-1, *Paper – Determination of ISO brightness*

ISO 5631-1, *Paper and board – Determination of colour by diffuse reflectance – Part 1: Indoor daylight conditions (C/2°)*

3 Principle

Sheets of paper are aged at an accelerated rate by exposing them to an elevated light irradiance. The elevated irradiance accelerates changes in the optical properties which occur when paper is exposed to 'normal' light levels over an extended period. By comparing diffuse blue reflectance factor (ISO brightness) and the b* CIEL*a*b* colour coordinate before and after ageing, a measure of the stability of the optical properties of the paper when exposed to light is obtained.

4 Apparatus

4.1 A light source, with the following characteristics:

Producing an even irradiance (total irradiance) to all test surfaces of 20 ± 1 W/m^2 in the wavelength range 290 nm to 800 nm with a UV component of 1,0 ± 0,1 W/m^2. The ratio of the irradiance in the wavelength range 400 nm to 600 nm to that in the range 600 nm to 800 nm shall be 1,0 to 1,5 with all wavelengths over the range 400 nm to 700 nm present in the radiation.

The uniformity of the total irradiance shall be such that it does not vary by more than ± 1 W/m^2 on any portion of the test surface of the specimen. If the light delivered by the source includes wavelengths below 300 nm, these shall be removed by the use of a suitable glass filter.

The total irradiance of the light source at the specimen surface shall be checked at regular intervals to maintain it within a range of ± 1 W/m^2 of its nominal value (value when first tested or first used) with a UV component maintained within ± 0,1 W/m^2. If the irradiance is outside either of these ranges, the lamp(s) shall be replaced.

4.2 Light chamber, of a size sufficient to mount the number of test pieces required for testing (8) in such a way that all of the surface area on one side of each specimen is exposed uniformly to the specified irradiance (4.1).

4.3 System for controlling the temperature of the surface of the test pieces, that keeps the surface temperature of the test pieces below 26 °C when exposed to the light used to age them. For example, a system for blowing air that meets the specifications of the atmosphere used to condition the test specimens (6), over the specimens at a sufficiently high rate.

5 Sampling

Only handle the paper samples with clean cotton gloves. The samples shall be kept in the dark except during sampling, whilst being placed and exposed in the light chamber and during testing.

If the average quality of a lot is to be determined, sampling shall be carried out in accordance with ISO 186. If another type of sample is to be tested, make sure that the sheets or specimens taken are representative of the sample received. Select sufficient specimens or sheets of adequate size for testing brightness and colour before and after ageing (8).

Unless the two sides of the specimens or sheets are easily distinguished, mark the same side of each specimen/sheet so that the ageing results can be associated with a particular side.

Randomise the sheets.

6 Conditioning

Keeping the specimens or sheets in the dark, condition them in accordance with ISO 187 immediately prior to initial testing of optical properties.

7 Preparation of test pieces for ageing

Carry out the preparation of the test pieces in the same atmosphere as used for conditioning (6).

Prepare sufficient test pieces for testing of optical properties (8). The test piece size and preparation shall conform with the requirements of ISO 2470-1 except that two sets of test pieces shall be prepared, one for testing the optical properties and the other for the backing pad which shall be used for testing of all test pieces, both unaged and aged, i.e. the backing pad shall not change. A long as the pad meets the optical requirements of ISO 2470-1 the number of the test pieces in the pad can be less than 10.

8 Procedure

Determine the diffuse blue reflectance factor (ISO brightness) in accordance with ISO 2470-1 and the b* CIEL*a*b* colour coordinate in accordance with ISO 5631-1, of the top side of the unaged test pieces in the same atmosphere as used for conditioning (6), except that the test pieces being tested shall not be part of the backing stack. Take note of the positions of testing by some appropriate means as the same areas shall be tested after accelerated ageing. Retain the stack of test pieces used as the backing for the optical tests on the unaged material for testing the test pieces after aging.

Immediately after testing the test pieces, mount them in the light chamber (4.2) such that the top surface of each test piece will be exposed to the same even light flux (4.1). Mount the test pieces such that they do not touch the chamber walls (4.2). The light chamber shall be kept in the same atmosphere as used for conditioning (6) during mounting and exposure of the test pieces.

Immediately after mounting, expose the test pieces to the specified light flux for (120 ± 0,5) h. Ensure that the temperature at the surface of each test piece is kept below 26 °C (and above 22 °C). A lower irradiance than that specified in 4.1 may be used as long as the ratio between the total and UV components is maintained and all other specifications of the irradiance are met. In this case it may be desirable to use a longer exposure

time. The deviation from the specified conditions must be reported. The results obtained cannot be considered to conform with the requirements of this part of the International Standard.

Do not insert additional test pieces into or remove test pieces from the light chamber during the period of exposure.

Immediately after ageing, determine the diffuse blue reflectance factor (ISO brightness), in accordance with ISO 2470-1, and the b* CIEL*a*b* colour coordinate, in accordance with ISO 5631-1, of the aged test specimens except that the same backing pad used for testing of unaged test pieces shall be used for testing each of the aged test pieces. Test an area of each test piece as close as possible to that tested prior to ageing such as to produce matched pairs of results.

If required, repeat the testing for the other side of the test pieces; formation of a backing pad, testing of unaged test pieces, ageing of the test pieces and testing of the aged test pieces.

If there is sufficient room in the test chamber, testing of both sides of the unaged test pieces may be carried out prior to ageing of the test pieces and then both the top side and reverse side aged in the ageing chamber at the same time.

9 Calculation

Calculate the change in diffuse blue reflectance factor (ISO brightness) and the change in b* CIEL*a*b* colour coordinate for matched pairs of results, pre-aged and aged, for the top side as shown below.

Calculate the change in ISO brightness, to the nearest percent, as follows:

$$\Delta R = \frac{(R_1 - R_2) \times 100}{R_1} \quad (1)$$

where,

ΔR is the change in diffuse blue reflectance factor (ISO brightness), as a percentage;

R_1 is the diffuse blue reflectance factor (ISO brightness) before ageing;

R_2 is the diffuse blue reflectance factor (ISO brightness) after ageing.

Calculate the change in b* CIEL*a*b* colour coordinate, to three significant figures, as follows:

$$(\Delta b^*) = \left| b^*_2 - b^*_1 \right| \quad (2)$$

where,

(Δb^*) is the change in b* CIEL*a*b* colour coordinate;

b^*_1 is the b* CIEL*a*b* colour coordinate before ageing;

b^*_2 is the b* CIEL*a*b* colour coordinate after ageing.

Calculate the mean change in diffuse blue reflectance factor (ISO brightness) to the nearest 1%, and the mean change in the b* CIEL*a*b* colour coordinate to three significant figures, and calculate the standard deviation for each. If required, calculate these for the reverse side as well.

10 Test report

The test report shall include the following information:

a) reference to this part of this International Standard;

b) all information necessary for complete identification of the sample;

c) the date and place of testing;

d) the temperature and relative humidity of the atmosphere used to condition the samples;

e) the number of tests carried out for each sample and side;

f) the mean values of the change in diffuse blue reflectance factor (ISO brightness) and the change in the b* CIEL*a*b* colour coordinate, and the corresponding standard deviations. If required, report these values both sides of the samples;

g) when the total irradiance is less than that specified in 4.1a), a statement on the level of irradiance used and the time of exposure. In this case the results cannot be considered to have been obtained using this part of the international standard.

k) any deviations from the International Standards used, and any circumstances and influence which might have affected the test results.

Annex A
(informative)

Interpretation and limitations of ageing tests

A.1 Interpretation of test results

It is very important to note that what is stable paper for one user may be unstable for another. Therefore, the limits of acceptability (the points at which a paper is no longer useful for its intended purpose) is to be defined by end-users. It is only with such information in hand that an approximate definition of the long term stability of the optical properties of a specific paper can be made.

NOTE If all that is desired is legibility of a printed text, paper can become significantly yellowed and still meet the requirements of the end user.

A.2 Limitations of light ageing test

It should be mentioned that ‘natural’ ageing is variously the result of the action of heat, light, and chemicals (e.g. pH), including pollutants from the air that become entrained into the paper. This protocol is intended to characterise only light induced reactions. In different conditions of ‘natural’ ageing, an infinite range of conditions can be found with a different "mix" of these elements. Therefore, for the greatest understanding of possible future ageing effects, the investigator may wish to accelerate paper ageing separately by elevated temperature, by elevated light irradiance, and by increased concentration of common pollutant gases. Relevant ISO standard test methods are appropriate means to gain some understanding of these influences.