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Leather — Measuring the colour and colour difference of finished leather

Cuir — Mesurage de la couleur et des écarts de couleur des cuirs finis

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by the Fastness Test Commission of the International Union of Leather Technologists and Chemists Societies (IUF Commission, IULTCS) in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 289, *Leather*, the secretariat of which is held by UNI, in accordance with the agreement on technical cooperation between ISO and CEN (Vienna Agreement).

IULTCS, originally formed in 1897, is a world-wide organization of professional leather societies to further the advancement of leather science and technology. IULTCS has three Commissions, which are responsible for establishing international methods for the sampling and testing of leather. ISO recognizes IULTCS as an international standardizing body for the preparation of test methods for leather.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Leather — Measuring the colour and colour difference of finished leather

1 Scope

This document specifies a method for the correct measurement of the colour of finished leather by instrumental means. The document describes general concepts of colour measurement adapted to leather and the calculation of differences in colour.

This document defines the following:

a) the use of D65 as the standard light source for the leather industry;

b) the use of D65 light source 10° as standard conditions for colour matching, for the definition of daylight simulators and as the reference light source for metamerism analysis;

c) the use of CIEDE2000 as the colour difference formula.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 2419, *Leather — Physical and mechanical tests — Sample preparation and conditioning*

ISO 11664-3, *Colorimetry — Part 3: CIE tristimulus values*

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

ISO/CIE 11664-6, *Colorimetry — Part 6: CIEDE2000 Colour-difference formula*

EN 15987, *Leather — Terminology — Key definitions for the leather trade*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 15987 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
colour measurement
numerical representation of the colour of a specimen obtained by use of a *colour measuring instrument* (3.2) in terms of tristimulus values, colour coordinates or spectral response within the visible and near UV spectra

3.2
colour measuring instrument
device which measures reflected radiations in the visible spectrum (wavelengths between 360 nm and 780 nm) covering as a minimum area wavelengths between 400 nm and 700 nm

Note 1 to entry: Instruments included in this definition are named colorimeters and spectrophotometers.

3.3
geometry
<colour measuring instrument> relative position illumination/observer (detector)

Note 1 to entry: Typical geometries include the following:

— d/0°;

— 0°/d;

— 0°/45°;

— 45°/0°;

with a tolerable angle of 0° to 10° on the diffuse geometries and 45° ± 2° on the 45° geometries. Different geometries may generate different results on the same specimen.

3.4
specularity
<colour measuring instrument> *specular reflectance* (3.6) on glossy, metallic and reflective specimens caused by illumination, with the potential to disturb colour measurement

Note 1 to entry: Specular reflectance may be included "SPINC" (for matt specimens) or excluded "SPEX" (for reflective specimens); different specularity may generate different results on the same specimen.

3.5
area of view
<optical aperture; colour measuring instrument> area and shape of the target covered by the instrument in a single colour measurement

3.6
specular reflectance
reflection without diffusion, in accordance with the laws of optical reflection

Note 1 to entry: As in a mirror.

3.7
standardization
<colour measuring instrument> measurement of one or more calibrated materials with a colour measuring instrument for the purpose of calculating a set of correction factors to be applied to subsequent measurements

Note 1 to entry: Calibrating materials are normally a white tile for the white standardization, and a light trap or black tile for the black standardization.

3.8
verification standard
<colour measurement> stable material which is used for the purpose of confirming (or verifying) the validity of an instrument standardization

Note 1 to entry: Colour measurements, which are made immediately following standardization, are compared with the original measurements of one standard, or series of standards, to verify the correct standardization.

4 Principle

The surface of a finished leather specimen is measured by reflectance methods in order to obtain a numerical representation of the colour of the specimen. This numerical representation may have two different scopes:

— the definition of a certain colour by absolute chromatic coordinates or by definition of a specific spectral distribution;

— the definition of a colour difference to define a specimen "pass/fail" boundary related to a reference sample within a uniform perceptive tolerance.

Considering that the chromatic coordinates as well as spectral distribution specifications depend on the instrument's geometry and measuring conditions, all relevant data such as reference illuminant, photopic/scotopic observer angle, instruments geometry and measurement area shall be reported.

Proper equipment set-up, standardization of the colour measuring instrument and presentation of the test specimens to the instrument are recommended to achieve consistent, reliable and meaningful reflectance measurement results.

In general, instrumental colour measurement procedures are dictated by the type of specimen to be measured and the instrument with which it will be measured. Many types of colour measuring instrumentation are available, differing in such features as area of view, illumination method and geometry. Conflicting results will be obtained through comparisons of data acquired on instruments of different designs. It is recommended that selected instruments conform with inter-instrumental agreement and profiling protocols, to ensure acceptable absolute measurements on different instruments.

5 Apparatus and materials

5.1 Reflectance colour measuring instrument, for illuminating a specimen and measuring the amount of light which is reflected from the surface of the specimen in the visible region of the spectrum (comprising the wavelengths from 360 nm to 780 nm, and including as a minimum the region from 400 nm to 700 nm). Illumination is usually polychromatic (white light).

Reflectance colour measuring instruments may be broadly divided into two groups.

a) **Spectrophotometers** (typically diffuse/0, using polychromatic illumination) diffract and measure the spectrum of light reflected from the specimen relative to a reference white at regular intervals. The spectral step width and optical band width shall be ≤ 20 nm (preferably 5 nm or 10 nm). These data may be used to calculate the desired tristimulus values (X, Y, Z) for any given illuminant and observer. Some spectrophotometers (typically 0/diffuse) illuminate the sample with monochromatic light and measure the amount of light reflected from the surface as the sample is illuminated at regular wavelength intervals.

b) **Colorimeters** measure the tristimulus values (X, Y, Z) directly through broadband filters which are designed to produce colorimetric values for one illuminant and observer. Colorimeters with D65 illumination and 10° observer are recommended. Measurement of reflectance factors at specific wavelengths is not possible with a colorimeter.

The recommended geometry for the colour measuring instruments should be one of the following combinations:

— d/0;

— 0/d;

— 0/45;

— 45/0;

where

d is diffuse;

0 is the normal (0° to 10°);

45 is (45° ± 2°).

The 0/45 and 45/0 geometries exclude the specular reflectance in the measurements and provide measurements corresponding to visual changes in the specimen appearance caused by changes in the pigment colour or changes in the surface gloss or texture. Diffuse (d) geometry instruments commonly include specular reflectance in the measurements. This avoids the differences caused by surface unevenness and provides measurements of the differences caused by changes in pigment colour only. These instruments may also exclude specular reflectance.

5.2 White calibrated standard, with which to standardize the instrument. The colorimetric values for this calibration standard are stored in the instrument or the software and require only that a specific standard be used to standardize the instrument.

5.3 Black standard, required for some instruments. It may be of zero reflectance (a light trap) or it may be calibrated, in which case the comments in 5.2 apply.

5.4 Verification standard or set of verification standards, required to verify the acceptability of absolute measurements in a single spectrophotometer or as profiling reference between different instruments.

5.5 Instrument calibration, the instructions of the instrument manufacturer regarding the calibration must be strictly followed.

6 Procedure

6.1 Standardization of colour measuring instrument

Proper standardization of any colour measuring instrument is necessary in order to achieve more precise and accurate results. In general, instrument standardization involves measuring a clean white surface of known reflectance factors and calculating (through built-in software operating the instrument or computer program) a series of correction factors which will be applied to subsequent measurements. Some instruments also require a black tile (or light trap) and a standard coloured tile or set of coloured tiles to verify accordance of the instrument standardization to absolute values. Each of these materials shall be maintained in its original clean, unscratched condition.

The frequency with which this standardization is performed depends on many factors, including the type of instrument, the environmental conditions in which the instrument operates, the required accuracy of the result and the number of measurements. For most applications, an interval of 8 h or 100 flashes is acceptable.

Once the standardization step has been performed, it is important to verify the success of the procedure by measuring one or a series of verification standards and comparing the resulting colorimetric values with the original values for these materials. If the measured values do not fall within an acceptable variation from their original values, the standardization is not considered valid. The number of verification standards and the acceptability limits depend on user requirements, but are typically one to three standards and an acceptance limit of 0,20 CIEDE2000 D65/10° units.

6.2 Sampling

Given that this is a non-destructive test, the whole leather sample can be used as a specimen. In addition, the measurement can be used to verify colour differences between different areas of the leather. The sample shall be as big as possible to be able to take many different measurements at different spots. The higher the number of measurements, the more representative the test result. At least three measurements shall be taken at different spots on the leather sample. For structured leather surfaces, for example suede or velour, and leather pieces with variable colour, at least five measurements shall be taken. For large leather pieces at least six measurements shall be taken at different spots.

6.3 Measuring procedure

6.3.1 Condition the specimen according to ISO 2419.

6.3.2 Calibrate the instrument according to 6.1.

6.3.3 Present the specimen to the colour measuring instrument following any special techniques required for the type of finish of the leather being measured. The following handling techniques according to the type of leather finish shall be observed.

— **Sueded articles (suede, split, nubuk):** gently brush the specimen in the fibre direction before colour measuring. Suggested measurement is with geometry d/8° and SPINC (specular included) specularity.

— **Glossy finishes (patent leather, metallized leather):** to remove the gloss effect on the colour, the instrument shall exclude the specular component for colour measurement, or adopting a 0/45° // 45°/0 geometry.

— **Aniline finish:** when there is a glossy finish, the gloss effect shall be removed by excluding the specular component for colour measurement or adopting a 0/45° // 45°/0 geometry.

— **Pigmented or semi-pigmented finish:** no handling technique is required before colour measurement. Included or excluded specular depending on the glossiness of the sample.

— **Wool-on skins:** gently brush the wool fibres in one direction before colour measuring. Suggested measurement is with geometry d/8° and SPINC (specular included) specularity.

6.3.4 Measure the specimen colour and obtain the spectral reflectance values, the tristimulus values and/or the *L**, *a**, *b** absolute coordinates of the CIELAB colour space.

6.3.5 For the determination of the difference in colour between two leathers, first take the absolute leather colour measurement using the colour reference, according to 6.3.3 and 6.3.4, and then measure in the same way the colour of the specimen on which the difference in colour is to be determined. Colour difference values are expressed in CIEDE2000 units, with reference to light source (normally D65) and standard observer angle (2° or 10°, normally 10° for CIEDE2000).

7 Method of calculation

7.1 General

Most calculations of colorimetric nature are performed by the software being used to operate the colour measuring instrument. In normal cases of reference to this method it will not be necessary for the user to perform these calculations; however, they are described here as a means of reference and standardization for those who may need to perform the calculations in accordance with ISO/CIE 11664-6.

7.2 Tristimulus values

The tristimulus values *(X, Y, Z)* are derived from spectral data and are the basis for all colorimetric calculations, in accordance with ISO 11664-3. The exact *(X, Y, Z)* values derived from a set of spectral data depend on several factors, including the wavelength range and interval of measurement and the user's choice of illuminant/observer functions used in the calculation.

NOTE 1 In order to obtain results that are compatible between users, the tristimulus values are calculated according to ASTM E308-15[1]. Most calculations of tristimulus values are performed by computer programs and a user therefore verifies with the instrument/software supplier that they are thus calculated.