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Analytical colorimetry —

Part 1: Practical colour measurement

Analyse colorimétrique —

Partie 1: Mesurage pratique de la couleur

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Foreword

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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).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 256, *Pigments, dyestuffs and extenders*

ISO 18314 consists of the following parts, under the general title *Analytical colorimetry*:

— *Part 1: Practical colour measurement*

— *Part 2: Saunderson correction, solutions of the Kubelka-Munk equation, tinting strength, hiding power*

— *Part 3: Special indices*

Analytical colorimetry —

Part 1:
Practical colour measurement

1 Scope

This part of ISO 18314 specifies the method for determining the colour coordinates of a paint film. This method is only applicable to paint films that appear to be uniformly of one colour, i.e. monochromatic, when examined with normal vision. Paint films that do not completely hide a non-transparent substrate represent an opaque system and can be measured by using the procedure in this part of ISO 18314.

Luminescent paint films, transparent paint films, and translucent paint films (for example for display or lamp glass), retroreflecting paint films (for example for traffic signs), and metallic paint films are outside the scope of this part of ISO 18314.

2 Normative references

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

ISO 1513, *Paints and varnishes — Examination and preparation of test samples*

ISO 1514, *Paints and varnishes — Standard panels for testing*

ISO 2808, *Paints and varnishes — Determination of film thickness*

ISO 15528, *Paints, varnishes and raw materials for paints and varnishes — Sampling*

3 Sample preparation

Take a representative sample of the paint to be tested as described in accordance with ISO 15528.

Examine and prepare the sample for testing in accordance with ISO 1513.

Prepare the test panels in accordance with ISO 1514. Apply the coating always in the same way (e.g. by spraying, brushing, or with application bars), dry or stove and, if necessary, condition the paint film as directed in the manufacturer's instructions or as otherwise agreed.

If the paint film is of reversible temperature-dependent colour, the temperature of the test sample should be maintained at (23 ± 2) °C by appropriate measures (for example by the use of a thermostatically controlled sample holder). Paint films of irreversible temperature-dependent colour should be postconditioned, until the colour does not change any more. In the case of paint films that do not completely hide the substrate, the colour depends on the colour of the substrate and the film thickness, which should be determined by one of the procedures given in ISO 2808.

The paint film sample shall not be scratched and shall be free from dust and grease (e.g. fingerprints).

For process control of painted articles take representative test samples. The number of samples shall be agreed upon between the parties.

4 Sample measurement

4.1 General

For highly precise measurement results, the samples shall be plane. Dependent on sample size, multiple readings shall be taken. The individual measurements shall exclude trends and outlayers. The aperture size of the instrument shall be as large as possible.

For measurements taken on curved samples, the geometrical conditions specified for plane samples are no longer applicable. Measurement uncertainty and deviation of results from those of plane surfaces will increase as curvature increases. When selecting the measurement area on curved surfaces, the smallest possible curvature (biggest curvature radius) shall be placed on the smallest possible measuring aperture. To increase repeatability, the use of a customized sample holder is recommended.

Comparison of samples with different surface properties (e.g. texture, gloss) may lead to different results depending on the measuring geometry of the instrument (see Clause 7).

4.2 Recommended colourimetric conditions

The measurements shall be performed for the following conditions:

— Illuminant: D65 (for determination of metamerism additional illuminants are needed);

— Observer: 10°;

— Colour space: CIELAB or DIN 99

— Colour differences: It is important to take into consideration that CIELAB colour space is not visually uniform for small colour differences. Therefore, the use of the colour difference correction formula CIEDE2000 or the new colour space DIN 99 are recommended.

NOTE Standard illuminant D65 is defined in ISO 11664-2. Standard colourimetric observer for 10° is defined in ISO 11664-1. CIELAB is defined in ISO 11664-4. The DIN 99 formula is defined in DIN 6176. The CIEDE2000 formula is defined in ISO 11664-6.

5 Calibration

5.1 General

The correct calibration of colour measuring instruments is one of the main requirements for achieving reproducible results. An incorrect or insufficient calibration can have a major impact, and may lead to wrong results.

In order to achieve the highest accuracy, both the basic conditions of calibration (temperature, positioning of the calibration standard) and the instructions of the manufacturer regarding the calibration have to be strictly followed.

5.2 Environmental conditions

The calibration shall be carried out under the same environmental conditions as the sample measurement taken thereafter.

5.3 White calibration

The white standard is made of a durable material, like ceramic, glass, or enamel. The calibration standard that is used for the day-to-day calibration process shall be the one provided by the instrument manufacturer. It has reflectance values that are traceable to a national standard. The white calibration shall be done according to the instrument vendor's recommendations, usually when beginning to work

with the instrument and after breaks. When performing extended measurement series and/or under strongly varying environmental conditions (for example temperature) the white calibration shall be repeated in regular intervals.

Proper identification shall be used to match the standard with the instrument to make certain that only the correct standard is used for calibration.

5.4 Black calibration

A black calibration standard is a standard which has low to no reflectance (for example a black light trap). Black calibration is used to establish a known zero point for the instrument. The black or zero reflectance calibration shall be performed with the black standard supplied by the instrument manufacturer. A black calibration is always done together with a white calibration. Some instruments perform the black calibration internally, thus eliminating the need for separate black calibration.

5.5 Control measurement

After certain time intervals it is recommended to verify the accuracy of the measurements through the use of coloured control standards. The instructions of the manufacturer shall be followed.

The white calibration standard may not be used for control measurements.

5.6 Storage of the calibration standards

All the calibration standards shall be protected from light, mechanical damage, or dirt. Calibration standards that are scratched or damaged in any way shall be replaced immediately. Dirty standards are to be cleaned according to the instructions of the manufacturer. Under common usage a calibration standard can typically be used for one year. Then it is recommended to have the manufacturer of the instrument verify that the values are still within the specifications.

6 Apparatus

6.1 Spectrophotometer

Measurements shall preferably be done with spectrophotometers. The spectral measuring range shall be at least 400 nm to 700 nm. The spectral step width and optical bandwidth shall be ≤20 nm (preferable 5 nm to 10 nm).

6.2 Tristimulus colourimeter

Tristimulus colourimeters can be used for applications that do not require control of metamerism.

7 Selection of appropriate measurement geometry

The perceived colour of an object is a combination of first surface reflection (Fresnel) and typically diffuse reflection from the volume. The first surface reflection (approximately 4 % of the incident light) is only dependent on the refractive ratio not on the colorants. Surface texture determines the angular scattering of the first surface reflection.

The di:8° geometry measures the total first surface reflection independent of the surface texture.

The 45°:0° geometry only measures the scattered part of the first surface reflection in the direction of 0°.

Table 1 gives the recommended measurement geometries for paint with different properties depending on the objective to be achieved.

Table 1 — Recommended measurement geometries

Sample properties		Recommended measurement geometries	
Material	**Surface**	**Final inspection**	**Colorants control**
		Goal: correlation to visual perception	Goal: independence of surface differences
Paint: opaque and translucent	Mat	45°:0°	di:8°
	Silk mat	45°:0°	di:8°
	High gloss	45°:0°, de:8°	di:8°, (45°:0°, de:8°)
	Textured	45°:0°	di:8°
	Bronzing	45°:0°	
	Orange peel	45°:0°	di:8°
Paint: transparent on high gloss metal	High gloss	di:8°	di:8°
Paint: transparent on mat substrate	High gloss	45°:0°	di:8°
Paste: measurement through high gloss glass	Glass high gloss	45°:0°, de:8°	45°:0°, de:8°
d = diffuse; i = specular included; e = specular excluded			