SLOVENSKI STANDARD
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Fotografija in grafična tehnologija - Merjenje optične gostote - 2. del: Geometrijski pogoji za gostoto pri transmisiji

Photography and graphic technology - Density measurements - Part 2: Geometric conditions for transmittance density

Photographie et technologie graphique - Mesurages de la densité - Partie 2: Conditions géométriques pour la densité de transmittance

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INTERNATIONAL STANDARD

ISO 5-2

Fifth edition
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Photography and graphic technology — Density measurements —

Part 2: Geometric conditions for transmittance density

Photographie et technologie graphique — Mesurages de la densité —

Partie 2: Conditions géométriques pour la densité de transmittance

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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 5-2 was prepared by ISO/TC 42, *Photography*, and ISO/TC 130 *Graphic technology*, in a Joint Working Group.

This fifth edition cancels and replaces the fourth edition (ISO 5-2:2001), which has been technically revised. This technical revision introduces the concept of ideal and practical conditions. In the course of this technical revision, all parts of ISO 5 have been reviewed together, and the terminology, nomenclature and technical requirements have been made consistent across all parts.

ISO 5 consists of the following parts, under the general title *Photography and graphic technology — Density measurements*:

— *Part 1: Geometry and functional notation*

— *Part 2: Geometric conditions for transmittance density*

— *Part 3: Spectral conditions*

— *Part 4: Geometric conditions for reflection density*

Introduction

This part of ISO 5 specifies the geometric conditions for transmittance densitometry, primarily (but not exclusively) as practised in black-and-white and colour photography and graphic technology. This part of ISO 5 is intended to specify geometrical conditions for the measurement of optical densities that are close to those used in practice. Diffuse transmittance densities are, among other things, relevant for contact printing and rating films on viewing boxes. Viewing films on light boxes is one of the most important applications where diffuse transmittance densities are relevant. Therefore, the specified conditions for the measurement of diffuse transmittance densities consider the properties of viewing boxes concerning diffusivity and the spectral reflectance factor. Another important application is the measurement of the diffuse transmittance density and hence the opaque area percentage of lithography-type black-and-white films for graphic technology. This part of ISO 5 also describes the geometric conditions for two types of projection density. The spectral conditions are specified in ISO 5-3.

The primary change between the first edition of this part of ISO 5 (published in 1974) and the second edition (published in 1985) was the replacement of the integrating sphere method with a diffuser (typically "opal glass") as the basis for specifying ISO 5 standard diffuse transmittance density. Although any means of diffusion that meets the specifications of this part of ISO 5 can be used, the method is often denoted simply by the words "opal glass" in order to differentiate it from the integrating sphere method. Slightly smaller density values are generally obtained compared to those based on the integrating sphere method because of inter-reflections between the opal glass and the specimen. The effect is dependent on the reflectance characteristics of the opal glass and the surface of the specimen facing the diffuser.

Diffuse transmittance density is a measure of the modulation of light by a film that is diffusely irradiated on one side and viewed from the other, as when a film is viewed on a diffuse transparency illuminator. The geometric conditions of projection with diffuse illumination are nearly equivalent to the conditions of viewing a film on a diffuse illuminator, the projection lens taking the place of the eye. When film is on a diffuse illuminator or in contact with a print material, light is inter-reflected between the film and the nearby surface. This inter-reflection affects the density and is best taken into account in a measuring instrument by the use of an opal-glass diffuser or integrator, rather than an integrating sphere. Apart from this fundamental reason for using densitometers employing opal-glass diffusers, such instruments are preferred because they are more durable and more convenient to manufacture and use.

Projection density is a measure of the modulation of light by a film that is regularly illuminated on one side and is projected by way of a regular collection system. Equipment employing optical condensers is used to view microfilm, motion pictures, and slides, and to make projection prints. The conditions defined in this part of ISO 5 for projection density simulate the geometric conditions affecting the transmitting characteristics of a small area on a negative or transparency at the centre of the frame of a typical projection system employing condensers. The area under consideration can be defined by a small opening, known as the "sampling aperture", in an otherwise opaque sheet in the frame.

The measured density depends on the half-angle of the cone of incident rays and the half-angle subtended by the projection lens at the sampling aperture. These half-angles can be indicated either in degrees or by f-numbers. Since the f-number is usually marked on projection lenses, the two types of ISO 5 standard projection density specified in this part of ISO 5 are identified by f-numbers, namely f/4,5 and f/1,6. The f/4,5 type is frequently used, since it is representative of microfilm readers. The f/1,6 type is considered representative of motion-picture projectors.

Significant changes from the fourth edition of this part of ISO 5 are explained below.

a) The terminology "transmission density" has been replaced by the term "transmittance density" for both diffuse and projection densities. Both densities require measurements relative to the incident flux (influx), and therefore the regular or diffuse transmittance of the specimen is measured. As explained in ISO 5-1, the correct density term corresponding to regular transmittance is "transmittance density".

b) A distinction is made between *ideal* and *realized* parameters for transmittance density. The definition of ISO 5 standard transmittance density is based upon ideal values specified for each parameter. However, actual instruments require reasonable tolerances for physical parameters, which are specified by the realizable parameters.

Photography and graphic technology — Density measurements —

Part 2: Geometric conditions for transmittance density

1 Scope

This part of ISO 5 specifies the geometric conditions for measuring ISO 5 standard diffuse and f/4,5 and f/1,6 projection transmittance densities.

ISO 5 standard diffuse density is primarily applicable to measurements of photographic images to be viewed on a transparency illuminator, or viewing box, to be contact printed, or to be projected with a system employing diffuse illumination.

ISO 5 standard projection density is primarily applicable to measurements of photographic images to be projected with systems employing optical condensers.

Although primarily intended for the measurement of photographic images, the densitometric methods specified in this part of ISO 5 are often applied to optical filters and other transparent materials.

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 5-1, *Photography and graphic technology — Density measurements — Part 1: Geometry and functional notation*

ISO 5-3, *Photography and graphic technology — Density measurements — Part 3: Spectral conditions*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5-1 and the following apply.

3.1
diffusion coefficient
β_{dc}
measure of the diffusivity of the illuminating or receiving system

NOTE See Annex A.

3.2
transmittance
τ
ratio of the transmitted flux to the incident flux under specified geometrical and spectral conditions of measurement

NOTE 1 In practical instruments for transmittance measurements, the incident flux is defined by the combination of all of the components that are placed before the reference plane (influx), so the incident flux is provided by the surface of the opal diffuser for diffuse transmittance and by the film gate for projection density.

NOTE 2 Adapted from ASTM E284.

[ISO 5-1:2009, definition 3.22]

3.3
transmittance density
D_τ
negative logarithm to the base 10 of the transmittance

NOTE The subscript is the lower case Greek letter tau.

[ISO 5-1:2009, definition 3.23]

4 Coordinate system, terminology and symbols

The coordinate system, terminology, and symbols described in ISO 5-1 are used in this part of ISO 5 as a basis for specifying the geometric conditions for ISO 5 standard transmittance density measurements.

5 Distinction between ideal and realized parameters

The unambiguous definition of ISO 5 standard density requires that geometric, as well as spectral, parameters be exactly specified. However, the practical design and manufacture of instruments requires that reasonable tolerances be allowed for physical parameters. The definition of ISO 5 standard transmittance density shall be based on the *ideal* value specified for each parameter. The tolerances shown for the *realized* parameter values represent allowable variations of these standard parameters, which for many applications have an effect of less than 0,01 on the density values resulting from measurements made with instruments. A method for determining conformance of a realized parameter with the tolerances is given in Annex B.

6 Requirements for ISO 5 standard diffuse transmittance density

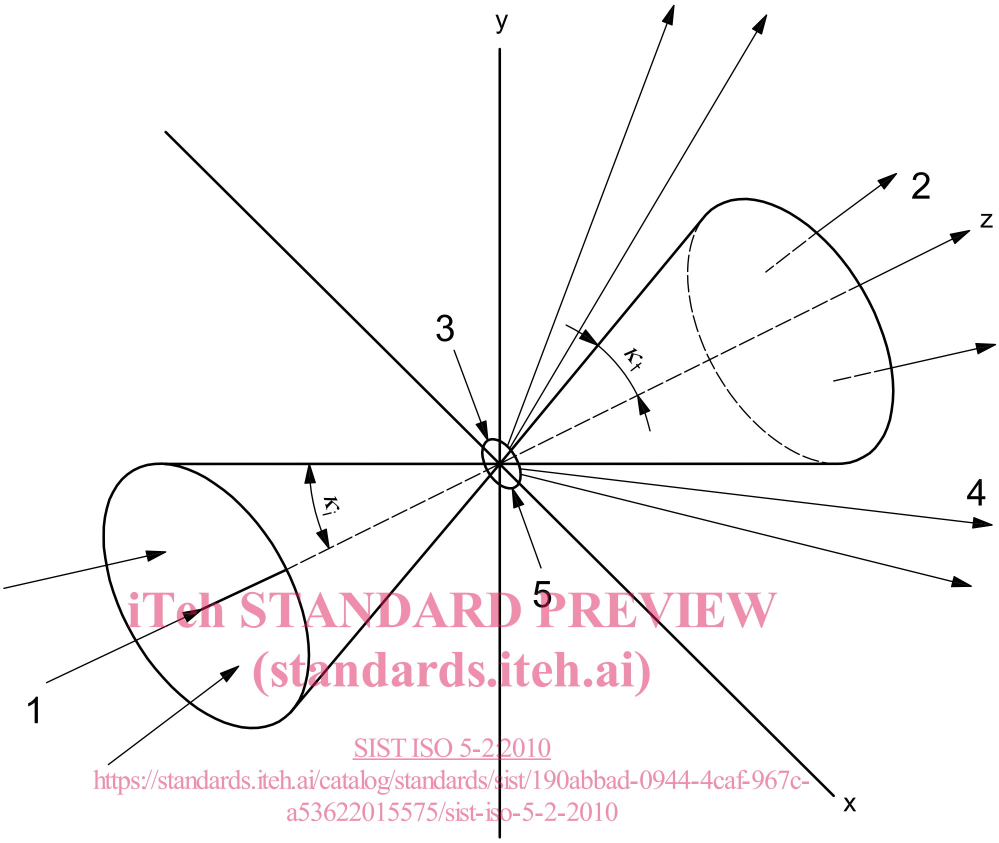
6.1 Geometric modes

Diffuse transmittance density measurements may be made with two equivalent measurement geometries. In the “diffuse influx mode”, the geometry of the illuminator is diffuse and the geometry of the receiver is directional, while in the “diffuse efflux mode”, the geometry of the illuminator is directional and the geometry of the receiver is diffuse. These modes are defined in Figure 1. A diffuse illuminator projects radiant flux onto the sampling aperture from all directions within the hemisphere, while a diffuse receiver collects radiant flux transmitted by the sampling aperture in all directions within the hemisphere. The modes can be described in terms of specified diffuse and directional distributions of illumination radiance or receiver responsivity, depending on the mode. The cone half-angle, κ, is the angle between the angle of illumination or view and the marginal ray. A cone half-angle of 90° indicates that the illuminator or receiver has a diffuse geometry.

Referring to the cone half-angles shown in Figure 1, the *ideal* angles of illumination and view and half-angles for the diffuse influx mode are $\theta_i = 0°$, $\kappa_i = 90°$, and $\theta_t = 0°$, $\kappa_t = 10°$. For the diffuse efflux mode, the *ideal* angles of view and illumination and half-angles are $\theta_t = 0°$, $\kappa_t = 90°$, and $\theta_i = 0°$, $\kappa_i = 10°$.

The *realized* angles of illumination and view and half-angles for the diffuse influx mode are $\theta_i = 0° \pm 2°$, $\kappa_i = 90°$, and $\theta_t = 0° \pm 2°$ $\kappa_t = 10° \pm 2°$. For the diffuse efflux mode, the *realized* angles of view and illumination and half-angles are $\theta_t = 0° \pm 2°$, $\kappa_t = 90°$, and $\theta_i = 0° \pm 2°$, $\kappa_i = 10° \pm 2°$.

NOTE The 90° specification implies physical contact between the specimen and the diffuse illuminator or receiver.



For diffuse density measurement with diffuse influx: $\kappa_i = 90°$ and $\kappa_t = 10°$.

For diffuse density measurement with diffuse efflux: $\kappa_i = 10°$ and $\kappa_t = 90°$.

For projection density measurements, for $f/4{,}5$: $\kappa_i = \kappa_t = 6{,}4°$.

For projection density measurements, for $f/1{,}6$: $\kappa_i = \kappa_t = 18{,}2°$.

Key

1 influx geometry

2 efflux geometry

3 sampling aperture

4 aperture simulating the entrance pupil of projection lens

5 point O

Figure 1 — Geometry for ISO 5 standard transmittance density measurements

6.2 Sampling aperture

The extent and shape of the area on which density is measured is the sampling aperture. Physically, the sampling aperture is realized by a diaphragm, which shall be in contact with the specimen to be measured. Figure 2 shows the four combinations which may be applied: two for the diffuse influx mode and two for the diffuse efflux mode. All other combinations are excluded.

NOTE 1 Figure 2 shows, for combinations b) and d), that the opaque material of the diaphragm constitutes a smooth surface with the diffusing material. This can be obtained by grinding the opal glass and filling the recess with an appropriate opaque material. Since these combinations are rather costly, combinations a) and c) will be preferred in practice.