BS ISO 18314-3:2015

BSI Standards Publication

Analytical colorimetry

Part 3: Special indices

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National foreword

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Foreword

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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 3:
Special indices

1 Scope

This part of ISO 18314 specifies different methods of calculating special indices, which are generally used to describe lightness respectively jetness of samples including chroma or hue within one colour-coordinate.

This part of ISO 18314 is applicable to tristimulus values and chromaticity coordinates calculated using colour-matching functions of the CIE 1964 standard colourimetric system. It can be used for the specification of colour stimuli perceived as belonging to a reflecting or transmitting object, where a one-dimensional value is required.

2 Symbols and abbreviated terms

a, b	absolute parameters
FI	flop-index
G_C	colour depending grey value
G_Y	grey value
Gyr	relative grey value
G_Y (GS)	grey value of a virtual general standard
G_Y (GS_f)	fixed mean value (of 10 preparations) of the actual general standard
G_Y (GS_v)	grey value of the actual prepared general standard
G_Y (Sample)	grey value of the sample
$L^*(\varepsilon)$	CIELab-76 lightness value at the aspecular angle ε
M_C	colour depending black value
M_Y	black value
Myr	relative black value
M_Y (GS)	black value of a defined virtual general standard
M_Y (GS_f)	fixed mean value (of 10 preparations) of the actual group standard
M_Y (GS_v)	black value of the actual prepared group standard
M_Y (Sample)	black value of the sample
W_{CIE}	is the CIE whiteness index
X, Y, Z	tristimulus values of a test stimulus

X_n, Y_n, Z_n	tristimulus values of a specific white colour stimulus
x, y	chromaticity coordinates of a test stimulus
x_n, y_n	chromaticity coordinates of a specific white colour stimulus
YI	yellowness index

3 Whiteness index

3.1 CIE whiteness index

$$W_{CIE} = Y + 800 \cdot (x_n - x) + 1700 \cdot (y_n - y) \quad (1)$$

This formula is valid within the range of 40 < W_{CIE} < 5Y – 280.

NOTE This formula follows CIE 15:2004 and ASTM E 313–10.

4 Yellowness index

$$YI = 100 \cdot \frac{a \cdot X - b \cdot Z}{Y} \quad (2)$$

The absolute parameters *a* and *b* depend on illuminant D65 and the standard observer 2° and 10°. See Table 1.

Table 1 — Parameters *a* and *b* for standard observer 2° and 10°

Standard observer	*a*	*b*
2°	1,298 5	1,133 5
10°	1,301 3	1,149 8

NOTE This equation follows ASTM E 313–10 and DIN 6167.

5 Black values

5.1 Black value, M_Y

$$M_Y = 100 \cdot \log \frac{Y_n}{Y} \quad (3)$$

NOTE This equation follows DIN 55979.

5.2 Colour depending black value, M_C

$$M_C = 100 \cdot \left(\log \frac{X_n}{X} - \log \frac{Z_n}{Z} + \log \frac{Y_n}{Y} \right) \quad (4)$$

NOTE Black value, M_C, describes higher jetness if there is a blue shade and lower jetness if the shade is brown.

5.3 Absolute contribution of hue, dM

$$\mathrm{d}M = M_C - M_Y \quad (5)$$

NOTE dM describes the amount of blue shade in case of positive values and the amount of brown shade in case of negative values.

5.4 Relative black value, *Myr*

$$Myr[\%] = \frac{M_Y\,(\text{Sample}) \cdot M_Y\,(\text{GS}_f)}{M_Y\,(GS) \cdot M_Y\,(\text{GS}_v)} \cdot 100\% \tag{6}$$

In case of carbon black pigments, a group standard can be defined as a general standard relating to the class of carbon black pigment. See Table 2.

Table 2 — Virtual black values M_Y (GS) for group standards

Group standards (GS)	Virtual black value M_Y (GS)
Gas black, powder, and beads	260
Oxidized gas black, powder, and beads	250
Furnace black, powder, and beads	255
Oxidized furnace black, powder, and beads	225
Lamp black, powder, and beads	205
Thermal black, powder, and beads	205
Acetylene black, powder, and beads	250

6 Grey values

6.1 Grey value, G_Y

$$G_Y = 100 \cdot \log \frac{Y_n}{Y} \tag{7}$$

6.2 Colour depending grey value, G_C

$$G_C = 100 \cdot \left(\log \frac{X_n}{X} - \log \frac{Z_n}{Z} + \log \frac{Y_n}{Y} \right) \tag{8}$$

6.3 Absolute contribution of hue, dG

$$dG = G_C - G_Y \tag{9}$$

NOTE dG describes the amount of blue shade in case of positive values and the amount of brown shade in case of negative values.

6.4 Relative grey value, Gyr

$$Gyr[\%] = \frac{G_Y\,(\text{Sample}) \cdot G_Y\,(\text{GS}_f)}{G_Y\,(\text{GS}) \cdot G_Y\,(\text{GS}_v)} \cdot 100\% \tag{10}$$

In case of carbon black pigments, a group standard can be defined as a general standard relating to the class of carbon black pigment. See Table 3.

Table 3 — Virtual grey values G_Y (GS) for group standards

Group standards (GS)	Virtual grey value G_Y (GS)
Gas black, powder, and beads	95
Oxidized gas black, powder, and beads	99
Furnace black, powder, and beads	99
Oxidized furnace black, powder, and beads	85
Lamp black, powder, and beads	64
Thermal black, powder, and beads	50
Acetylene black, powder, and beads	85

7 Flop-index

The flop-index (*FI*) is a special measure to characterize the angular variation of lightness of almost neutral metallic colour shades. Its formal definition is

$$FI = 2{,}69 \frac{\left[L^*(\varepsilon_1) - L^*(\varepsilon_3)\right]^{1{,}11}}{\left[L^*(\varepsilon_2)\right]^{0{,}86}} \tag{11}$$

The parameters (exponents, pre-factor) have been chosen in a way so that for conventional metallic pigments the order of magnitude is $FI \approx 10$. $L^*(\varepsilon)$ denotes the CIELab-76 lightness value at the aspecular angle ε with ε_1=15°, ε_2=45°, ε_3=110°.

NOTE This formula has been developed by D. H. Alman.[1]

Annex A
(informative)

Considerations regarding black values

The impression of hue or colour intensity is a subjective sensory perception. Consequently, differentiation between jet-black paints is not totally without problems. A visual assessment is always significantly influenced by the ambient conditions and by the physical and mental state of the observer. For reliable determination, measurement equipment is required which provides reproducible results for the measurement range with minimum reflections.

Metrological assessment of the jetness is preferably performed using a spectral photometer with 45°/0° (or 0°/45°) geometry. Here the specimen is placed at an angle of 45° and generally subjected to circular illumination. The light reflected by the specimen is measured at an angle of 0°. The spectrophotometer might be selected in testing of calibration repeatability. The difference of standard value Y has to be lower than ±0,003 in the jetness area of Y = 0,04 until Y = 0,05.

The visual evaluation is influenced to a great extent by the ambient conditions and by the physical and mental state of the observer. It is consequently necessary to define and observe certain boundary conditions. As natural daylight is subject to continuous fluctuations, a standardised artificial light source has to be used that produces a light similar to that of daylight type D65 by filtering.

The observation angle has to correspond to the 45°/0° (or 0°/45°) geometry of the measuring instrument. As the light falls perpendicularly onto the paint coating, the observer views the specimen at an angle of 45°. The area around the specimens should be kept neutral. Reflections of other objects have to be avoided. Matt black specimen mountings and backgrounds and complete darkening of the examination room are of benefit for the evaluation of deep black specimens.

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[1] Alman D.H. Directional color measurement of metallic flake finishes, Proc. ISCC Williamsburg Conf. on Appearance, 53 (1987)

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[3] ASTM E 313-10, *Standard Practice for Calculating Yellowness and Whiteness Indices from Instrumentally Measured Color Coordinates*

[4] DIN 6167:1980-01, *Description of yellowness of near-white or near-colourless materials*

[5] DIN 55979:1989-04, *Testing of pigments; Determination of the black value of carbon black pigments*

1) Available from CIE (International commission on illumination): CIE Central Bureau, Kegelgasse 27, A-1030 Vienna, Austria; www.cie.co.at

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