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**Graphic technology — Colour and  
transparency of printing ink sets for four-  
colour printing —**

Part 1:  
**Sheet-fed and heat-set web offset  
lithographic printing**

*Technologie graphique — Couleur et transparence des gammes  
d'encre d'impression en quadrichromie —*

*Partie 1: Impression lithographique offset sur feuilles et à chaud*



Reference number  
ISO 2846-1:2006(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 2846-1 was prepared by Technical Committee ISO/TC 130, *Graphic technology*.

This second edition cancels and replaces the first edition (ISO 2846-1:1997), of which subclauses 4.2 and 5.2 and Annex D have been technically revised. Some very minor changes have been made for the purposes of simplification, and an effort has been made to clarify and update this document in some places. Clauses 4 and 5 have been interchanged with each other. In addition, the test-print preparation requirements have been deleted and referenced to ISO 2834-1. Annex B, describing the history of the development of the colour standard, has been removed and Annex E relettered to Annex B.

ISO 2846 consists of the following parts, under the general title *Graphic technology — Colour and transparency of printing ink sets for four-colour printing*:

- *Part 1: Sheet-fed and heat-set web offset lithographic printing*
- *Part 2: Coldset offset lithographic printing*
- *Part 3: Publication gravure printing*
- *Part 4: Screen printing*
- *Part 5: Flexographic printing*

## Introduction

This part of ISO 2846 defines the colour and transparency of lithographic printing inks. Different sets of inks (both for proof and production printing) conforming to this part of ISO 2846 will produce a similar colour when printed on the same substrate at the appropriate film thickness. This enables colour separations for offset-lithographic printing to be based on known colour references and simplifies the task of consistently printing the same images in multiple printing sites.

It should be noted that the colorimetric characteristics specified can only be obtained when the inks are printed on the reference substrate. However, the similarity of two inks on a reference substrate generally ensures similarity on another substrate, and it is this similarity that has enabled industry specifications or standards such as ISO 12647-2<sup>[1]</sup>, which specifies the colour of these inks on other substrates, to be developed.

The colour specified in the previous edition of this part of ISO 2846 was based on extensive measurements of commercial ink sets made in Europe, Japan and the USA. A working group of ISO/TC 130 process control and material experts examined data sets from various countries at the time that edition was prepared and found that a single set of colour coordinates could adequately represent all three proposals within reasonable tolerances. In addition, they found that the transparency of various inks could also be adequately represented by a new method of evaluation. A review undertaken prior to the revision of this edition suggested that there had been little change in the colour and transparency of the inks commercially available and that the characteristics specified in this part of ISO 2846 could be reconfirmed.



# Graphic technology — Colour and transparency of printing ink sets for four-colour printing —

## Part 1: Sheet-fed and heat-set web offset lithographic printing

### 1 Scope

This part of ISO 2846 specifies the colour and transparency characteristics that have to be met by each ink in a process colour ink set intended for proof and production printing using offset lithography. The specified printing conditions (which use a laboratory printability tester), the defined substrate and a method for testing to ensure conformance are also defined. Characteristics are specified for inks used for sheet-fed, heat-set web and radiation-curing processes.

This part of ISO 2846 does not apply to fluorescent inks and it does not specify pigments (or spectral characteristics — except informatively) in order not to preclude developments which may enable different pigment combinations to be used advantageously while still achieving the colorimetric requirements specified in this part of ISO 2846.

### 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 535, *Paper and board — Determination of water absorptiveness — Cobb method*

ISO 536, *Paper and board — Determination of grammage*

ISO 2144, *Paper, board and pulps — Determination of residue (ash) on ignition at 900 °C*

ISO 2834-1, *Graphic technology — Laboratory preparation of test prints — Part 1: Paste inks*

ISO 6588-1, *Paper, board and pulps — Determination of pH of aqueous extracts — Part 1: Cold extraction*

ISO 8254-1, *Paper and board — Measurement of specular gloss — Part 1: 75° gloss with a converging beam, TAPPI method*

ISO 8791-4, *Paper and board — Determination of roughness/smoothness (air leak methods) — Part 4: Print-surf method*

ISO 13655, *Graphic technology — Spectral measurement and colorimetric computation for graphic arts images*

ANSI CGATS.5:2003, *Graphic technology — Spectral measurement and colorimetric computation for graphic arts images*

### 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

#### 3.1

##### **standard ink**

ink intended for four-colour printing which, when printed on the reference substrate and within the applicable range of ink film thicknesses, complies to the colorimetric and transparency specifications of this part of ISO 2846

#### 3.2

##### **transparency**

ability of an ink film to transmit light

NOTE It is generally expressed as some measure of the unwanted scattering.

#### 3.3

##### **transparency measurement value**

*T*

reciprocal of the slope of the regression line between ink film thickness and colour difference for overprints of chromatic inks over black substrate

### 4 Test method

#### 4.1 Procedure

Colorimetric conformance shall be verified by printing each ink on the reference substrate, described in Annex A, at a range of ink film thicknesses. The colours of the resultant test prints shall be measured and the colour difference determined between the sample and the pertinent value given in Table 1. If at least one of these samples has a smaller colour difference than that specified in 5.2, the ink conforms colorimetrically to this part of ISO 2846.

NOTE It is often more convenient to determine the colorimetric conformance of an ink graphically. This is achieved by calculating the colour difference ( $\Delta E_{ab}^*$ ) from the values in Table 1 for each of the prints made and plotting this against the ink film thickness. The ink conforms if the resultant curve shows a pronounced minimum which is below the  $\Delta E_{ab}^*$  value specified in Table 1. (See Annex B for further information.)

Transparency value, *T*, shall be determined by printing each of the chromatic process inks on to a black substrate meeting the requirements of 4.2.2, at a range of ink film thicknesses. The colour difference,  $\Delta E_{ab}^*$ , is determined for each sample between the overprinted and unprinted black substrate. The gradient of the linear regression of ink film thickness on colour difference shall be determined. An ink conforms to the transparency requirements of this part of ISO 2846 if the reciprocal of the gradient is negative, or greater than the value specified. (See Annex B for further information.)

The gradient of the regression equation may be determined directly from the data obtained. However, it is recommended that it be obtained from a graphical plot of the values of  $\Delta E_{ab}^*$  against ink film thickness. Such a plot enables any unexpected characteristics of the data to be easily visualised. (See Annex B for further information.)

If one or more printed samples of each ink conform to the colorimetric values within the tolerances specified, and the ink also meets the transparency criteria, that ink can be said to comply to this part of ISO 2846.

#### 4.2 Test print preparation

##### 4.2.1 Prints for colorimetric evaluation

For each of the inks to be evaluated, a number of test prints shall be made, each produced at a different ink film thickness, according to the conditions specified in ISO 2834-1.



They shall be made on the reference substrate specified in Annex A. The range of ink film thicknesses produced shall encompass that specified for the process for which the ink is intended. (See 5.4.)

#### 4.2.2 Prints for transparency evaluation

The test prints for transparency evaluation shall be produced by printing the inks to be tested on a black substrate such that a minimum of four samples is achieved, each with a different ink film thickness. The printing shall be undertaken as described in ISO 2834-1. The range of ink film thicknesses achieved should at least cover that defined in 5.4.

The black substrate shall have a lightness,  $L^*$ , less than 6 when determined in accordance with ISO 13655 (with the exception that a white backing shall be used when measuring the print; see 4.3).

Although in principle it is possible for the user to produce, themselves, the black substrate by printing, it is difficult to ensure that the lightness is sufficiently low without adversely affecting the gloss and printing properties of the substrate. It is usually preferable to use a black substrate or a substrate pre-printed commercially. However, if it is necessary to print the black, the recommendations given in Annex B should be followed. Appropriate substrates are the contrast card or the contrast strip <sup>1)</sup>.

#### 4.2.3 Drying of test prints

Prior to colour measurement, all samples shall be thoroughly dry. Inks formulated for oxidation drying shall be left for at least 24 h, those formulated for radiation curing shall be dried with an appropriate radiation source within the appropriate time and heat-set inks shall be heat dried with appropriate drying equipment.

NOTE Be aware that the appropriate time for radiation curing inks can be down to parts of a second only.

### 4.3 Colour measurement procedures

Test prints shall be measured in accordance with ISO 13655, except that a white backing which is in conformance with ANSI CGATS.5 shall be used.

Conforming to ISO 13655 means that samples shall be measured spectrally, with a  $0^\circ:45^\circ\text{a}$  or  $45^\circ\text{a}:0^\circ$  geometry instrument, and for calculation of CIELAB colour values the CIE 1931 ( $2^\circ$ ) standard colorimetric observer data is used together with CIE standard illuminant D50; see Reference [3]. Where spectral data is obtained at wavelength intervals greater than 5 nm, the weighting functions for the standard colorimetric observer specified in ISO 13655 are used.

For calculating the colour difference from the reference values, the CIE 1976 colour difference,  $\Delta E_{ab}^*$ , shall be used.

NOTE 1 ISO 13655 is currently under revision and it is the intent of the committee to add a white backing condition identical to that of ANSI CGATS.5.

NOTE 2 For the comparison of measurements, it is useful to record the following details:

- the ink designation and batch number;
- the ink layer thicknesses;
- the substrate used;
- the printability tester used and the settings used on the tester (speed, force, printing forme);
- environmental conditions (lab temperature and relative humidity);
- spectrophotometer used;
- any deviations from this part of ISO 2846.

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1) Leneta paper or card (No. 105 C) which may be purchased from Leneta Corp., Mahwah, NJ, USA; contrast strip: comparison test strips Ka APCO C with contrast band (several widths) which may be purchased from IGT Testing Systems, Amsterdam, The Netherlands. These products are examples of suitable products available commercially. This information is given for the convenience of users of this part of ISO 2846 and does not constitute an endorsement by ISO of these products.

## 5 Requirements for colour, transparency and ink film thickness range

### 5.1 General

For an ink to conform to this part of ISO 2846 it shall meet the specifications for colour defined in 5.2, and the specification for transparency defined in 5.3, at some ink film thickness **within** the range specified in 5.4.

### 5.2 Colorimetric values

When printed in accordance with Clause 4, an ink shall produce a colour that falls within the defined colour difference tolerances,  $\Delta E_{ab}^*$ , from the  $L^*$ ,  $a^*$ ,  $b^*$  values specified in Table 1.

**Table 1 — Colorimetric values for 0°:45°a geometry, illuminant D50, 2° observer**

Ink	CIELAB values <sup>a</sup>			Tolerances <sup>a</sup>			
	$L^*$	$a^*$	$b^*$	$\Delta E_{ab}^*$	$\Delta a^*$	$\Delta b^*$	$L^*$
Yellow	91,0	-5,1	95,0	4,0	—	—	—
Magenta	50,0	76,0	-3,0	4,0	—	—	—
Cyan	57,0	-39,2	-46,0	4,0	—	—	—
Black	18,0	0,8	0,0	—	± 1,5	± 3,0	18,0 <sup>b</sup>

<sup>a</sup> Parameters  $L^*$ ,  $a^*$ ,  $b^*$ ,  $\Delta E_{ab}^*$ ,  $\Delta a^*$  and  $\Delta b^*$  are defined in ISO 13655.  
<sup>b</sup> For black, there is no symmetrical tolerance for  $L^*$  but an upper limit.

NOTE 1 Typical spectral data for inks conforming to this part of ISO 2846 are provided in Annex C. Reference spectral data for 8°:di or di:8° geometry are also included in Annex C.

NOTE 2 Reference data for tristimulus values calculated from the CIE 1931 (2°) standard colorimetric observer, together with CIE illuminant D65, are included in Annex D for both 8°:di or di:8° and 0°:45°a. Tristimulus data for 8°:di or di:8° geometry and illuminant D50 are also included in Annex D.

### 5.3 Transparency characteristics

When printed in accordance with Clause 4, an ink shall produce a transparency,  $T$ , value greater than that specified in Table 2.

**Table 2 — Transparency requirements**

Ink	Transparency, $T$
Yellow	0,08
Magenta	0,12
Cyan	0,20

For highly transparent inks (usually cyan) the slope of the regression line may be zero or negative. In such a situation the transparency value is considered to be approaching infinity and therefore meets the specification.

NOTE For information concerning transparency evaluation using instruments with different geometry, see B.3.2.

### 5.4 Ink film thickness

The range of ink film thicknesses within which a standard ink shall conform is provided in Table 3 for the different ink drying processes specified in this part of ISO 2846.

**Table 3 — Range of ink film thicknesses in micrometres**

Drying mechanism	Ink			
	Cyan	Magenta	Yellow	Black
Drying by oxidation/setting	0,7 to 1,1	0,7 to 1,1	0,7 to 1,1	0,7 to 1,3
Radiation curing	0,7 to 1,3	0,7 to 1,3	0,7 to 1,3	0,9 to 1,3
Heat-set web	0,7 to 1,3	0,7 to 1,3	0,7 to 1,3	0,9 to 1,3

## Annex A (normative)

### Reference substrate

For the purposes of this part of ISO 2846, a lightfast, gloss-coated, wood-free paper free of optical brightener shall be used as the printing substrate, the characteristics of which shall be as follows:

#### Colorimetric values

Specification: CIELAB values  
 $L^* = 95,5 \pm 2,0$   
 $a^* = -0,4 \pm 1,0$   
 $b^* = 4,7 \pm 1,5$

Method: ISO 13655 (see 4.3)

#### Water absorptiveness

Specification: 2 g/m<sup>2</sup> to 5 g/m<sup>2</sup> after 10 s

Method: ISO 535

#### Gloss

Specification: 70 % to 80 %

Method: ISO 8254-1

#### Mass per area

Specification: (150 ± 3) g/m<sup>2</sup>

Method: ISO 536

#### Ash content

Specification: 20 % to 30 %

Method: ISO 2144

#### pH

Specification: 8 to 10

Method: ISO 6588-1

#### Roughness

Specification: 0,9 µm to 1,1 µm at a pressure of 1 N/mm<sup>2</sup>

Method: ISO 8791-4

NOTE In practice there has been only one supplier of this material and it has become the de facto standard. This material is the gloss-coated, woodfree paper Phoenix Imperial APCO II/III from Scheufelen, D-73250 Lenningen, Germany.<sup>2)</sup>

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2) This information is given for the convenience of users of this part of ISO 2846 and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

## Annex B (informative)

### Extended explanation of the test procedures, including examples

#### B.1 Colorimetric verification

In order to evaluate whether an ink meets the specifications of this part of ISO 2846, it is necessary to print a number of samples, each of known ink film thickness, which adequately represent the range of ink film thicknesses specified for that ink in 5.4. These samples may be prepared on a printability tester according to the method described in ISO 2834-1. A small quantity of ink is run up on the inking system, the printing forme is weighed prior to printing and then the test sample is printed on the reference substrate. The forme is then re-weighed and the difference noted. If the mass density of the ink is known (this may be determined by weighing a known volume of ink) and the area printed is measured, it is possible to calculate the ink film thickness applied to the substrate from the difference in mass before and after printing. The ink film thickness,  $s$ , can be calculated using the following equation:

$$s = \frac{\Delta m}{\rho \times A}$$

where

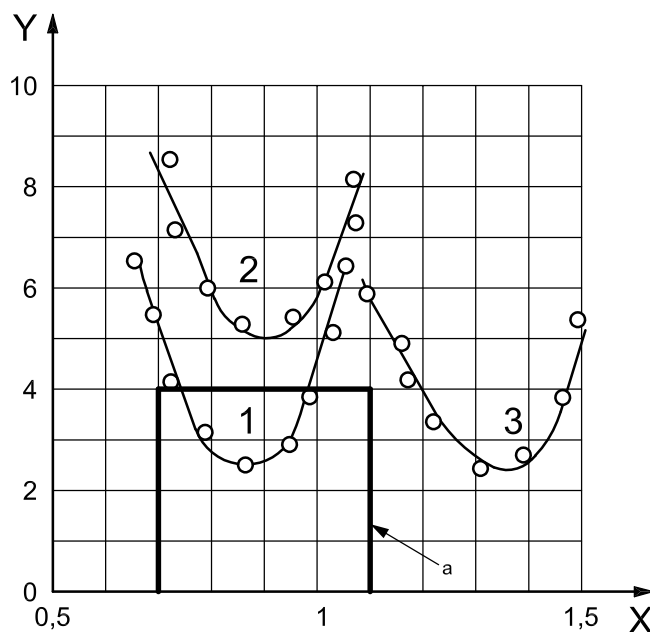
$\Delta m$  is the difference in mass of the forme before and after printing;

$\rho$  is the mass density of the ink;

$A$  is the printed area.

A number of samples is obtained covering the range of ink film thicknesses specified in this part of ISO 2846.

When dry, a number of the printed samples, distributed throughout the range of ink film thicknesses, are selected and their colour measured. This is undertaken with the sample lying on a white backing (4.3) and measured using the 2° observer and illuminant D50. The CIELAB colour difference between each sample and the colours specified in Table 1 of this part of ISO 2846 are then calculated and plotted as a function of ink film thickness as shown in Figure B.1. The ink meets the specifications of this part of ISO 2846 if, at some ink film thickness in the specified range, it falls below the colour difference specified in Table 1 of this part of ISO 2846. Figure B.1 shows the tolerance range for an oxidative setting ink, and curve 1 in that figure shows an ink which conforms to this part of ISO 2846. Curves 2 and 3 are examples of inks which deviate from this part of ISO 2846. Curve 2 belongs to an ink of the wrong colour, most probably of incorrect hue, whereas curve 3 shows an ink of the correct colour but at the wrong concentration of colorant.



### Key

X ink film thickness in micrometres,  $s$

Y  $\Delta E_{ab}^*$ , colour difference

1 ink drying by oxidation/setting which conforms to this part of ISO 2846

2 ink drying by oxidation/setting which does not conform to this part of ISO 2846 due to a deviation in colour

3 ink drying by oxidation/setting which does not conform to this part of ISO 2846; it is correct in colour but not in concentration

<sup>a</sup> Tolerance range.

**Figure B.1 — Example evaluation of oxidative setting printing ink (colour difference plotted as a function of ink film thickness)**

## B.2 Determination of transparency

Using the same procedure as above, a series of prints needs to be made covering at least the range of ink film thicknesses specified in 5.4 and preferably beyond, for higher precision. However, for this test the black substrate may be any gloss-coated paper, of reasonable opacity, which may have been pre-printed with an area of black ink that has an  $L^*$  value no greater than 6. Such material may be purchased from the Leneta Corporation or IGT Testing Systems or produced by the user by printing the substrate with two or more coatings of black ink, allowing sufficient time between printings for the ink to dry (4.2.2).

For the determination of transparency, each strip of black substrate should be coded and the colour of the black repeatedly measured and averaged on each, prior to overprinting with the test inks over the range of ink film thicknesses specified.

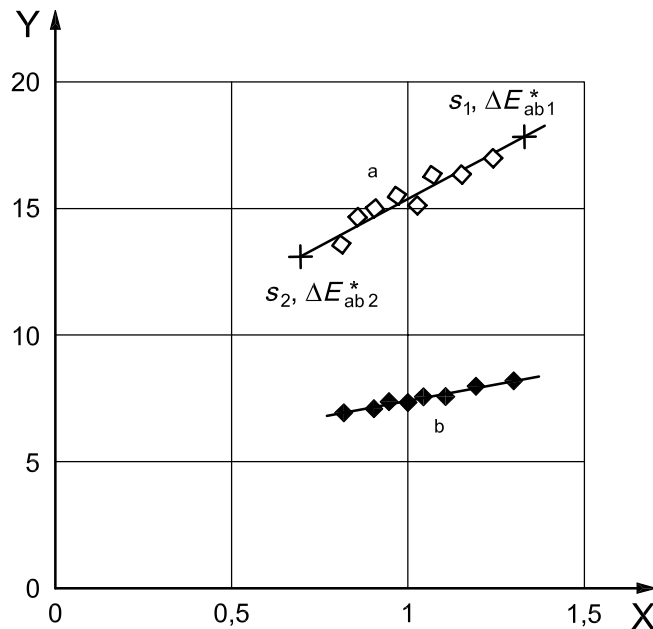
After the samples which have been printed with the test inks are dry, the colour of each sample should be measured as described in B.1, in the same position on the sample as was measured for the black. (See the cautionary discussion concerning production and measurement of the samples in B.3.)

The colour difference between the two measurements is then calculated for each sample and plotted as a function of ink film thickness. The 'best fit' straight line through these points is then drawn as shown in Figure B.2 and the slope of the line is calculated. (Alternatively the gradient of the linear regression equation may be calculated directly from the data.) The reciprocal of this value is then computed and this is the value  $T$  of the transparency measurement. Using the graphical method, this value may be calculated directly as follows (refer to Figure B.2):

$$T = \frac{s_1 - s_2}{\Delta E_{ab1}^* - \Delta E_{ab2}^*}$$

where

- $T$  is the value of the transparency measurement;
- $s_1$  is the ink film for the point on the graph at the higher level of film thickness;
- $s_2$  is the ink film for the point on the graph at the lower level of film thickness;
- $\Delta E_{ab1}^*$  is the colour difference for the point on the graph at the higher level;
- $\Delta E_{ab2}^*$  is the colour difference for the point on the graph at the lower level.



**Key**

- X ink film thickness in micrometres,  $s$
- Y  $\Delta E_{ab}^*$ , colour difference
- a Transparency value,  $T = 0,13$ .
- b Transparency value,  $T = 0,50$ .

**Figure B.2 — Assessment of transparency according to this part of ISO 2846**

Providing the value achieved from this calculation is **greater** than that specified in 5.3, the transparency of the ink is in conformance with this part of ISO 2846. For perfectly transparent inks (or those close to it), the gradient of the linear regression equation, and therefore its reciprocal, could be negative. This special case would also conform to this part of ISO 2846.

## B.3 Issues to be noted when preparing and measuring samples for transparency assessment

### B.3.1 Selection and printing of the black ink

If transparency is measured using samples on which a black ink has been printed on the substrate by the user, care needs to be taken in the selection of the black ink used. A black must be selected that exhibits little or no bronzing and which exhibits a similar level of gloss to the same sample when overprinted by the test ink. Any pre-printed material cited in 4.2.2 can give rise to anomalous results if the gloss change is significant. Any measure of transparency based on optical measurements could be affected by such surface phenomena and care needs to be taken to select materials which minimize them. If this is not done, erroneous results may well be obtained. In severe cases this may even arise with a  $0^\circ:45^\circ\text{a}$  or  $45^\circ\text{a}:0^\circ$  geometry. Such results are normally obvious from simple visual assessment of the samples.

It is possible to have an ink with such a high degree of transparency that the resultant overprint reflects less light than that of the black ink alone. This is simple to understand in that both the black and test inks will absorb light. It is with such an ink that the graph obtained as shown in Figure B.2 will have a negative or zero slope. However, in practice most inks scatter light to such a degree that this scenario is not likely, particularly for magenta and yellow. Thus, if such a result is obtained, it is sensible to be cautious. It is wise to assume that such phenomena as "super-transparency" on the one hand (whereby the result appears blacker when overprinted by the coloured ink than without) or an ink seeming excessively opaque on the other hand are the result of gloss or bronzing effects which are different between the black ink and the overprint surfaces. If unexpected results are obtained, the nature of the black substrate and printed samples should be investigated to see whether these phenomena are a possible cause. Visual assessment will generally confirm whether or not the test ink is really as highly transparent or opaque as suggested by the regression coefficient and, if not, should reveal the source of the difficulty.

### B.3.2 Use of sphere instruments for measuring transparency

It is because the variation in surface effects is more likely to influence results obtained on an integrating sphere instrument (even with the specular component excluded) that values for transparency obtained using a sphere instrument, equivalent to those obtained using a  $0^\circ:45^\circ\text{a}$  geometry instrument, have not been provided in Annex D.

Nevertheless, with care, the procedure can still prove useful for the evaluation of samples of similar surface characteristics. Results obtained with such instruments give absolute values of  $T$  different from those obtained with a  $0^\circ:45^\circ\text{a}$  geometry instrument, but are ranked in the same order and with similar relative differences between them. The procedure can also prove useful for "troubleshooting" unexpected results obtained with a  $0^\circ:45^\circ\text{a}$  geometry instrument.

**NOTE** For a more extensive discussion of the issues raised in this clause the reader is referred to the paper by Bassemir and Zawacki <sup>[2]</sup> given in the Bibliography.

## Annex C (informative)

### Spectral data

For some applications, such as calculating tristimulus values for a different observer or illuminant, it is useful to have recourse to spectral data. As stated in the introduction, it was deliberately decided not to standardize such data since it can be very restrictive for ink manufacturing and the future development of ink with improved properties. However, the following data may be taken as "typical" of that which was obtained during development of this part of ISO 2846.

Two tables of data are presented: Table C.1 is for  $0^\circ:45^\circ\text{a}$  geometry and Table C.2 is for  $8^\circ:\text{di}$ . The data in Table C.1 is in accordance with the values in Table 1. The data of Tables C.1 and C.2 have been used to compute the values in the tables of Annex D.

For the purposes of this part of ISO 2846, the  $0^\circ:45^\circ\text{a}$  and  $45^\circ\text{a}:0^\circ$  geometries are deemed to be equivalent to each other, as are the  $8^\circ:\text{di}$  and  $\text{di}:8^\circ$  geometries. Thus, whilst only one of the equivalent geometries is specified in the tables of this annex, it may be interpreted that either is acceptable. Of course, the values obtained with each geometry are different.



**Table C.1 — Typical spectral reflectance data for inks conforming to this part of ISO 2846, 0°:45°a geometry**

Wavelength nm	Reflectance factor				
	Cyan	Magenta	Yellow	Black	Substrate <sup>a</sup>
380	0,094	0,245	0,113	0,019 7	0,720
390	0,200	0,219	0,087	0,020 2	0,741
400	0,312	0,206	0,067	0,020 8	0,759
410	0,409	0,208	0,053	0,022 9	0,773
420	0,452	0,214	0,044	0,024 7	0,787
430	0,522	0,228	0,041	0,025 1	0,799
440	0,606	0,242	0,041	0,025 5	0,808
450	0,664	0,237	0,045	0,025 9	0,819
460	0,690	0,213	0,056	0,026 1	0,828
470	0,699	0,181	0,060	0,026 3	0,834
480	0,695	0,148	0,082	0,026 5	0,840
490	0,679	0,119	0,168	0,026 8	0,847
500	0,647	0,092	0,348	0,026 9	0,869
510	0,597	0,068	0,584	0,026 9	0,871
520	0,525	0,047	0,741	0,026 5	0,880
530	0,436	0,038	0,803	0,025 7	0,883
540	0,341	0,035	0,831	0,025 0	0,886
550	0,245	0,029	0,848	0,024 3	0,888
560	0,158	0,022	0,856	0,023 7	0,892
570	0,102	0,018	0,864	0,023 5	0,894
580	0,072	0,039	0,869	0,023 5	0,894
590	0,057	0,177	0,874	0,024 1	0,895
600	0,047	0,431	0,877	0,024 8	0,898
610	0,041	0,653	0,881	0,025 6	0,898
620	0,040	0,789	0,885	0,026 4	0,899
630	0,041	0,852	0,889	0,027 6	0,900
640	0,043	0,880	0,895	0,028 9	0,900
650	0,051	0,895	0,900	0,030 2	0,901
660	0,062	0,903	0,904	0,031 6	0,901
670	0,068	0,907	0,906	0,032 9	0,902
680	0,065	0,910	0,907	0,034 1	0,903
690	0,060	0,914	0,909	0,035 5	0,903
700	0,048	0,918	0,912	0,037 3	0,903
710	0,043	0,921	0,914	0,039 7	0,901
720	0,053	0,923	0,914	0,042 3	0,899

<sup>a</sup> Reference substrate, see Annex A.

Table C.2 — Typical spectral reflectance data for inks conforming to this part of ISO 2846, 8°:di geometry

Wavelength nm	Reflectance factor				
	Cyan	Magenta	Yellow	Black	Substrate <sup>a</sup>
380	0,137	0,271	0,187	0,088	0,730
390	0,249	0,247	0,159	0,090	0,750
400	0,360	0,234	0,137	0,091	0,767
410	0,454	0,233	0,120	0,095	0,781
420	0,498	0,238	0,108	0,099	0,795
430	0,565	0,250	0,105	0,101	0,806
440	0,644	0,261	0,105	0,102	0,815
450	0,696	0,258	0,112	0,104	0,826
460	0,717	0,240	0,127	0,104	0,835
470	0,723	0,213	0,133	0,104	0,841
480	0,714	0,186	0,161	0,104	0,848
490	0,691	0,164	0,257	0,106	0,855
500	0,652	0,145	0,432	0,108	0,876
510	0,598	0,122	0,640	0,108	0,879
520	0,530	0,099	0,774	0,108	0,889
530	0,451	0,088	0,826	0,107	0,893
540	0,368	0,085	0,850	0,106	0,896
550	0,280	0,076	0,866	0,104	0,900
560	0,197	0,066	0,875	0,103	0,905
570	0,141	0,058	0,883	0,102	0,909
580	0,111	0,091	0,887	0,104	0,908
590	0,096	0,253	0,890	0,112	0,908
600	0,086	0,503	0,893	0,120	0,909
610	0,079	0,705	0,895	0,126	0,909
620	0,079	0,825	0,898	0,130	0,909
630	0,080	0,880	0,902	0,133	0,910
640	0,083	0,904	0,906	0,136	0,910
650	0,094	0,917	0,911	0,138	0,911
660	0,107	0,924	0,914	0,141	0,910
670	0,114	0,927	0,915	0,143	0,911
680	0,111	0,930	0,916	0,145	0,912
690	0,105	0,934	0,918	0,148	0,912
700	0,089	0,939	0,920	0,151	0,913
710	0,083	0,942	0,922	0,155	0,911
720	0,096	0,942	0,922	0,159	0,908

<sup>a</sup> Reference substrate, see Annex A.

## Annex D (informative)

### Tristimulus values for 8°:di geometry and illuminant D65

The information in this annex is given for the convenience of users of colorimetric measurement instruments which are not in accordance with the geometry or illuminants defined in ISO 13655.

For the purposes of this part of ISO 2846, the 8°:di and di:8° geometries are deemed to be equivalent to each other. Thus, whilst only one of the equivalent geometries is specified in the tables of this annex, it may be interpreted that either is acceptable.

The values in Tables D.1 and D.2 have been calculated from the spectral values listed in Table C.2. The values in Table D.3 have been calculated from the spectral values listed in Table C.1.

**Table D.1 — Colorimetric values for 8°:di geometry for illuminant D50**

Ink	CIELAB values		
	$L^*$	$a^*$	$b^*$
Yellow	92,1	-5,4	78,1
Magenta	55,4	66,6	1,0
Cyan	59,8	-32,2	-43,8
Black	39,6	4,0	2,0
Substrate	95,9	-0,4	5,0

If data obtained using instruments with 8°:di geometry for illuminant D50 are to be communicated (where the measurement geometry is not in accordance with ISO 13655), then this geometry should be explicitly stated in the report.

**Table D.2 — Colorimetric values for 8°:di geometry for illuminant D65**

Ink	CIELAB values		
	$L^*$	$a^*$	$b^*$
Yellow	91,6	-11,1	78,7
Magenta	53,8	65,0	-2,1
Cyan	61,2	-24,7	-40,9
Black	39,5	3,4	2,0
Substrate	95,9	-1,0	5,0

If data obtained using instruments with 8°:di geometry for illuminant D65 are to be communicated (where the measurement geometry and the illuminant are not in accordance with ISO 13655), then both the geometry and the illuminant should be explicitly stated in the report.

Table D.3 — Colorimetric values for 0°:45°a geometry for illuminant D65

Ink	CIELAB values		
	$L^*$	$a^*$	$b^*$
Yellow	90,4	-11,2	96,2
Magenta	48,1	75,2	-6,8
Cyan	58,6	-30,6	-42,8
Black	18,0	0,5	-0,5
Substrate	95,4	1,0	4,8

If data obtained using instruments for illuminant D65 are to be communicated (where the illuminant is not in accordance with ISO 13655), then the illuminant should be explicitly stated in the report.

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