INTERNATIONAL STANDARD

ISO 2846-3

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

Part 3: Publication gravure printing

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

Partie 3: Impression hélio

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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 3.

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 part of ISO 2846 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 2846-3 was prepared by Technical Committee ISO/TC 130, *Graphic technology.*

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*

Annex A forms a normative part of this part of ISO 2846. Annexes B to D are for information only.

Introduction

The demand for the publication gravure printing process to become more consistent and predictable has required a means of standardizing the product to ensure the easy flow of business between the various parties involved in its production. An essential component in this process is the colorimetric characteristics of the ink set.

To produce a set of standard four-colour process inks suitable for gravure printing it is necessary to specify a number of parameters. It is the purpose of this part of ISO 2846 to describe those parameters which affect the colorimetric characteristics in such a manner that a standard set of inks can be supplied by any ink manufacturer to any printer who can then supply prints to a print buyer with confidence in the colour of the work produced.

This part of ISO 2846 will allow publication gravure printers to obtain different sets of inks that will produce a similar colour when printed on the same substrate. In addition, it will allow colour separations for gravure printing to be based on known colour standards. The colorimetric characteristics specified may only be obtained when the inks are printed on the reference substrate. However, two inks of the same type that are similar in colorimetric characteristics and transparency according to this part of ISO 2846 will normally ensure similarity on another substrate.

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

Part 3: Publication gravure printing

1 Scope

This part of ISO 2846 specifies the colour and transparency to be produced by a process colour ink set including extender intended for four-colour publication gravure printing when printed under specified gravure printing conditions. It also specifies the test method to ensure conformance.

This part of ISO 2846 does not specify pigments (or spectral reflectance) 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.

NOTE This part of ISO 2846 may also apply to certain non-publication gravure applications.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 2846. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 2846 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 535:1991, *Paper and board — Determination of water absorptiveness — Cobb method*

ISO 536:1995, *Paper and board — Determination of grammage*

ISO 2144:1997, *Paper, board and pulps — Determination of residue (ash) on ignition at 900 °C*

ISO 2846-1:1997, *Graphic technology — Colour and transparency of ink sets for four-colour-printing — Part 1: Sheet-fed and heat-set web offset lithographic printing*

ISO 6588:1981, *Paper, board and pulps — Determination of pH of aqueous extracts*

ISO 8254-1:1999, *Paper and board — Measurement of specular gloss — Part 1: 75° gloss with a converging beam, TAPPI method*

ISO 8791-4:1992, *Paper and board — Determination of roughness/smoothness (air leak methods) — Part 4: Print-surf method*

ISO 13655:1996, *Graphic technology — Spectral measurement and colorimetric computation for graphic arts images*

3 Terms and definitions

For the purposes of this part of ISO 2846, the following terms and definitions apply.

3.1
extension
addition of a transparent material (colorant-free ink) to the ink to reduce the pigment concentration without significantly influencing the rheological properties of the ink

3.2
press-ready ink
ink that has all necessary components and is at press viscosity

3.3
transparency
ability of an ink film to transmit and absorb light without scattering

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

[ISO 2846-1:1997, 3.5]

4 Test method

4.1 Principle

Each ink shall be printed on the reference substrate described in annex A at a range of colorations obtained by varying the extension of the press-ready ink. The colours which result shall be measured colorimetrically and the colour difference between the sample and the pertinent value in Table 1 shall be plotted versus the percentage of press-ready ink. If one or more samples conform to the values and tolerances specified, and the ink also meets the transparency criteria, that ink complies to this part of ISO 2846.

Transparency, T, shall be evaluated by printing or applying each of the chromatic process inks on a black substrate at a range of ink extensions. The CIELAB colour difference, $\Delta E_{ab}{}^{*}$, shall be determined for each sample, between the overprinted and unprinted black. The linear regression coefficient (slope of the regression line) between the percentage by mass of press-ready ink in each of the extended ink samples being tested and colour difference shall be calculated from a plot of $\Delta E_{ab}{}^{*}$ vs. percentage press-ready ink over a range of extensions. An ink conforms to this requirement if the transparency, T, which is the reciprocal of the regression coefficient, is negative or greater than the value specified. For further details, see annex D.

4.2 Test print preparation

4.2.1 Prints for colorimetric evaluation

For each ink to be evaluated, prepare an extension series with 50 %, 60 %, 70 %, 80 %, 90 % and 100 % of press-ready ink using extender diluted to press viscosity. Apply the series of extended inks to the reference substrate specified in annex A with a method that produces an even ink film thickness. Examples are printing with a printability tester for gravure inks or coating applicator. The wet ink film thickness used for the extension series shall be approximately equal.

The method chosen shall produce a curve that shows a pronounced minimum or a data point which is in conformance with Table 1 when $\Delta E_{ab}{}^{*}$ is plotted versus percentage of press-ready ink. If the extension series does not produce such a curve, produce another series of specimens with a different ink film thickness. Produce a higher ink film thickness if the colour difference decreases with an increasing percentage of press-ready ink. Produce a lower ink film thickness if the colour difference decreases with a decreasing percentage of press-ready ink.

See annex D for further information.

4.2.2 Prints for transparency evaluation

Test prints for transparency evaluation shall be produced by printing the inks to be tested over black. The black shall have a lightness (L^*) less than 6 when determined according to ISO 13655.

One appropriate substrate is the contrast card[1)].

Since the CIELAB values of the black need to be established, both when unprinted and overprinted by the chromatic ink, the measurements of the black alone shall be made prior to overprinting.

The ink to be tested shall then be printed on the substrate such that a range of samples is achieved, each with a different percentage of press-ready ink.

4.2.3 Drying of test prints

Prior to colour measurement, all samples shall be thoroughly dried.

4.3 Colour measurement procedure

Test prints shall be measured in accordance with ISO 13655, except that a substrate backing consisting of at least 3 sheets of the unprinted reference substrate shall be used.

NOTE The samples are measured spectrally, with a 0°/45° or 45°/0° geometry instrument. For calculation of CIELAB values and colour differences, CIE 1931 (2°) standard colorimetric observer data are used together with CIE illuminant D_{50}.

5 Colour and transparency

5.1 General

For an ink to conform to this part of ISO 2846 it shall meet the specification for colour defined in 5.2 and the specification for transparency defined in 5.3.

5.2 Colorimetric values

To meet the specification for colour, an ink shall produce a colour that falls within the colour difference tolerances from the specified colorimetric values given in Table 1, when printed as defined in 4.2.1 at some percentage of press-ready ink.

NOTE 1 Unlike some other parts of ISO 2846, this part of ISO 2846 does not specify limits for concentration or ink film thickness within which to meet the specified colour difference, as such requirements are not applicable to the gravure process.

NOTE 2 Typical spectral data for inks conforming to this part of ISO 2846 are provided in annex B. Reference spectral data for 8°/diffuse (specular included) are also included in annex B.

NOTE 3 CIELAB data calculated from the CIE 1931 (2°) standard colorimetric observer, together with CIE standard illuminant D_{65}, are included in annex C for both geometries. CIELAB data for 8°/diffuse or diffuse/8° (specular included) geometry and illuminant D_{50} are also included in that annex.

1) Leneta paper or card (No. 105C) which can be purchased from Leneta Corp. Mahwah, N.J., USA. Leneta paper or card is a tradename of a product supplied by Leneta Corp. This information is given for the convenience of the 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.

Table 1 — Colorimetric values for 0/45 and 45/0 geometry, illuminant D50, 2° observer

Ink	CIELAB values			Tolerances			
	L^*	a^*	b^*	$\Delta E_{ab}{}^*$	L^*	Δa^*	Δb^*
Yellow	90,0	– 1,0	100,0	5,0	—	—	—
Magenta	51,0	78,0	8,0	6,0	—	—	—
Cyan	50,0	– 31,0	– 50,0	6,0	—	—	—
Black	14,0	– 1,0	2,0	—	$\leqslant$ 14,0[a]	$\pm$ 1,5	$\pm$ 3,0

[a] This means that for black there is no symmetrical tolerance for L^* but an upper limit.

5.3 Transparency characteristics

To meet the specification for transparency, an ink shall produce a value greater than that specified in Table 2 when determined according to the principles and test methods outlined in clause 4.

Table 2 — Transparency requirements

Ink	Transparency measurement value T
Yellow	3,0
Magenta	3,0
Cyan	12,0

For highly transparent inks, the slope of the regression line may be zero or negative. In such a situation the transparency T meets the specification.

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

Annex A
(normative)

Reference substrate

For the purpose of this part of ISO 2846, a light-fast gloss coated wood-free paper free of optical brightener shall be used, the characteristics of which shall be as follows:

Colorimetric values

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^2 to 5 g/m^2 after 10 s

Method: ISO 535

Gloss

Specification: 70 % to 80 %

Method: ISO 8254-1

Mass per area

Specification: (150 $\pm$ 3) g/m^2

Method: ISO 536

Ash content

Specification: 20 % to 30 %

Method: ISO 2144

pH

Specification: 8 to 10

Method: ISO 6588

Roughness

Specification: (1,0 $\pm$ 0,1) µm at a pressure of 1 N/mm^2

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 wood-free paper Phoenix Imperial APCO II/II from Scheufelen, D-73250 Lenningen, Germany. This information is given for the convenience of the 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)

Spectral data

For some applications, such as calculating CIELAB values for a different observer or illuminant, it is useful to have access to spectral data. As already stated, it was deliberately decided not to standardize such data since it can be very restrictive for ink manufacturing and 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 B.1 is for 0°/45° geometry and Table B.2 is for 8°/diffuse (specular included). The data in Table B.1 is in accordance with the values in Table 1. The data in Tables B.1 and B.2 have been used to compute the values in the tables of annex C.

For the purposes of this part of ISO 2846, the 0°/45° and 45°/0° geometries are deemed to be equivalent to each other as are the 8°/diffuse and diffuse/8° geometries (specular included). 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 B.1 — Typical spectral reflectance data for inks conforming to this part of ISO 2846, 0°/45° geometry

Wavelength	Reflectance factor				
nm	Cyan	Magenta	Yellow	Black	Substrate[a]
380	0,082 9	0,207 2	0,052 7	0,010 4	0,720 0
390	0,159 0	0,192 0	0,042 3	0,011 1	0,741 0
400	0,243 8	0,175 0	0,036 3	0,011 6	0,759 0
410	0,339 1	0,171 8	0,031 1	0,012 4	0,773 0
420	0,386 8	0,175 5	0,029 2	0,013 0	0,787 0
430	0,450 5	0,182 6	0,028 8	0,013 6	0,799 0
440	0,526 4	0,189 2	0,029 9	0,014 4	0,808 0
450	0,584 2	0,184 5	0,033 4	0,015 1	0,819 0
460	0,607 7	0,165 1	0,040 2	0,015 7	0,828 0
470	0,611 7	0,138 1	0,047 1	0,016 1	0,834 0
480	0,598 0	0,112 2	0,069 7	0,016 5	0,840 0
490	0,570 0	0,089 5	0,139 5	0,017 0	0,847 0
500	0,525 7	0,069 2	0,273 3	0,017 5	0,869 0
510	0,465 1	0,053 2	0,456 9	0,017 9	0,871 0
520	0,393 5	0,037 8	0,625 5	0,018 1	0,880 0
530	0,315 2	0,029 5	0,739 0	0,018 0	0,883 0
540	0,238 5	0,027 6	0,808 3	0,017 8	0,886 0
550	0,166 0	0,023 3	0,843 3	0,017 4	0,888 0
560	0,103 7	0,013 7	0,859 5	0,017 0	0,892 0
570	0,065 2	0,006 5	0,871 2	0,016 8	0,894 0
580	0,045 3	0,037 8	0,875 7	0,016 7	0,894 0
590	0,036 5	0,242 9	0,880 0	0,016 7	0,895 0
600	0,031 7	0,544 6	0,883 0	0,016 7	0,898 0
610	0,028 9	0,740 2	0,885 5	0,016 9	0,898 0
620	0,028 4	0,825 5	0,889 1	0,017 2	0,899 0
630	0,029 0	0,858 8	0,891 1	0,017 5	0,900 0
640	0,030 8	0,875 5	0,894 9	0,017 9	0,900 0
650	0,035 7	0,882 1	0,898 6	0,018 4	0,901 0
660	0,041 9	0,886 4	0,900 9	0,018 9	0,901 0
670	0,044 3	0,888 8	0,900 7	0,019 4	0,902 0
680	0,042 7	0,893 5	0,900 6	0,019 8	0,903 0
690	0,039 1	0,900 3	0,901 8	0,020 3	0,903 0
700	0,034 9	0,907 9	0,904 5	0,020 9	0,903 0
710	0,029 7	0,919 0	0,899 2	0,023 5	0,901 0
720	0,036 7	0,914 6	0,898 6	0,024 2	0,899 0

[a] Reference substrate, see annex A.

Table B.2 — Typical spectral reflectance data for inks conforming to this part of ISO 2846, 8°/diffuse (specular included) geometry

Wavelength	Reflectance factor				
nm	Cyan	Magenta	Yellow	Black	Substrate[a]
380	0,102 3	0,265 3	0,072 3	0,043 8	0,730 0
390	0,179 7	0,243 7	0,062 7	0,046 6	0,750 0
400	0,265 7	0,239 1	0,057 3	0,049 4	0,767 0
410	0,362 3	0,243 5	0,052 5	0,052 4	0,781 0
420	0,410 8	0,253 6	0,051 1	0,054 4	0,795 0
430	0,475 5	0,262 2	0,051 0	0,056 6	0,806 0
440	0,552 3	0,251 9	0,052 3	0,059 1	0,815 0
450	0,610 8	0,219 1	0,056 0	0,061 3	0,826 0
460	0,634 6	0,183 7	0,062 9	0,062 7	0,835 0
470	0,638 5	0,151 6	0,069 8	0,063 4	0,841 0
480	0,624 1	0,127 7	0,092 0	0,063 7	0,848 0
490	0,594 4	0,107 7	0,160 4	0,063 9	0,855 0
500	0,547 4	0,087 3	0,291 8	0,064 5	0,876 0
510	0,483 2	0,068 6	0,471 5	0,063 8	0,879 0
520	0,409 6	0,057 5	0,636 9	0,063 0	0,889 0
530	0,331 0	0,053 1	0,748 4	0,061 5	0,893 0
540	0,255 2	0,051 0	0,816 8	0,060 0	0,896 0
550	0,184 2	0,050 3	0,851 7	0,058 4	0,900 0
560	0,123 4	0,054 0	0,868 1	0,057 1	0,905 0
570	0,085 9	0,070 6	0,879 9	0,056 3	0,909 0
580	0,066 5	0,165 9	0,884 4	0,055 9	0,908 0
590	0,058 0	0,407 1	0,888 4	0,055 9	0,908 0
600	0,053 5	0,647 5	0,891 0	0,056 2	0,909 0
610	0,050 8	0,779 8	0,893 1	0,056 5	0,909 0
620	0,050 4	0,836 0	0,896 4	0,056 8	0,909 0
630	0,051 0	0,856 5	0,898 3	0,057 1	0,910 0
640	0,052 8	0,863 9	0,902 0	0,057 5	0,910 0
650	0,057 6	0,866 7	0,905 6	0,058 0	0,911 0
660	0,063 7	0,867 7	0,907 8	0,058 5	0,910 0
670	0,066 1	0,869 0	0,907 6	0,058 9	0,911 0
680	0,064 5	0,869 9	0,907 5	0,059 2	0,912 0
690	0,061 0	0,870 6	0,908 7	0,059 5	0,912 0
700	0,056 9	0,870 4	0,911 4	0,059 9	0,913 0
710	0,051 8	0,870 1	0,906 2	0,061 6	0,911 0
720	0,058 6	0,870 7	0,905 5	0,062 1	0,908 0

[a] Reference substrate, see annex A.

Annex C
(informative)

Colorimetric values for non-normative conditions

For the purposes of this part of ISO 2846 the 8°/diffuse and diffuse/8° geometries are deemed to be equivalent to each other.

The values in the following tables have been calculated from the spectral values listed in annex B.

If data is to be communicated, the fact that the measurement geometry used is not normative shall be explicitly included in the report.

Table C.1 — Colorimetric values for 8°/diffuse (specular included) geometry for illuminant D_{50}

Ink	CIELAB values		
	L^*	a^*	b^*
Yellow	90,46	– 0,98	93,03
Magenta	56,26	71,85	9,29
Cyan	52,28	– 27,49	– 48,54
Black	29,10	– 1,45	– 1,00
Substrate	95,93	– 0,42	4,96

Table C.2 — Colorimetric values for 8°/diffuse (specular included) geometry for illuminant D_{65}

Ink	CIELAB values		
	L^*	a^*	b^*
Yellow	89,72	– 6,66	93,68
Magenta	54,39	71,00	5,16
Cyan	53,80	– 19,28	– 45,57
Black	29,15	– 1,50	– 0,81
Substrate	95,87	– 1,01	5,01

Table C.3 — Colorimetric values for 0°/45° and 45°/0° geometry for illuminant D_{65}

Ink	CIELAB values		
	L^*	a^*	b^*
Yellow	89,25	– 6,87	101,07
Magenta	48,95	76,87	3,90
Cyan	51,63	– 21,91	– 46,80
Black	13,99	– 1,37	2,13
Substrate	95,41	– 0,99	4,76

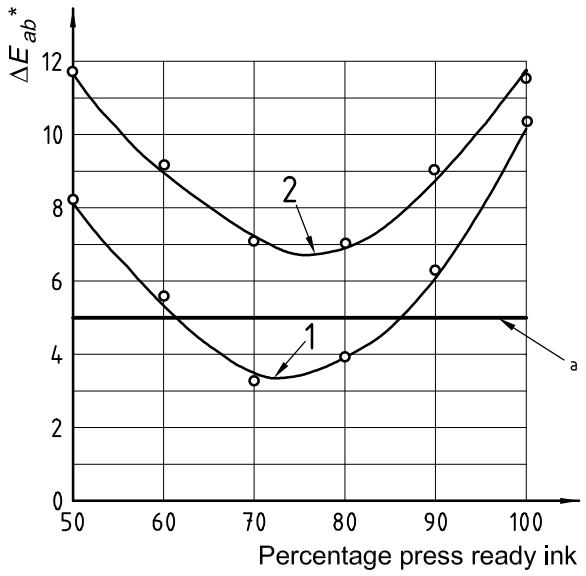
Annex D
(informative)

Detailed explanation of the test method, including examples

D.1 Colorimetric verification

In order to evaluate whether an ink meets this part of ISO 2846, it is necessary to print a number of test prints, each produced using a press-ready ink with a range of extensions. When dry the test prints are measured for colour according to ISO 13655, except the sample is backed with three sheets of unprinted reference substrate. The colour difference between each sample and the colours specified in this part of ISO 2846 are then calculated and plotted as a function of percentage of press-ready ink as shown in Figure D.1. It meets the requirements if at some percentage of press-ready ink it falls below the colour difference tolerance specified in this part of ISO 2846.

Figure D.1 shows the tolerance limit for a yellow ink and curve 1 shows an ink which conforms to this part of ISO 2846. Curve 2 shows an ink deviating from this part of ISO 2846, most probably due to incorrect hue.



a Tolerance limit

Figure D.1 — Assessment of conformance

D.2 Determination of transparency

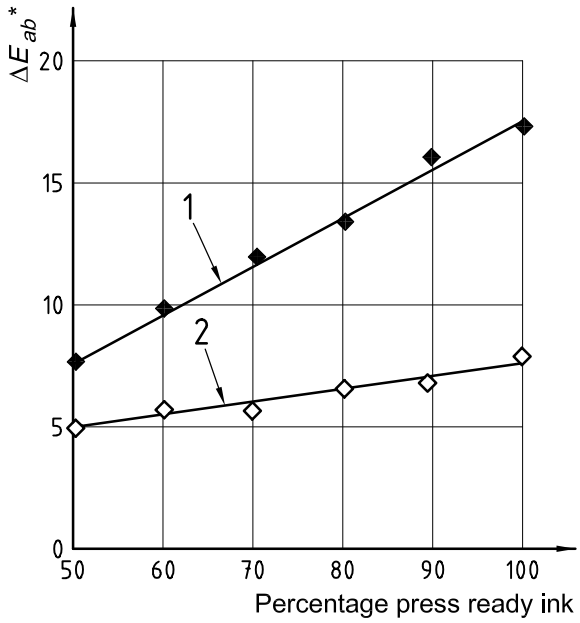
Using the procedure described in D.1 a series of prints is made covering at least the practical range of extension. For this test a black substrate is used such as Leneta card or any coated paper, of reasonable opacity, which has been pre-printed with an area of black ink that has an L^* value no greater than 6. Such material may be purchased (see footnote in 4.2.2) or produced by the user by printing the substrate with black ink, allowing sufficient time for the ink to dry.

For the determination of transparency each strip of the black substrate should be coded and the colour of the black measured on each, in a defined area, prior to overprinting with the test ink.

After the samples which have been printed with the test inks are dry the colour of each sample should be measured as described earlier, in the same place as it was measured for the black (see also clause D.3).

The colour difference between the two measurements is then calculated for each sample and these are plotted as a function of the percentage of press-ready ink as shown in Figure D.2. The slope of the linear regression line through the data points is calculated. The reciprocal of this value is then computed and this is the transparency measurement value T.

Providing the value achieved from this calculation is negative or greater than that specified in this part of ISO 2846 the ink is in conformance with this specification.



Key

1 $T = 5{,}0$

2 $T = 20{,}0$

Figure D.2 — Assessment of transparency

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

D.3.1 Selection and printing of the black ink

If transparency is measured using samples on which a black ink has been pre-printed on the reference substrate by the user care needs to be taken in the selection of the black ink used. A black must be selected which exhibits little or no bronzing and which exhibits a similar level of gloss to the same sample when overprinted by the test ink. Even the pre-printed contrast card can give rise to anomalous results if the gloss change is significant. Any measure of transparency 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°/45° or 45°/0° 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. It is with such an ink that the graph obtained as shown in Figure D.2 will have a negative or zero slope.

D.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 a sphere instrument that figures for transparency, equivalent to those obtained using a 0°/45° geometry instrument, have not been provided.

Results obtained with sphere instruments give different values of T to those obtained with a 0°/45° geometry instrument but are ranked in the same order and with similar differences between them.

For a more extensive discussion of the transparency issue, see bibliography reference [3].

Bibliography

[1] ISO 12647-1:1996, *Graphic technology — Process control for the manufacture of half-tone colour separations, proof and production prints — Part 1: Parameters and measurement methods*

[2] ISO 12647-4:—[2)], *Graphic technology — Process control for the manufacture of half-tone colour separations, proofs and production prints — Part 4: Publication gravure process*

[3] BASSEMIR, R and ZAWACKI, W. *A method for the measurement and specification of process ink transparency*. TAGA (Technical Association of the Graphic Arts) Proceedings (1994), pp 297 - 312

2) To be published.

ICS 87.080

Price based on 13 pages