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

Part 5: Flexographic printing

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

Partie 5: Impression flexographique

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Foreword

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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 2846-5 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*

Introduction

The demand for the flexographic printing process to become more consistent and predictable has required standardization of the process to ensure that the various parties involved in flexographic printing production are able to control their part of the process in a meaningful way. An essential component in this process is the specification of the colorimetric and transparency characteristics of the ink set.

The purpose of this part of ISO 2846 is to define the colorimetric and transparency characteristics of standard sets of flexographic process inks. Standard inks allow flexographic printers to obtain different sets of inks which will all produce a similar colour when printed on the same substrate (paper, board, plastic, etc.). So, by meeting the requirements of this part of ISO 2846 a standard set of inks can be supplied by any ink manufacturer to any printer, who can then supply prints to a print buyer confident that the colour of the work produced will be that required. In addition, this part of ISO 2846 will allow colour separations for flexographic printing to be produced to known colour standards.

The colorimetric characteristics specified may only be obtained when the inks are printed on the specified reference substrate. However, two inks that are similar in colorimetric characteristics and transparency, according to this part of ISO 2846, will normally ensure similarity between the results obtained when both inks are printed on another substrate.

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

Part 5: Flexographic printing

1 Scope

This part of ISO 2846 specifies the colour and transparency to be produced by each ink in a process colour ink set (including extender) intended for four-colour flexographic printing, when printed under specified flexographic printing conditions. It also describes the conformance test method.

This part of ISO 2846 does not specify pigments (or spectral reflectance), in order not to preclude developments that 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 absortiveness — Cobb method*

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

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

ISO 2846-1, *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, *Paper and board — Measurement of specular gloss — Part 1: 75 degree 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*

3 Terms and definitions

For the purposes of this document, 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
T
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]

4 Requirements

4.1 General

For an ink set to conform to this part of ISO 2846 each ink shall meet the specification for colour defined in 4.2, at some percentage of press-ready ink, as well as the specification for transparency defined in 4.3.

4.2 Colorimetric values

To meet the specification for colour, each ink in the set shall produce a colour that falls within the tolerances specified for the appropriate colorimetric values given in Table 1, when printed as defined in 5.2.1 at some percentage of press-ready ink.

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

Ink	CIELAB values		Tolerances				
	L^*	a^*	b^*	ΔE_{ab}^*	Δa^*	Δb^*	ΔL^*
Yellow	91,0	− 5,0	95,0	5,0	—	—	—
Magenta	52,0	71,0	1,0	6,0	—	—	—
Cyan	58,0	− 38,0	− 45,0	6,0	—	—	—
Black	⩽ 18,0	0,5	0,0		± 1,5	± 2,0	$^{0,0}_{-18,0}$ [a]

[a] This means that 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 A. Reference spectral data for 8°/diffuse (specular included) are also included in Annex A.

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

4.3 Transparency characteristics

To meet the specification for transparency, each ink in the set shall produce a value greater than that specified in Table 2 when determined according to the principles and test methods outlined in 5.2.

Table 2 — Transparency requirements

Ink	Transparency T
Yellow	*2*
Magenta	*5*
Cyan	*8*

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

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

5 Test methods

5.1 Principle

Colorimetric conformance is verified by printing each ink on the reference substrate described in Annex D at a range of colorations obtained by varying the extension of the press-ready ink. The colours of the resultant test prints are 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 Table 1 the ink conforms colorimetrically to this part of ISO 2846.

It is often more convenient to determine the colorimetric conformance of an ink by graphic means. This is achieved by calculating the colour difference (ΔE^*_{ab}) from the values given in Table 1, for each print made from the extension series and plotting this against the percentage by mass of press-ready ink. The ink conforms if the resultant curve shows a pronounced minimum which is below the ΔE^*_{ab} value specified in Table 1. If the ink series does not produce such a curve, another series of specimens should be prepared starting from a different ink extension. A lower extension should be applied if the colour difference decreases with an increasing percentage of press-ready ink; a higher extension if the colour difference increases with a increasing percentage of press-ready ink. See Annex C for further information.

Transparency, T, is determined by printing or applying each of the chromatic process inks on to a black substrate at a range of ink extensions. The CIELAB colour difference, ΔE^*_{ab}, is determined for each sample, between the overprinted and unprinted black substrate. These values of ΔE^*_{ab} are plotted against the percentage by mass of press-ready ink over a range of extensions. The linear regression coefficient (slope of the regression line) of this plot is determined. An ink conforms to the transparency requirements of this part of ISO 2846 if the reciprocal of the regression coefficient is greater than the value specified or negative, see Annex C 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.

5.2 Test print preparation

5.2.1 Prints for colorimetric evaluation

For each ink to be evaluated an extension series with 50 %, 60 %, 70 %, 80 %, 90 % and 100 % of press-ready ink shall be prepared using an extender diluted to press viscosity. The series of extended inks shall be applied to the reference substrate specified in Annex D by a method that produces an even ink film thickness. (Typical methods for producing the test prints are printing with a printability tester for flexographic inks, or by using a coating applicator.) The ink film thickness applied shall be close to practice and approximately the same for all prints made from the extension series.

5.2.2 Prints for transparency evaluation

Test prints for transparency evaluation shall be produced by printing the inks to be tested over a black such that a range of samples is achieved, each with a different percentage of press-ready ink. The black shall have a lightness, L^*, less than 6 when determined in accordance with ISO 13655 and the CIELAB values of the unprinted black shall be measured prior to overprinting.

NOTE Although in principle it is possible for the user to produce the black 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. One appropriate substrate is the contrast card[1)].

5.2.3 Drying of test prints

Prior to colour measurement all samples shall be thoroughly dried.

5.2.4 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 Conformance to ISO 13655 means that the samples are measured spectrally with a 0°/45° or 45°/0° geometry instrument. The CIE 1931 (2°) standard colorimetric observer data are used, together with that for CIE illuminant D_{50}, for calculation of CIELAB values and colour differences. Where spectral data are obtained at wavelength intervals greater than 5 nm, the weighting functions for the standard colorimetric observer specified in ISO 13655 are used.

1) Leneta paper or card. (No 105 C) which may be purchased from Leneta Corp., Mahwah, NJ, USA. Leneta is the trade name of a product supplied by Leneta Corporation. 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 A
(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 stated in the introduction 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 those which were obtained during development of this part of ISO 2846.

Two tables of data are presented: Table A.1 is for 0°/45° geometry and Table A.2 is for 8°/diffuse (specular included). The data in Table A.1 are in accordance with the values in Table 1. The data of Tables A.1 and A.2 have been used to compute the values in the tables of Annex B.

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 A.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	0,0907	0,3199	0,0660	0,0228	0,7200
390	0,1413	0,2980	0,0627	0,0223	0,7410
400	0,2626	0,2667	0,0611	0,0226	0,7590
410	0,3651	0,2548	0,0608	0,0231	0,7730
420	0,4054	0,2472	0,0606	0,0233	0,7870
430	0,4777	0,2493	0,0609	0,0239	0,7990
440	0,5864	0,2464	0,0622	0,0246	0,8080
450	0,6813	0,2242	0,0632	0,0253	0,8190
460	0,7162	0,1936	0,0639	0,0256	0,8280
470	0,7339	0,1656	0,0653	0,0258	0,8340
480	0,7313	0,1382	0,0696	0,0259	0,8400
490	0,7107	0,1169	0,0860	0,0260	0,8470
500	0,6727	0,1032	0,1839	0,0260	0,8690
510	0,6130	0,0818	0,4866	0,0258	0,8710
520	0,5269	0,0642	0,7571	0,0255	0,8800
530	0,4260	0,0579	0,8502	0,0250	0,8830
540	0,3278	0,0572	0,8721	0,0247	0,8860
550	0,2381	0,0571	0,8720	0,0245	0,8880
560	0,1682	0,0561	0,8706	0,0245	0,8920
570	0,1290	0,0577	0,8700	0,0246	0,8940
580	0,1109	0,0672	0,8714	0,0248	0,8940
590	0,0958	0,1582	0,8724	0,0251	0,8950
600	0,0715	0,4158	0,8714	0,0254	0,8980
610	0,0500	0,6719	0,8716	0,0257	0,8980
620	0,0391	0,8083	0,8733	0,0261	0,8990
630	0,0344	0,8688	0,8737	0,0264	0,9000
640	0,0323	0,8951	0,8764	0,0268	0,9000
650	0,0317	0,9061	0,8814	0,0274	0,9010
660	0,0321	0,9107	0,8833	0,0278	0,9010
670	0,0330	0,9115	0,8805	0,0282	0,9020
680	0,0329	0,9125	0,8783	0,0286	0,9030
690	0,0322	0,9138	0,8787	0,0290	0,9030
700	0,0314	0,9146	0,8795	0,0295	0,9030
710	0,0310	0,9154	0,8805	0,0300	0,9010
720	0,0317	0,9159	0,8818	0,0305	0,8990

[a] Reference substrate, see Annex D.

Table A.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	0,1419	0,2793	0,0900	0,0368	0,7300
390	0,1867	0,2721	0,0881	0,0379	0,7500
400	0,2633	0,2626	0,0878	0,0395	0,7670
410	0,3419	0,2581	0,0885	0,0410	0,7810
420	0,3847	0,2551	0,0891	0,0420	0,7950
430	0,4381	0,2600	0,0905	0,0432	0,8060
440	0,5194	0,2597	0,0926	0,0448	0,8150
450	0,5809	0,2429	0,0946	0,0461	0,8260
460	0,6017	0,2178	0,0956	0,0467	0,8350
470	0,6087	0,1947	0,0974	0,0471	0,8410
480	0,6029	0,1700	0,1025	0,0475	0,8480
490	0,5878	0,1518	0,1204	0,0481	0,8550
500	0,5702	0,1372	0,2176	0,0513	0,8760
510	0,5486	0,1130	0,4719	0,0591	0,8790
520	0,5015	0,0944	0,6866	0,0654	0,8890
530	0,4293	0,0876	0,7646	0,0669	0,8930
540	0,3529	0,0864	0,7825	0,0666	0,8960
550	0,2825	0,0849	0,7839	0,0658	0,9000
560	0,2274	0,0840	0,7817	0,0652	0,9050
570	0,1973	0,0876	0,7811	0,0651	0,9090
580	0,1834	0,1041	0,7821	0,0653	0,9080
590	0,1755	0,1987	0,7837	0,0656	0,9080
600	0,1673	0,4202	0,7854	0,0660	0,9090
610	0,1613	0,6298	0,7876	0,0666	0,9090
620	0,1591	0,7385	0,7900	0,0671	0,9090
630	0,1587	0,7867	0,7923	0,0677	0,9100
640	0,1593	0,8070	0,7942	0,0683	0,9100
650	0,1609	0,8154	0,7963	0,0688	0,9110
660	0,1629	0,8192	0,7979	0,0694	0,9100
670	0,1638	0,8213	0,7986	0,0699	0,9110
680	0,1634	0,8230	0,7995	0,0704	0,9120
690	0,1621	0,8241	0,8002	0,0709	0,9120
700	0,1612	0,8247	0,8010	0,0714	0,9130
710	0,1623	0,8254	0,8013	0,0720	0,9110
720	0,1656	0,8259	0,8015	0,0724	0,9080

[a] Reference substrate, see Annex D.

Annex B
(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 Tables B.1 to B.3 have been calculated from the spectral values listed in Annex A.

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

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

Ink	CIELAB values		
	L^*	a^*	b^*
Yellow	87,56	− 4,60	80,43
Magenta	53,67	61,50	− 0,21
Cyan	61,57	− 22,76	− 30,22
Black	30,49	− 0,87	8,20
Substrate	95,93	− 0,42	4,50

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

Ink	CIELAB values		
	L^*	a^*	b^*
Yellow	86,96	− 9,80	80,60
Magenta	52,23	60,13	− 3,29
Cyan	62,56	− 18,82	− 28,04
Black	30,41	− 1,74	8,20
Substrate	95,87	− 1,01	5,01

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

Ink	CIELAB values		
	L^*	a^*	b^*
Yellow	90,33	− 10,66	95,47
Magenta	50,26	69,82	− 2,78
Cyan	59,59	− 29,96	− 41,64
Black	18,00	0,36	0,06
Substrate	95,41	− 0,99	4,76

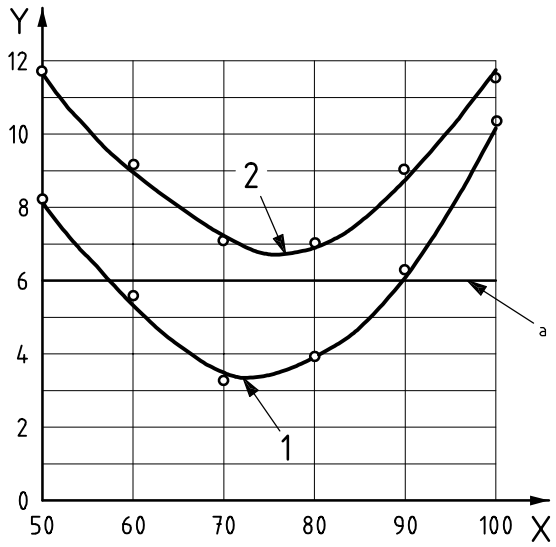
Annex C
(informative)

Detailed explanation of the test method, including examples

C.1 Colorimetric verification

In order to evaluate whether an ink meets the requirements of 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 in accordance with ISO 13655, except that the sample is backed with 3 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 C.1. The ink meets the requirements of this part of ISO 2846 if, at some percentage of press-ready ink, the curve falls below the colour difference tolerance specified in this part of ISO 2846.

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



Key

X percentage of press-ready ink

Y colour difference

[a] Tolerance limit.

Figure C.1 — Assessment of conformance

C.2 Determination of transparency

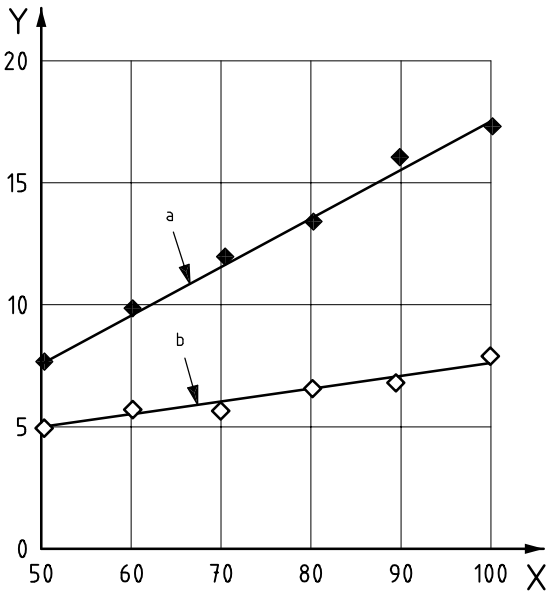
Using the procedure described in C.1 a series of prints is made covering at least the practical range of extension. For this test a black substrate is used such as Leneta card or any coated paper, of reasonable opacity, which has been pre-printed with an area of black ink that has an L^* value no greater than 6. Such material may be purchased (see footnote in 5.2.2) 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 that 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 C.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 C.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 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

X percentage of press-ready ink

Y colour difference

a T = 5,0.

b T = 20,0.

Figure C.2 — Assessment of transparency

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

C.3.1 Selection and printing of the black ink

If transparency is measured using samples on which a black ink has been preprinted on the reference substrate by the user, care should 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 should 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 C.2 will have a negative or zero slope.

C.3.2 Use of integrating 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 that figures for transparency, equivalent to those obtained using a 0°/45° geometry instrument, have not been provided.

Results obtained with integrating 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.

Annex D
(normative)

Reference substrate

For the purposes of this part of ISO 2846, a light-fast gloss-coated woodfree paper, free of optical brightener, shall be used. The characteristics of this paper shall be as follows:

Colorimetric values

CIELAB values:	L^* = 95,5 ± 2,0
	a^* = – 0,4 ± 1,0
	b^* = 4,7 ± 1,5
Method:	See ISO 13655

Water absorptiveness

Specification:	2 g/m^2 to 5 g/m^2 after 10 s
Method:	See ISO 535

Gloss

Specification:	70 % to 80 %
Method:	See ISO 8254-1

Mass per area

Specification:	(150 ± 3) g/m^2
Method:	See ISO 536

Ash content

Specification:	20 % to 30 %
Method:	See ISO 2144

pH

Specification:	8 to 10
Method:	See ISO 6588

Roughness

Specification:	(1,0 ± 0,1) µm at a pressure of 1 N/mm^2
Method:	See 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[2)].

2) Phoenix Imperial APCOII/II, which may be purchased from Scheufelen. Phoenix Imperial is the trade name of a product supplied by Scheufelen, D-73250 Lenningen, Germany. 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.

Bibliography

[1] ISO 12647-1:2004, *Graphic technology — Process control for the production of half-tone colour separations, proof and production prints — Part 1: Parameters and measurement methods*

[2] ISO 12647-4:—[3], *Graphic technology — Process control for the manufacture of half-tone colour separations, proofs and production prints — Part 4: Publication gravure processes*

[3] Second Edition, *Flexographic Image Reproduction Specifications and Tolerances*, Second Edition 11/2000, Flexographic Technical Association, 900 Marconi Ave., Ronkonkoma, NY, 11779, USA

[4] 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 to 312

3) To be published.

ICS 87.080

Price based on 13 pages