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Textiles — Tests for colour fastness —

Part J05: Method for the instrumental assessment of the colour inconstancy of a specimen with change in illuminant (CMCCON02)

Textiles — Essais de solidité des teintures —

Partie J05: Méthode d'évaluation instrumentale de la variation de nuance d'un échantillon en fonction de l'illuminant (CMCCON02)

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Foreword

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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 105-J05 was prepared by Technical Committee ISO/TC 38, *Textiles*, Subcommittee SC 1, *Tests for coloured textiles and colorants*.

ISO 105 was previously published in 13 “parts” under the general title *Textiles — Tests for colour fastness*, each designated by a letter (e.g. “Part A”), with publication dates between 1978 and 1985. Each part contained a series of “sections”, each designated by the respective part letter and by a two-digit serial number (e.g. “Section A01”). A complete list of these parts is given in ISO 105-A01.

Textiles — Tests for colour fastness —

Part J05:
Method for the instrumental assessment of the colour inconstancy of a specimen with change in illuminant (CMCCON02)

1 Scope

This part of ISO 105 provides a colorimetric method for calculating an estimate of the magnitude (and optionally the direction) of the change in the perceived colour of a textile specimen when the chromaticity of the illumination by which it is viewed is changed. It therefore provides an estimate of the colour inconstancy of the specimen.

NOTE 1 Colour inconstancy and metamerism are related but distinct. With respect to a change in the quality of illumination,

a) colour inconstancy is the extent of change in the colour appearance of a single specimen,

b) metamerism is the extent of change in the colour difference between two specimens.

This part of ISO 105 therefore provides a method for assessing (a) but not (b).

NOTE 2 Comparison of the results of this method and those from visual assessments is valid only when the visual assessments are made

a) in lighting of the same spectral power distributions as used in the colorimetric calculations,

b) with the specimens illuminated at 1 000 lux to 4 000 lux,

c) by an assessor who is fully adapted to the relevant viewing conditions.

2 Principle

The tristimulus values (X_r, Y_r, Z_r and X, Y, Z respectively) of the specimen are measured or computed using CIE Standard Illuminant D65 as reference illuminant and an agreed test illuminant. All calculations are based upon the CIE 1964 Standard Colorimetric Observer. A chromatic adaptation transform (CAT02 simplified appropriately for the current application) is then applied to the tristimulus values in the test illuminant to determine the tristimulus values of the corresponding colour of the specimen in illuminant D65 (X_c, Y_c, Z_c). Finally, using the colour-difference formula specified in ISO 105-J03, the colour difference between the tristimulus values of the corresponding colour in illuminant D65 (X_c, Y_c, Z_c) and the measured or computed values in illuminant D65 (X_r, Y_r, Z_r) is calculated. This colour difference is the required Colour-Inconstancy Index, CMCCON02.

NOTE 1 For further information on CMCCON02 and CAT02, see Reference [1] in the Bibliography.

NOTE 2 The corresponding colour is the colour that would have the same appearance in illuminant D65 as it has in the test illuminant.

3 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 105-J01, *Textiles — Tests for colour fastness — Part J01: General principles for measurement of surface colour*

ISO 105-J03, *Textiles — Tests for colour fastness — Part J03: Calculation of colour differences*

4 Procedure

All tristimulus values in this part of ISO 105 shall be obtained using the CIE 1964 Standard Colorimetric Observer (10°).

4.1 Measure or calculate, as appropriate to the instrumentation and software available and in accordance with ISO 105-J01, the tristimulus values (X_r, Y_r, Z_r and X, Y, Z respectively) of the specimen in illuminant D65 and in the agreed test illuminant.

4.2 Calculate the RGB cone responses to the specimen (R, G, B) and the perfect reflecting diffuser (p.r.d.) (R_w, G_w, B_w), each under the test illuminant, and to the p.r.d. (R_{wr}, G_{wr}, B_{wr}) under illuminant D65:

$$\left.\begin{aligned} \begin{pmatrix} R \\ G \\ B \end{pmatrix} &= \boldsymbol{M}_{\text{CAT02}} \begin{pmatrix} X \\ Y \\ Z \end{pmatrix} \\ \begin{pmatrix} R_w \\ G_w \\ B_w \end{pmatrix} &= \boldsymbol{M}_{\text{CAT02}} \begin{pmatrix} X_w \\ 100 \\ Z_w \end{pmatrix} \\ \begin{pmatrix} R_{wr} \\ G_{wr} \\ B_{wr} \end{pmatrix} &= \boldsymbol{M}_{\text{CAT02}} \begin{pmatrix} X_{wr} \\ 100 \\ Z_{wr} \end{pmatrix} \end{aligned}\right\} \text{ where } \boldsymbol{M}_{\text{CAT02}} = \begin{pmatrix} 0{,}732\,8 & 0{,}429\,6 & -0{,}162\,4 \\ -0{,}703\,6 & 1{,}697\,5 & 0{,}006\,1 \\ 0{,}003\,0 & 0{,}013\,6 & 0{,}983\,4 \end{pmatrix}$$

and X_{wr}, Z_{wr} are the tristimulus values of the p.r.d. in illuminant D65 and X_w, Z_w those of the p.r.d. in the test illuminant. The tristimulus values are normalized such that Y_w and Y_{wr} have values of 100.

NOTE 1 Matrix $\boldsymbol{M}_{\text{CAT02}}$ is that defined in CAT02 [2].

NOTE 2 The R_w, G_w, and B_w are all positive for the common illuminants such as A, C, D55, D65, D75, F1 to F12.

4.3 Calculate the corresponding RGB cone responses:

$$R_c = R(R_{wr}/R_w)$$

$$G_c = G(G_{wr}/G_w)$$

$$B_c = B(B_{wr}/B_w)$$

4.4 Calculate the tristimulus values of the corresponding colour in illuminant D65:

$$\begin{pmatrix} X_c \\ Y_c \\ Z_c \end{pmatrix} = \boldsymbol{M}_{\text{CAT02}}^{-1} \begin{pmatrix} R_c \\ G_c \\ B_c \end{pmatrix} \text{ where } \boldsymbol{M}_{\text{CAT02}}^{-1} = \begin{pmatrix} 1{,}096\,124 & -0{,}278\,869 & 0{,}182\,745 \\ 0{,}454\,369 & 0{,}473\,533 & 0{,}072\,098 \\ -0{,}009\,628 & -0{,}005\,698 & 1{,}015\,326 \end{pmatrix}$$

This calculation shall be performed using the six decimal places shown in the reverse matrix $\boldsymbol{M}_{\mathrm{CAT02}}^{-1}$. If necessary, double precision arithmetic shall be used.

4.5 Calculate the colour difference between the colours represented by the tristimulus values of the corresponding colour in illuminant D65 (X_c, Y_c, Z_c) as batch and those measured or computed for the specimen in illuminant D65 (X_r, Y_r, Z_r) as standard according to ISO 105-J03.

5 Interpretation of results

5.1 The colour difference calculated in 4.5 is the required CMCCON02, which is a measure of the magnitude of the colour inconstancy of the specimen between the test illuminant and illuminant D65. If CMCCON02 is sensibly zero, the specimen is colour constant between these two illuminants. (This does not imply that it is necessarily colour constant between any other pair of illuminants.) The larger the value of CMCCON02, the more colour-inconstant is the specimen.

5.2 If desired, cylindrical component differences (ΔL^*, ΔC^* and ΔH^*) may be reported in order to indicate the nature and direction of the CMCCON02.

6 Test report

The test report shall include the following:

a) the number and year of publication of this part of ISO 105;

b) all details necessary for complete identification of the specimen;

c) identification of the colorimeter or spectrophotometer, including the CIE geometry type, with which the input data were obtained;

d) the date of the test;

e) identification of the test illuminant, e.g. illuminant A;

f) the origin of the illuminant D65 and test illuminant weighting functions, e.g. ASTM E308-01 [3];

g) the colour-difference formula used to calculate the value of CMCCON02, e.g. CMC(1:1);

h) the value of CMCCON02, e.g. CMCCON02 = 3,1;

i) if desired, the components ΔL^*, ΔC^*, and ΔH^* of CMCCON02.

Annex A
(informative)

Test data and worked examples

To help check computer programs giving CMCCON02, some representative test data and example calculations based thereon are given in Tables A.1 and A.2. Two green specimens, designated P and Q, are considered. Their reflectance values are given in Table A.1.

Table A.1 — Reflectance values for specimens P and Q

	P	Q
400	17,38	14,63
420	18,58	16,90
440	22,67	20,68
460	25,53	26,47
480	26,63	33,03
500	26,57	33,25
520	26,02	28,69
540	25,84	24,11
560	25,68	20,97
580	23,57	19,09
600	19,77	18,42
620	15,48	21,40
640	11,71	23,57
660	17,13	30,36
680	35,61	45,92
700	58,92	63,26

All the following calculations have been made using the tables of weighting functions given in ASTM E308-01 [3] for illuminants D65/10 and A/10 at 20 nm intervals with bandpass-correction.

Table A.2 — Calculation of the corresponding colours using CAT02 and the colour inconstancy using CMCCON02

	Perfect reflecting diffuser (p.r.d.)			Specimen P			Specimen Q		
Step 4.1									
X_{wr}, Y_{wr}, Z_{wr} p.r.d. illuminant D65/10	94,81	100,00	107,31						
X_w, Y_w, Z_w p.r.d. illuminant A/10	111,15	100,00	35,20						
X_r, Y_r, Z_r D65/10				20,29	23,91	25,47	20,51	24,09	26,14
X, Y, Z A/10				22,48	22,74	8,54	24,09	22,91	8,99
Step 4.2									
R, G, B from X, Y, Z A/10				24,86	22,84	8,77	26,03	21,99	9,22
R_w, G_w, B_w from X_w, Y_w, Z_w D65/10	118,69	91,76	36,31						
R_{wr}, G_{wr}, B_{wr} from X_{wr}, Y_{wr}, Z_{wr} D65/10	95,01	103,70	107,17						
Step 4.3									
R_c, G_c, B_c				19,90	25,81	25,89	20,84	24,85	27,22
Step 4.4									
X_c, Y_c, Z_c corresponding colour A to D65				19,35	23,13	25,95	20,88	23,20	27,30
Step 4.5									
Standard = X_r, Y_r, Z_r				20,29	23,91	25,47	20,51	24,09	26,14
Batch = X_c, Y_c, Z_c				19,35	23,13	25,95	20,88	23,20	27,30
CMCCON02 DE_{CIELAB}					2,61			6,72	
CMCCON02 $DE_{CMC(1:1)}$					2,48			6,27	

The results clearly indicate that specimen P is much more constant than specimen Q.