ISO BRIGHTNESS—A MORE COMPLETE DEFINITION

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THE NEW VERSION OF ISO 2470 DEFINES THE CONDITIONS FOR MEASURING ISO BRIGHTNESS OF FLUORESCENT MATERIALS

THE CONCEPT OF ISO BRIGHTNESS WAS DEVELOPED several decades ago, primarily as a way of monitoring the bleaching process. At the same time, papermakers became interested in measuring the brightness not only of the pulp that they purchased but also of the paper and board that they produced, and the measurement method soon became the subject of a number of national and international standards.

Standardization means that the property being measured is defined. ISO brightness was defined in terms of:

- a distribution function with an effective wavelength of 457 nm
- a specific type of instrument defined in ISO 2469
- a specific calibration routine also described in ISO 2469.

It was realized, however, that using the Zeiss Elrepho instrument—the only instrument then conforming to ISO 2469—there might be problems if fluorescent whitening agents (FWA) were present. A cautionary note was therefore added to the standard text. ISO 2470:1977 that described the measurement of diffuse blue reflectance factor (ISO brightness) for paper and board included the following statement:

> "Paper or board that has been treated with a fluorescent dyestuff or exhibits significant fluorescence may be measured, but the agreement between values obtained with different instruments may be unsatisfactory ...."
> and it included an additional note stating that
> ".... measurements can be made satisfactorily on samples exhibiting fluorescence if the spectral power distribution of the irradiation in the long-wave region is standardized."

It was thus clearly stated that the definition of brightness was incomplete and that fluorescence may influence the measurement of ISO brightness. Note that the method referred not to a need to eliminate the fluorescence but to a need for standardization of the power distribution of the radiation that gives rise to this fluorescence. In the latest revision of ISO 2470, an important step has been taken in this direction.

BRIGHTNESS OR WHITENESS?

In the late 1980s, attention turned to the question of whiteness. It was emphasized that the perception of whiteness is intimately related to the perception of color. In standardization circles, it was thought that interest in the measurement of ISO brightness as a paper property would decline, giving way to the measurement of CIE-whiteness. This doesn't seems to be the case.

It can be argued that the ISO brightness function is not related to perceptual colorimetry and that it is therefore an unsatisfactory choice if it is desired to measure a property related to the appearance of the material. Nevertheless, interest in measuring ISO brightness as a paper property is apparently as strong as ever. This has led the ISO/TC 6/WG 3 working group to devote its energies to creating a rigorous definition of ISO brightness along the lines envisaged in the 1977 version of the ISO standard.

CONFUSION DUE TO NEW PRODUCTS

When the Datacolor Elrepho 2000 instrument appeared on the market in the mid-1980s, it included an adjustable filter (*1*) to permit the adjustment of the relative UV-content of the radiation falling upon the test piece, but it has taken many years to decide how this should be done. At the same time, the use of FWA has increased enormously and this has led to confusion. During recent years, an extreme divergence of practice has unfortunately developed, and at least four user groups can be discerned:

- Those who measure brightness with the UV-filter in the Elrepho 2000 set at zero or thereabouts in order to achieve a UV-content as similar as possible to that in the now obsolescent Zeiss Elrepho or in the Technidyne Micro-TB 1C. This has always been the official recommendation.
- Those who measure brightness with the UV-content adjusted to the CIE-illuminant D65, although attempts have been made to emphasize that this property is not ISO brightness and that it should be called D65 brightness.
- Those who have felt that the problem can best be solved by completely eliminating the fluorescence with a 420nm cut-off filter. The objection to this procedure is that it gives a value that represents the brightness of the non-fluorescent substrate, i.e the brightness if no FWA were present, and this is not really of interest. The FWA does affect the appearance of paper and there is no point in eliminating its effect.
- Those who like to have as high a brightness value as possible and use the maximum UV-content available in the instrument. This is an undefined level dependent on the condition of the lamp in the instrument and it is normally in excess even of that given by the CIE-illuminant D65.

PROPOSAL FOR AN ILLUMINANT

To avoid the confusion and considering all the relevant factors, Bristow and Karipidis (*2*) recently put forward a proposal that ISO brightness should be rigorously related to the CIE-illuminant C.

An important consideration in arriving at this proposal was the need to establish a means of adjusting the UV-content in the instrument using reference standards having assigned values traceable to fundamental radiometric and colorimetric reference levels, and that is close to the original Zeiss Elrepho situation. At the same time, it was noted that Jordan and O'Neill had made an important contribution by showing that the indoor assessment of whiteness correlated best with measurements made with instruments having an unfiltered quartz-halogen lamp illumination similar to that in the Zeiss Elrepho instrument (*3*). This meant that it was possible, through the CIE-illuminant C, to link ISO brightness and and a whiteness value relevant to indoor lighting conditions.

A REVISED MEASUREMENT STANDARD

ISO/TC6/WG3 has accepted this proposal, and it has been incorporated into a revised version of the ISO Standard for the determination of ISO brightness. This revised version has received international approval at the final draft international standard (ISO/FDIS) level and will shortly be published as the new Standard ISO 2470:1999.

The new standard declares that ISO brightness shall be defined in relation to the CIE illuminant C, and it prescribes a procedure for adjusting the UV-content of the illumination in modern abridged spectrophotometers using reference standards provided by one of the ISO/TC6 authorized laboratories.

The Foreword to ISO 2470:1999 states that:

> "This edition of the Standard differs from the 1977 version in that it describes the use of abridged spectrophotometers and also prescribes a routine for adjusting the relative UV-content of the illumination in this type of instrument to a defined level when materials containing fluorescent whitening agents are to be measured."

And the Introduction points out that:

> "The definition of ISO brightness is historically linked to the Zeiss Elrepho instrument having as light source an incandescent lamp that excites fluorescence to only a limited extent. It is here specified that, in instruments of the abridged spectrophotometer type, the UV-content of the illumination be adjusted using a suitable filter to conform to the CIE-illuminant C as defined by a fluorescent reference standard having an assigned ISO brightness value (as prescribed in detail in Annex B of the document). Only if this is done may the property measured on fluorescent materials be called ISO brightness."

This means that the procedure adopted by the first user-group mentioned above is closest to what has now been internationally approved as the procedure corresponding to the definition of ISO brightness. When the UV-content of the illumination in the Datacolor Elrepho 2000 is adjusted using a fluorescent reference standard, the filter position is usually about 30, but the movement of the filter is non-linear and the UV-content with a setting of 30 does not differ greatly from that at a setting of zero.

Annex B of ISO 2470:1999 describes the routine by which the authorized laboratories shall adjust their reference instruments using the ISO brightness value assigned to a suitable fluorescent transfer standard, calculated from absolute radiance factor data corresponding to the CIE-illuminant C and supplied by a competent standardizing laboratory. The authorized laboratories then prepare reference standards—reference standards of level 3—for distribution to industrial laboratories. The authorized laboratories have recently engaged in comparative tests to ensure international agreement for this type of reference standard.

Work within ISO/TC/WG3 has taken place in close cooperation with the makers of modern instruments, who are making the necessary adjustments to ensure that the UV-adjustment filter can automatically be set to the correct position in relation to a reference standard with an assigned ISO brightness value. Small differences may still be discernible between different instruments, but the ISO/TC 6/WG 3 working group considers that this is an important advance towards achieving much greater international agreement than has been apparent in the last few years for this important property.

The latest edition of ISO 2470 is a method for paper and board, as well as pulp. However, the adjustment with a fluorescent reference standard is necessary only when FWA is present in the material. Those laboratories measuring pulps or papers free from FWA require no such fluorescent standards, because the ISO brightness value is then not affected by the UV-content of the illumination and is independent of the position of the UV-adjustment filter. All other laboratories must make the necessary filter adjustment if they claim to be measuring ISO brightness.

The five laboratories currently authorized by ISO/TC6 to supply of reference standards of level 3 to industrial laboratories are CTP in Grenoble, France; KCL in Espoo, Finland; PAPRICAN in Pointe Claire, QC, Canada; STFI in Stockholm, Sweden; and TOL in New Albany, IN, USA.

CIE-WHITENESS

When work on developing routines for measuring whiteness began in the late 1980s, the major interest was in measurement in the CIE-illuminant D65 environment, although this represents a level of UV-radiation that is in excess of that normally present in situations where paper is bought, sold and used. This work has advanced to the stage where ISO 11475:1999 for the determination of CIE whiteness (D65/10°) has now been published. An important feature of this International Standard is that it specifies a method for adjusting the UV-content of the illumination on the test piece to match the CIE standard illuminant D65 using a reference standard with an assigned CIE-whiteness (D65/10°) value.

More recently, attention has been given to the development of a method for measuring what has come to be known as "indoor whiteness". This has now also reached the final stage of balloting as ISO/FDIS 11476.

At first, it was assumed that by analogy with the method for CIE-whiteness (D65/10°), adjustment of the instrument for measurement of CIE-whiteness (C/2°) would be achieved with a reference standard having the appropriate assigned whiteness value, but the ISO/TC 6/WG 3 working group has now rejected this idea. It is felt that a laboratory can in practice adopt only one method of adjusting to the CIE-illuminant C, and it has been decided that, even when measuring CIE whiteness (C/2°), the adjustment to the CIE illuminant C shall be carried out on the basis of a fluorescent reference standard having an assigned ISO brightness value. This decision acknowledges the fact that laboratories require greater precision in the measurement of ISO brightness than in the measurement of CIE whiteness.

CONCLUSIONS AND RECOMMENDATIONS

A greater agreement in the ISO brightness values reported by different mills will not be achieved merely because ISO 2470:1999 is published. Although it represents an important milestone, the publication of a new Standard achieves nothing unless mills and laboratories adapt their routines to the new requirements.

It is clear that a laboratory cannot claim that it is measuring ISO brightness unless it uses an instrument with the correct geometry calibrated in the correct way. In addition, if fluorescent materials are being measured, the UV-content of the illumination falling upon the sample must now be adjusted to conform to the CIE-illuminant C. It is further prescribed that this adjustment shall be made with a fluorescent reference standard having an ISO brightness value assigned by one of the ISO/TC6 Authorized Laboratories.

The members of ISO/TC 6/WG 3 who have worked to develop the new revised version of ISO 2470 hope that their efforts will be greeted with enthusiasm and that laboratories will hasten to ensure that their measurements conform to the new requirements.

There are, however, still problems. When all measurements are made in instruments calibrated and adjusted in conformity with the new standard, there will still be slight differences between different instruments, and it cannot be expected that the inter-instrument agreement on fluorescent materials will be as good as the agreement on non-fluorescent materials. A significant step will nevertheless have been taken towards a more uniform consensus and perhaps the next revision of ISO 2470 will show how the residual variations can be reduced.

Laboratories wishing to continue along their traditional path and to continue to measure a brightness value under other conditions are of course free to do so, but they must clearly indicate that the brightness that they measure is not ISO brightness. TJ

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