RISE

Optical Calibration Laboratory,
Fluorescent Reference Standard

CIE Illuminant D65 - Instructions for use

Scope

The following description refers to the calibration and UV adjustment required by the international standard ISO 11475 Paper and board – Determination of CIE whiteness, D65/10° (outdoor daylight).

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Principle

The appearance of an illuminated object is dependent upon the illumination and viewing conditions. For paper and board product containing fluorescent whitening agents (FWAs), its total radiance factor is the sum of the reflected radiance factor and the luminescent radiance factor (ISO 11475). Since the luminescent radiance factor originates from fluorescence of the FWAs, its magnitude depends on the amount of UV radiation of the illumination. It is therefore essential to calibrate not only the radiance (reflectance) factor scale but also the UV content of the illumination used in the measurement apparatus.

The adjustment for the UV content is achieved by adjusting the position of the adjustable UV filter in the apparatus so that the light incident upon the sample has an effective UV content corresponding to that in the CIE illuminant D65. The UV filter adjustment is based on the CIE whiteness (D65/10°) value W (ISO 11475). It means to match the measured whiteness value of the reference standard (type F or FB) with the assigned value provided by RISE Innventia.

The Optical Calibration Laboratory (OCL) at RISE Innventia provides both fluorescent and non-fluorescent reflectance standards. Depending on the illumination condition, one of the following reference standards is needed.

- Type B fluorescent reference standard is used for adjusting the UV content to the CIE illuminant C.

- Type F fluorescent reference standard is used for adjusting the UV content to the CIE illuminant D65.

- Type FB fluorescent reference standard is used for adjusting the UV content to both the CIE illuminants D65 and C.

For apparatus having no movable UV filter, a mathematical UV adjustment method (equivalent to a mathematical UV filter) is employed. The instructions for use are exactly the same, provided that the same type of fluorescent reference standard is used.

Instructions for use

The fluorescent reference standard type F (or FB) supplied by OCL is to be used – after prior calibration of the instrument with a non-fluorescent standard.

The following instructions relate specifically to filter instrument. The routine is in principle the same for other instruments. Nevertheless, follow the manufacturer's instructions, to be on the safe side.

1. Make sure that the UV cut-off filter is OUT. The current position of the UV filter is unimportant – leave the filter as it is.

2. Calibrate the instrument in the normal way with a non-fluorescent reference standard.

3. Place the fluorescent standard in the measurement position and measure the CIE whiteness value.

4. Compare the measured value with the assigned CIE whiteness value on the label. Too high a measured whiteness value indicates that the UV content in the illumination is too high, and too low a measured whiteness value indicates that the UV content is too low.

5. Adjust the position of the UV filter and make a new measurement.

6. Repeat steps 4 and 5 until measurement gives the correct CIE whiteness value. It should normally be possible to achieve a setting, where the measured value differs from the assigned one by not more than 0.2 units.

7. Check the calibration of the instrument by measuring the white non-fluorescent standard again. Adjustment of the UV filter's position may disturb the calibration of the instrument. It is necessary to make a new calibration whenever the position of the UV filter has been adjusted. Steps 2–6 must then be repeated.

   Note: The full procedure involving steps 2–6 may have to be repeated multiple times before the position of the UV filter is found in which the instrument has the correct UV content in the illumination and is also properly calibrated.

8. It may be an advantage to have a stable fluorescent tile of plastic or similar material for use as a working standard to check the setting from time to time. Measure the CIE whiteness of a working standard and record the value obtained. The working standard should only be used to check for a drift from a setting already established with a paper reference standard.

After a lamp change

Sometimes, the UV content of the illumination is too low to match the assigned CIE whiteness value. There are normally two options. The first is to change the lamps. If the problem remains, one should then consider replacing the GG395-filter with e.g. a UG3-filter. The relative UV content of the illumination reaching the sample may be increased, as the UG3-filter does not reduce the UV radiation as much as the GG395-filter.

A new adjustment of the position of the UV filter must be made whenever the lamps or the filter in the instrument are changed. This applies even after changing the size of the measurement aperture. A paper reference standard rather than a plastic working standard has to be used since the plastic substrate is not as sensitive to the UV radiation over the same wavelength range as the paper reference standard.

If several instruments are available, each instrument should be adjusted using a fluorescent paper reference standard. The plastic tile should not be used for transfer between instruments.

Calculation of CIE whiteness, D65/10°

This section explains how the CIE whiteness and CIE tint are calculated and is NOT required for the calibration purpose. These values can serve as an extra check on the validity of the adjustment.

The CIE whiteness (D65/10°) value W is defined as

$$W_{10} = Y_{10} + 800(0.31381 - x_{10}) + 1700(0.33098 - y_{10}), \qquad (1)$$

where Y_{10} is the Y-value and x_{10}, y_{10} are the chromaticity coordinates of the standard. This CIE whiteness value is assigned to the standard on the front of the data label. It is important to point out that the adjustment is made for the overall UV content on the basis of the CIE whiteness value. Full agreement over the whole (UV) spectral range may have not been achieved. On the reverse side of the standard, data are nevertheless given to provide a basis for checking approximately the validity of the adjustment. The data given are the corresponding tristimulus values and D65 brightness value as determined with the RISE Innventia reference instrument, together with the CIE tint value, defined according to:

$$T_{W,10} = 900(0.31381 - x_{10}) - 650(0.33098 - y_{10}), \qquad (2)$$

where a positive value indicates a green tint and a negative value a red tint. If the material is considered as colorimetrically white, its tint value must lie between the limits:

$$-4 < T_{W,10} < 2.$$

In addition, information is given relating to the amount of fluorescence in the reference standard. This is quantified as the difference in whiteness of the sample with and without UV excitation. A UV exclusion filter with a cut-off at 420 nm, such as a GG420/3-filter is used for the latter measurement.