Improved methods for adjusting the UV contents of standard illuminants in paper industry

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Technological activities

1. Improved methods for adjusting the UV contents of measurement instrument illumination for the Paper Making and the Graphics Industries

2. New fluorescent reflectance standards for the Paper Industry and for the Graphics Industry

3. Methods for mutual conversions between D/0°, D/8°, and 45°/0° measurement geometries
Activity 1

- **Goal**
  - Improved methods for the adjustment of the UV spectral contents of the standard illuminants
    - For paper industry
      - D65 and C
    - For graphic industries
      - CIE A; D50;
  
- **Current ISO standards**
  - UV adjustment against one single assigned value
    - CIE whiteness (D65);
    - ISO brightness (C)
  - Fluorescent metamerism
Status of the project

- **Report1**—deliverable 3.2.1 (due May 31, 2014)
  - Improved methods for adjusting the UV contents of standard illuminations for papermaking industry.
  - Oral presentation.

- **Report2** – deliverable 3.2.2 (due Aug. 31, 2014)
  - UV content adjustment based on spectra for papermaking and graphic industries
  - Internal report
  - Draft for journal publication
Artefacts – D 3.2.1 (due Nov-30, 2014)
- For paper making industry
- At least 4 fluorescent reference standards (D65 and C illuminants)
- Ongoing

Artefact – D 3.2.4 (Due Feb-28, 2015)
- For graphic industry
- At least 2 fluorescent reference standards (D50 and A illuminants)
- Has started
Definition of ISO brightness

- **Illuminant**
  - CIE C

- **Calculated from spectral reflectance factor**
  - Weighted by the ISO blue filter
    - Between 400 and 500 nm
    - Peak at 457 nm.

\[
R_{457} = \frac{\sum_{400}^{510} F(\lambda) R(\lambda)}{\sum_{400}^{510} F(\lambda)}
\]
reflectance

$B_{ISO} = 107.5$

$B_{ISO} = 95.3$

- ISO profile
- daylight
- low UV
Definition of CIE whiteness

- CIE D65/10°

\[
W = Y + 800(x_0 - x) + 1700(y_0 - y)
\]

\[
T_w = 900(x_0 - x) - 650(y_0 - y)
\]

- Important criteria
  - -3<T_w<3  ➔ is white
  - Otherwise ➔ not white
Approach

- UV adjustment against total spectrum
- Numerical UV filtering
Conventional UV filtering technique

- Two UV filters move in/out
  - UV full
  - UVX(400)
  - UVX(420)
Different UV adjustment techniques

**Traditional UV adjustment**

- Two UV filters move in/out
  - UV full
  - UVX(400)
  - UVX(420)

**Numerical UV adjustment**

- Three Xe lamps
  - UV full
  - UVX(400)
  - UVX(420)
Algorithms of the UV adjustment techniques

- Traditional UV filtering

\[ R(\lambda) = (1 - \alpha - \beta)R_{uvfull}(\lambda) + \alpha R_{uvx400}(\lambda) + \beta R_{uvx420}(\lambda) \]

- Constraints: \[ 0 \leq \alpha \leq 1, \quad 0 \leq \beta \leq 1, \quad 0 \leq (1 - \alpha - \beta) \leq 1 \]

- Numerical UV filtering

\[ R(\lambda) = \gamma R_{uvfull}(\lambda) + \alpha R_{uvx400}(\lambda) + \beta R_{uvx420}(\lambda) \]

- Constraints: \[ \alpha + \beta + \gamma = 1 \]
Summary

- Fluorescent samples have been measured at NRC under standard illuminants, CIE C, D65, and D50.

- A method to reproduce the total reflectance factor (including fluorescent contribution) with numerical UV adjustment technique has been established.
  - Good spectral reproduction has been achieved by numerical UV filtering techniques.

- There are clear advantages with numerical UV-filtering technique than conventional with move-in UV filters