Color Rendering

I. Preface

An object looks whitish under the fluorescent lamp and meanwhile, the same object looks yellowish under the incandescent lamp. The same object looks different in(or under?) different light sources. You can see how light source change the color of objects by comparing under fluorescent lamp, incandescent lamp, daylight and etc.

Color Rendering is the property of the light source that effects the color of the object.

II. Color Rendering Index (CRI)

CRI is a numerical representation to evaluate the Color Rendering Properties of the light source.

CRI shows how accurately a sample light source reproduces an object color compare to the *reference light source.

The CRI value of 100 means the sample light source reproduces the same color as the reference light source does.

Therefore the higher the value of CRI, the more it resembles to the reference light source.

When evaluating CRI, the reference light source is chosen to have the same (or within the range of 5 mireds) correlated color temperature as the sample light source.

* Reference light source

a) Lower than 5,000 Kelvin : Planckian radiator

b) 5,000 Kelvin and higher : CIE daylight

CIE defines 14 colors and JIS defines 15 colors as the test colors to evaluate CRI. (Refer to Table 1). CRI evaluates how accurately the sample light source renders the 14 or 15 colors in comparison to the reference light source.

* Test Color (Refer to Table 1)

No.1-8: Typical color of generally existing things. Value 6 and Chroma 4-8 are selected.

No.9-15: Relatively high valued Chroma of Red, Yellow, Green, Blue / leaf green and human complexion are selected.

Ri	Munsell Hue Value / Chroma	Appearance color under the daylight
R1	7.5R 6/4	Light grayish red
R2	5Y 6/4	Dark grayish yellow
R3	5GY 6/8	Strong yellow green
R4	2.5G 6/6	Moderate yellowish green
R5	10GB 6/4	Light bluish green
R6	5PB 6/8	Light blue
R7	2.5P 6/8	Light violet
R8	10P 6/8	Light reddish purple
R9	4.5R 4/13	Strong red
R10	5Y 8/10	Strong yellow
R11	4.5G 5/8	Strong green
R12	3PB 3/11	Strong blue
R13	5YR 8/4	Light yellowish pink (human complexion)
R14	5GY 4/4	Moderate olive green
R15	1YR 6/4	Japanese complexion (available in JIS only)

Table 1

III. Calculating CRI

There are two types of CRI. One is General CRI, which is also named as Ra. And the other is Special CRI, which is also named as Ri. This section explains how to calculate those two types of CRI.

1) General CRI (Ra)
The average value of R1 to R8 (Refer to Table 1)
$Ra = \Sigma (i=1 \text{ to } 8) Ri \times 1/8$

2) Special CRI (Ri)
The particular (Individual) value of each 14 (CIE) or 15 (JIS) test color. (Refer to Table 1: R1-R15)
$Ri = 100 - 4.6 \times \Delta Ei \ (i=1 \text{ to } 14 \text{ or } 15)$

ΔEi: The color difference (chromaticity coordinate value difference) between standard light and reference light source on CIE 1964 U*V*W*.

List of references

Lighting Handbook 1st Edition (Edited by The Illuminating Engineering Institute of Japan / Issued by Ohmsha)
Phosphor Handbook (Edited under the Auspices of Phosphor Research Society
Editorial Committee Co-chairs by Shigeo Shionoya / William M. Yen.)