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technote

MEASURING THE COLOR OF YOUR COLOR VIEWING FACILITIES

The Complexity of Fluorescent Lamp Color Measurement

Virtually all graphic arts and photographic color viewing facilities utilize fluorescent light sources because these sources provide uniform, diffused 5000 Kelvin illumination efficiently and economically. Accurate color measurement of such fluorescent sources, however, is a technical challenge due to the mercury emission lines in the energy spectra of these lamps.

Absolute, or “benchmark” color measurements of light sources are normally made in a laboratory with a spectroradiometer, an instrument which analyzes the relative proportions of the spectrum colors in a light source, producing a spectral power distribution (SPD) curve. An SPD curve is a “fingerprint” of the light source, depicting the actual distribution of the spectrum colors from 380 to 740 nanometers in the visible light spectrum.

The SPD of a standard incandescent lamp (shown in Figure 1), for example, is a smooth “climbing” curve shape, depicting relatively small amounts of energy in the violet-blue-green areas of the spectrum, with increasing levels of energy in the yellow-red areas.

Fig. 1 - SPD of Incandescent Source

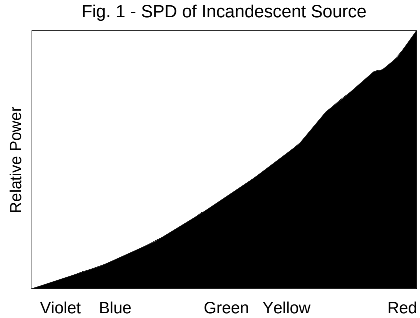
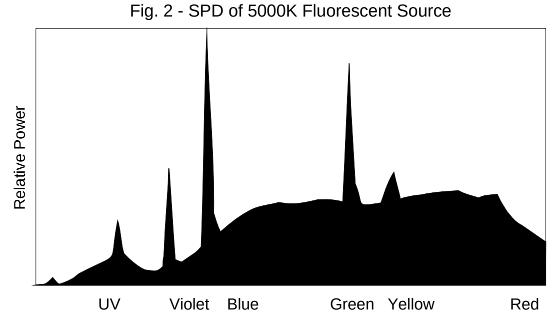


Fig. 2 - SPD of 5000K Fluorescent Source



Unlike the smooth curve of an incandescent light source, a (5000 Kelvin) fluorescent lamp’s SPD (shown in Figure 2) is interrupted by intense “spikes” of energy known as mercury emission lines. These lines are common to all fluorescent light sources and unless they are precisely measured and quantified, they will cause significant errors in the colorimetric and correlated color temperature measurements of such sources. A Spectroradiometer is required for such analyses.

Selecting An Instrument For Light/Color Measurement

Important! There is no simple “one-number” method for making color measurements of a 5000 Kelvin fluorescent light source - or any other fluorescent source, for that matter. Accurate light source measurement is a sophisticated science, normally performed in a laboratory with complex instrumentation and technology. While **relative or comparative** light/color measurements can be made “in the field,” they must be made with a qualified instrument and correlated to a standard reference light source of the same quality as the source being tested.

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Equally as Important! Before attempting to measure the light quality of a color viewing facility, keep in mind that the industry's viewing Standard (ISO 3664:2009) specifies much more than the color quality of the light source; it specifies a **complete set of viewing conditions**, including: light quality, light intensity, evenness, illuminating/viewing geometry, and surround conditions. In order to establish compliance with the ISO viewing standard, therefore, the status of all five elements must be determined, not just the light quality.

The Three Basic Instruments

There are three basic types of color measuring instruments for light sources: spectroradiometers, colorimeters, and color temperature meters. Following is a brief description of each.

Spectroradiometers

Spectroradiometers measure the relative amounts of each of the component colors in the spectrum of a light source at very precise wave lengths, generating a characteristic curve shape, or "fingerprint", of the light source. Spectroradiometry is the most accurate and dependable method of determining the color quality of light sources, especially sources with mercury lines such as fluorescent lamps.

To accurately analyze light sources with mercury lines, it is necessary to make spectroradiometric measurements at every two nanometers across the visible spectrum, which spans the wave length range of 380 to 740 nanometers, for a total of 180 discrete measurements. The latest version of the ISO standard further specifies measurement of the UV and calls for a measurement range of 300 to 730 nanometers with a maximum bandpass of 5 nanometers. From this measurement data, a data processor computes the absolute Correlated Color Temperature, Color Rendering Index, and Chromaticity (i.e., XYZ values and/or LAB values) of the light source. Sophisticated spectroradiometer systems, unfortunately, are not readily available to color printers and other graphic arts color processors who might wish to analyze their viewing conditions.

Colorimeters

Colorimeters measure the chromaticity, or color balance, of a light source through red, green, and blue (X,Y,Z) filters that simulate the color response of the human eye. Because a colorimeter measures three large segments of the visible spectrum, rather than the 180 individual measurements of a spectroradiometer, it does not have the discriminability required for the accurate color measurement of light sources having mercury emission lines.

Even when they are used for comparative colorimetric measurements of such light sources, colorimeters cannot be used on a "direct reading" basis. They must be correlated and factored to a known reference light source whose actual spectrum and chromaticity values are very close to those of the light source being measured.

Color Temperature Meters

Color temperature meters are based upon the Kelvin color temperature scale, which correlates changes in the physical temperature of a black iron body to changes in its color appearance. (Kelvin temperature is equivalent to degrees Centigrade, plus 273.) While a color temperature meter can measure the color appearance of an incandescent light source with an acceptable degree of accuracy, it cannot accurately determine the correlated color temperature of a fluorescent light source or other sources with emission lines.

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Most color temperature meters measure light through only two filters (red and blue) which provides insufficient data to classify the color characteristics of a light source. In fact, a color temperature meter will typically display a color temperature value that is significantly different than the actual color temperature of a fluorescent source (determined by spectroradiometry).

Summary

1. Industry Standard Viewing facilities are comprised of **a complete set of viewing conditions,** all of which must be evaluated and maintained, in order to comply with ISO 3664:2009.

2. The only accurate, consistent method for making direct color measurements of fluorescent lamps or other light sources with emission lines is spectroradiometry.

3. Color temperature meters cannot accurately measure the correlated color temperature of fluorescent lamps.

4. Colorimeters may be used to make **relative** measurements of fluorescent light sources if they have (a) CIE X, Y, Z* filtration and (b) can be adjusted or calibrated to match the chromaticity values of a reference light source having an SPD curve very close to that of the source being measured.

*CIE is the French acronym for the International Commission on Illumination, an International Standards body which specifies a three-dimensional system of color description, in which X = redness, Y = greenness (and brightness), and Z = blueness.

GTI Graphic Technology, Inc. is the industry's specialist in the design, manufacture, measurement, and maintenance of Standard lighting and viewing facilities. For assistance in implementing and maintaining industry Standard viewing conditions, contact GTI at (Tel) 845-562-7066, (Fax) 845-562-2543, or (E-mail) info@gtilite.com.

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