KYDEX THERMOPLASTIC SHEET

Understanding CIE *L*a*b Colour Space

For information applicable to KYDEX® FST please refer to 300 series technical briefs.

TB - 130-A

CIE *L*a *b Colour Space

KYDEX, LLC uses CIE *L*a*b Colour Space to measure colour because visual colour matching is extremely subjective, as one person's view of a colour may differ from another's. Xrite (1997), a manufacturer of spectrophotometers explains "This can lead to confusion and frustration between customers, suppliers, vendors, production, and management."

Since Isaac Newton discovered that white light contained all the colours of the spectrum in 1666 (Beretta, G. pg. 17), people have been trying to adequately describe colour in a quantifiable and reproducible way. Light moves as a wave, with wavelengths from 360-750 nanometers visible to the naked eye. When we see something as a certain colour, what we are actually seeing are the reflected colours that are not absorbed by the object.

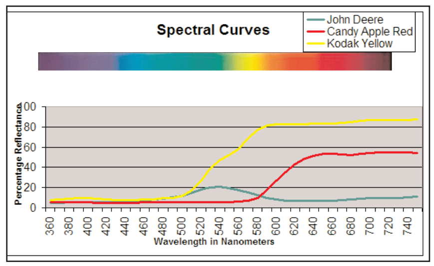

figure 1

How does this work?

Let us take, for example, three common colours: John Deere Green, Candy Apple Red, and Kodak Yellow. You have likely seen these colours before and can picture them in your mind. When we shine light onto something, it reflects some of it back. The mixture of wavelengths it reflects and the strength of that reflection is plotted as a spectral curve. Figure 1 shows the spectral curve (as a reflected percentage) of these three colours under cool white fluorescent light.

The two major factors in to how we see colour are the lighting source, and the quality of the viewers colour vision. The lighting source can radically affect the appearance of a colour sample. Although two samples may appear the same colour under sunlight, putting them under fluorescent light may make them look significantly different. This difference between these samples under different lighting sources is called metamerism, which can lead to problems in colour matching. If we make a colour match in the *L*a*b under fluorescent lighting and the customer compares those colours by the office window it may look like a poor match.

In this case, we lack both a standard observer and a standard light source, and we are comparing apples to oranges. To eliminate such discrepancies CIE *L*a*b Colour Space was developed to standardize and quantify objectively how we measure a colour.

Colours are measured in the CIE *L*a*b system with a standard illuminant; the most common being CWF2 - Cool White Fluorescent (such as an office building), and D65 – Daylight. These standards are the same anywhere in the world, and are independent of local conditions. They are traceable back to a known standard, and calibrated regularly.

With standardization of the lighting source the most subjective of part of the equation is still left open, that of the standard observer. In the CIE *L*a*b Colour Space the human eye has been replaced by using electronic measurement of the colour. The machine, called a spectrophotometer reads the colour and records the spectral data. Since this machine is calibrated with a standard, all spectrophotometer readings can be compared regardless of who took them and when. Using this data the machine mathematically derives the colour's position in the CIE *L*a*b colour space.

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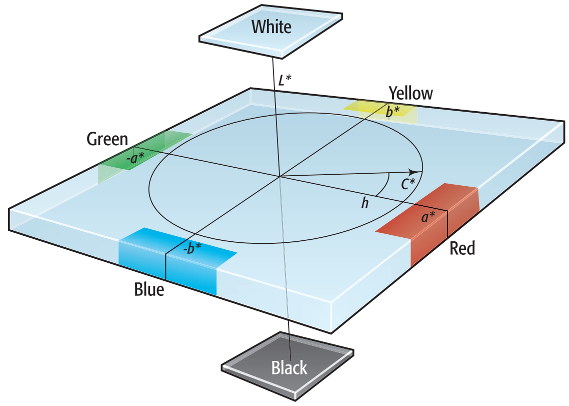

Figure 2

Interpretation of the CIE *L*a*b Colour Space

CIE *L*a*b envisions a three dimensional space, with three axes, represented in Figure 2 (Eye-Colour. 2002)

*L is the light and dark axis. It can be thought of as the average value of a spectral curve, with 0 representing no reflection (black) and 100 representing high reflection (white).

*a is the red and green axis. A positive *a value indicates a colour is red. A negative value indicates green.

*b is the yellow to blue axis. A positive *b value indicates a colour is yellow. A negative value indicates blue.

Taken together, these three numbers represent particular colour that can be compared anywhere in the world. Our three common colours under CWF2 using the CIE*L*a*b Colour Space yield the results shown below.

Interpretation of the CIE *L*a*b Colour Space

	*L	*a	*b
John Deere Green	44.48	-18.62	22.33
Candy Apple Red	46.68	37.06	32.77
Kodak Yellow	82.61	14.63	80.45

John Deere Green is light rather than dark (+44.48), green rather than red (-18.62), and yellow rather than blue (+22.33).

Candy Apple Red is light rather than dark (+46.68), red rather than green (+37.06), and yellow rather than blue (+32.77).

After establishing standards for a given colour, we can then begin to compare them. Below, in figure 3 are spectral data from a production lot compared to a standard.

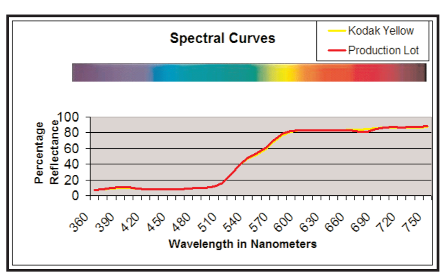

Figure 3

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Using CIE *L*a *b

Using the CIE*L*a*b system we can look at the *L*a*b values and calculate the differences as seen below.

	*L	*a	*b
Kodak Yellow	82.61	14.63	80.45
Production Lot	82.11	14.11	81.57
Difference	0.5	-0.53	1.11

Since we can quantify the standard, the production lot, and the difference, we have a reference to communicate, and assure the quality of, the colour. In this case, the Production Lot is slightly lighter, less red and more yellow than our standard. These differences are called deltas. Derived from these deltas is another measure called Delta E, which signifies the overall colour difference. **Our standard production tolerance is a maximum deviation of 1.0 on the light-dark axis, 0.6 on the red-green axis, and 0.8 on the blue-yellow axis with a maximum deviation of 1.0 on the ΔE.** However we can set colour tolerances and produce material within a customer's specific tolerance, if needed.

References

Xrite. (1997). A guide to Understanding Color Tolerancing, L10-024.pdf retrieved online February 24, 2003, at http://www.xrite.com/HelpDesk/DocDetail.ASP?DocNr=152

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