Interpretation of Color Data (A Simplistic Overview)

Visual Perception:

Color is a visually perceived aspect of almost every object around us. Several variables of the three main factors including the light source, the sample, and the observer, affect visual perception of color. PolyOne measures color instrumentally to ensure reproducible measurements and to eliminate the bias of the human observer.

Colorimetry:

Color instruments generate tristimulus values in an X, Y and Z coordinate system. Depending on the specific instrument, these tristimulus values are converted to Hunter **L**, **a**, **b** or CIELAB **L***, **a*** and **b*** units. The difference between the two systems is the mathematical manipulation of the basic tristimulus values.

Both Hunter and CIELAB are 3-dimensional systems where **L** (or **L***) represents lightness/darkness, **a** (or **a***) represents red/green and **b** (or **b***) represents yellow/blue. When comparing various samples, or a sample to a reference standard, Δ (delta or difference) values are reported. Thus:

- a positive Δ**L** value is lighter and a negative value is darker,
- a positiveΔ**a** value is redder and a negative value is greener
- a positiveΔ**b** value is yellower and a negative value is bluer

when referenced to a standard. The attached 3-D graph shows the relationship of these values (Fig.1.)

A Δ**E**, referred to as a Total Color Difference, is a mathematical representation as follows:

$$\Delta E = \sqrt{(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2}$$

and is simply a method of combining all the individual Δ values.

Ultra Violet (UV) light exposure and color change:

When rigid PVC samples are exposed to Ultra Violet (UV) light, the color will change over time. The amount of change is dependent on the degree or length of exposure and the affect it has on the colorants, (if applicable), and the composition of the of the PVC compound.

- Accelerated testing uses specific UV lamps to approximate UV rays emanating from the sun. But the UV level is intensified to reduce the exposure time needed. This is a loose approximation as the intensity of UV radiation varies around the world. Testing equipment typically used is either QUV, (UVA, UVB lamps), or Xenon arc.
- Actual outdoor exposure testing can also be conducted utilizing 3 different geographic locations. Consequently, for the same time period, ie degree or length of exposure, the color change can differ from one outdoor test site to another.

LOCATION	CLIMATE
Arizona	representing a hot and dry climate with a high UV level
Florida	representing a hot and moist climate with a salty atmosphere and a high UV level
Ohio	representing a varied climate from hot to cold, moist to dry and an industrial environment

Interpretation of Colorimetric Data:

Interpretation of the actual ∆**L**, ∆**a** and ∆**b** data is difficult to explain. For example, a ∆**a** (red/green) value of 0.5 is visually more apparent in a white sample than in a green. While PolyOne does not define tolerable color changes, we do define tolerable color variation in our manufacturing process. Most PolyOne weatherable rigid PVC products have ∆**L**, ∆**a** and ∆**b** manufacturing limits of ±0.7, ±0.6 and ±0.6 respectively. These same limits can be very loosely applied to color change of weathered samples. Thus a color change of ±0.7, ±0.6 and ±0.6 (∆**L**, ∆**a** and ∆**b**) MAY not be visually unacceptable. But again, and this is a very important point, the visual difference is dependent on the actual color of the sample.

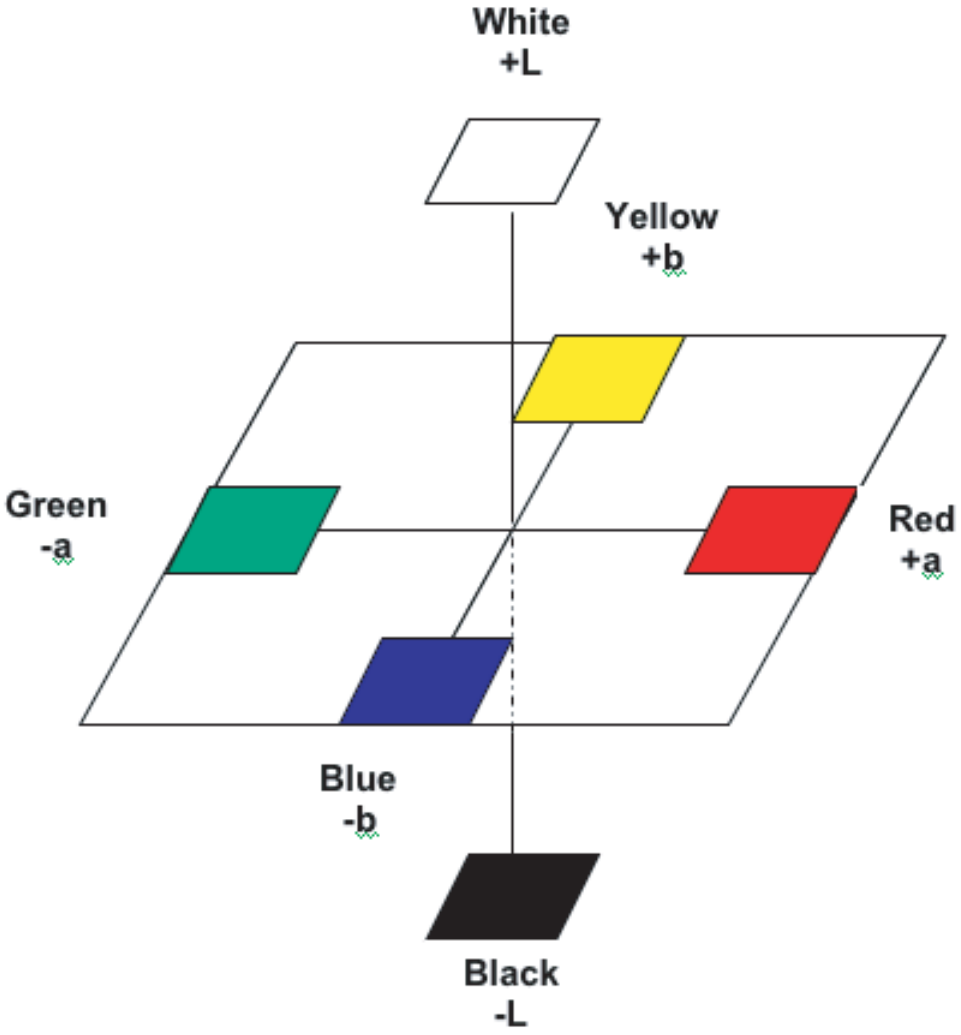
Using ∆**L**, ∆**a** and ∆**b** numbers sets up a rectangular shaped grid. Historically, any sample within that grid was deemed to be acceptable. AAMA 303 (American Architectural Manufacturers Association) has defined an acceptable color change due to weathering of WHITE window profiles made from exterior grades of rigid PVC as follows (Hunter units):

∆**L** = -4 to +2
∆**a** = -2 to +2
∆**b** = -2 to +8

AAMA 303 also references ASTM D4726, which defines an ellipsoidal space, ie the corners of the rectangles are cut off.

As is evident, these values fall beyond the ±0.7, ±0.6 and ±0.6 (∆**L**, ∆**a** and ∆**b**) noted above. But they are defined as acceptable to the window profile industry. Since color is subjective, acceptability of color change is even more subjective.

CIE L*a*b* Color Space



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