TECHNICAL BULLETIN

Color Computer Numbers

Background

Historical information is often carried over, revised, and retooled as the years go by. Sometimes new theories and information are added along the way. Occasionally, a person or committee will come up with a totally new system that they think better describes the subject. It is no different with color computer theory. Several theories were developed to mathematically describe color and many are still in use today. This isn't to say that one theory is the best; many are good systems and a user needs to decide what will work for them. That being said, we do have some recommendations for customers setting limits for color differences.

Color Space

CIE Lab and Hunter Lab are two planes in which we can plot colors. Both were developed to describe how our eyes see color.

Color Tolerancing

For color matching, we need a way to describe the difference between one color and another. This difference is represented with the symbol delta (Δ) or sometimes more simply "D". Putting limits on the difference between colors is called tolerancing.

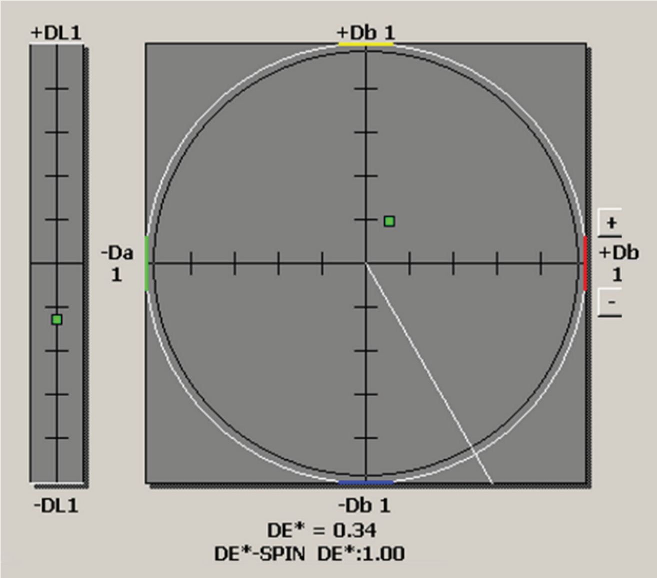
Hunter lab uses ΔE.

CIE Lab uses ΔE*, ΔEfmc2, ΔEcmc, and ΔE2000 as the main methods of tolerancing. Because both Hunter lab and CIE Lab use the ΔE notation, CIE lab is differentiated with an asterisk (*).

ΔL*, Δa*, Δb*

Most customers choose CIE Lab for their color space. The components for CIE lab:

ΔL* describes Light (+) and Dark (-).
Δa* describes Red (+) and Green (-)
Δb* describes Yellow (+) and Blue (-).



In the example above, the center of the graph is our standard, and the green dot is the sample. The sample is darker (-L), redder (+a), and yellower (+b) than the standard. The total color difference is summed up as DE* = 0.34 with the white circle being the tolerance of 1.00 DE*. This sample passes tolerance.

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Using Color Numbers

Using numbers as a way to describe what an eye sees is very powerful tool; however, it also has drawbacks.

In a world full of engineering specifications and tolerances, it is natural to try to put limits on every possible difference, and color is no exception. Even the best color computers with the latest method of calculating color difference sometimes disagree with what we see visually. Usually the culprit "tricking" the color computer is a difference in pigmentations, causing metamerism or a difference in materials (paint to plastic, for example).

The color computer calculations work best as a QC tool when pigmentation is defined, which is to say the standard and sample are using the pigmentation. Only a trained color formulator should use the color computer as a tool to develop and match differing pigmentations and use their eye as the ultimate test.

Recommendations

Choose a color standard with the level of performance that you will require. It is best to make your own color standards with materials that pass your specifications.

Specifying one of the newer tolerancing systems (ΔEcmc, ΔE2000) will cut down on the number of rejected parts due to inconsistencies between color computer readings and visual assessments. These newer tolerancing systems were designed to increase accuracy between the visual assessment and the color computer readings.

Always use visual inspection as the final pass/fail.

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