Application Note

AN 1009.00

Selecting Yellowness and Whiteness Indices to Measure Samples

"Both yellowness and whiteness indices are used to determine product quality and acceptance."

ABSTRACT

White is the color of purity and freshness and an indicator of freedom from contaminants. A white surface is one that reflects uniformly throughout the visible spectrum while absorbing at a very low level. A whiteness index is typically biased in the blue-yellow dimension. Absorption in the blue part of the spectrum causes visual yellowness. This yellowness is associated with scorching, soiling, and general product degradation by light, chemical exposure, and processing. Yellowness indices are used chiefly to quantify these types of degradation with a single value.

This application note considers several of the most commonly used yellowness and whiteness indices and the industries that use them.

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CHALLENGE: To understand the industry required YI or WI needed to communicate product quality.

A whiteness index is looking for the perfect white and is typically biased in the blue-yellow dimension. This means that higher whiteness index values are obtained if the white material is lighter or slightly bluer than the perfect white, and lower whiteness index values are obtained if the white material is darker or slightly yellower than the perfect white.

Yellowness indices are used chiefly to quantify clear, near-colorless liquids or solids in transmission and near-white, opaque solids in reflectance. Most available indices are based on CIE XYZ but roll up the calculations into a single value. Table 1 shows the most commonly used indices for determining yellowness or whiteness. There are additional visual and numeric scales that are not considered in this application note.

TABLE 1. COMMON YI & WI INDICES BY INDUSTRY

Industry	Yellowness YI	Whiteness WI
Paint	E313	E313
Textiles	E313	E313
Soaps, detergents, cleaners	E313	E313
Plastics	YI D1925	E313

ASTM E313 FOR YELLOWNESS & WHITENESS

The American Standards Test Methods (ASTM) defines whiteness and yellowness indices for paper, paint and plastic although it is widely used in many industries. The E313 Whiteness Index is used for measuring any near-white material. Conversely, the ASTM's E313 yellowness index is used to determine the degree to which a sample's color shifts away from an ideal white.

If you are looking for an index and have no recommendation, then E313 is an excellent scale to adopt for your product.

ASTM D1925 FOR YELLOWNESS

The ASTM D1925 method was withdrawn in 1995, but this formula still provides useful information. This index is always calculated for C/2°, regardless what illuminant and observer are chosen. The focus of this index is on evaluation of transparent plastics. By definition, the theoretical "perfect white" has reflectance values of 100% across the visible spectrum with corresponding colorimetric values of L* = 100.00, a* = 0.00, and b* = 0.00. If a white item is near, but not perfectly, white, it may be darker (have a lower L* value), and possibly be slightly chromatic, either in the red-green dimension (a*) or in the yellow-blue dimension (b*).

TINT INDICES

As a supplement, tint indices are biased in the red-green dimension and describe the amount of greenish or reddish tint in products that are close to perfect white. Negative tint values indicate a reddish cast (slightly positive a*), while positive tint values indicate a greenish cast (slightly negative a*). The tint indices are highly sensitive to color change, and make it easy to quantify very small lot-to-lot differences between white materials. There are three types of tint available using HunterLab instruments: CIE Tint, ASTM E313 Tint, and Ganz Tint. These indices are companion indices to the CIE Whiteness, ASTM E313 Whiteness, and Ganz Whiteness indices, respectively.

REFERENCES

AATCC Test Method 110, "Whiteness of Textiles," AATCC, Research Triangle Park, North Carolina, www.aatcc.org

ASTM E313, "Standard Practice for Calculating Yellowness and Whiteness Indices from Instrumentally Measured Color Coordinates," ASTM, West Conshohocken, Pennsylvania, www.astm.org

CIE Publication 15:2004, Colorimetry, 3rd ed., CIE, Wien, Austria, www.cie.co.at

Griesser, Rolf, "Assessment of Whiteness and Tint of Fluorescent Substrates with Good Interinstrument Correlation," Color Research and Application, 19:6, 1994.

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ABOUT HUNTERLAB

HunterLab, the first name in color measurement, provides ruggedly dependable, consistently accurate, and cost effective color measurement solutions. With over 6 decades of experience in more than 65 countries, HunterLab applies leading edge technology to measure and communicate color simply and effectively. The company offers both diffuse/8° and a complete line of true 45°/0° optical geometry instruments in portable, bench-top and production in-line configurations. HunterLab, the world's true measure of color.

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