

Measurement of Color for Paper (Tristimulus Values)

The TAPPI brightness measurement (commonly used to test virgin fibers) does not measure color because it depends on the blue portion of the visible spectrum. To accurately characterize colored fibers and sheets, a three number colorimetric measurement must be used. The color of the handsheets were measured following TAPPI Standard Method T422 om-88, "Spectral reflectance factor transmittance, and color of paper and pulp (polychromatic illumination)" A Technidyne Corporation Technibrite Micro TB-k located in the Paper Testing Laboratory of IPST is used to perform this measurement. This machine illuminates the sample with diffuse light, measures the reflected light, and calculates the CIE L*, a*, b* values.

Determination of Dye Removal Index

For any one sheet, the 'color difference' from a white sheet can be reduced to a single number that represent the distance in color space from an ideal bleach. The ideal bleach is pure white. The CIE L*a*b* coordinates for the ideal bleach point are a*=b*=0, L*=100. The first step is to determine the tristimulus values for the sheet. Then the geometric distance (R) from the measured location in L*, a*, b* color space to pure white is calculated. The distance in color space from a point P₁ with coordinates a₁, b₁, L₁, to the ideal bleach point is calculated from the formula $R^2 = a^2 + b^2 + (100-L)^2$. After bleaching, the material is now at point P₂ in color space with coordinates a₂, b₂, L₂. The reduction in distance from the ideal bleach point in moving from point P₁ to P₂ is ΔR^2 . The formulas for calculating ΔR^2 are given in Equation 1. The dye removal index (DRI) for a bleaching process is based on the change in R that occurs during that process. The dye removal index is expressed as a percentage of the original distance from the ideal bleach point. The DRI does not give the direction of the color change, but rather measures how much color was removed.

Equation 1 Dye Removal Index Calculation*Error! Bookmark not defined.*

Distance from Ideal Bleach Point = R^2

$$R^2 = a^2 + b^2 + (100-L)^2$$

Amount of Color Removal = $-\Delta R^2$

$$\Delta R^2 = R_2^2 - R_1^2$$

$$\Delta R^2 = (a_2^2 - a_1^2) + (b_2^2 - b_1^2) + [(100-L_2)^2 - (100-L_1)^2]$$

$$\text{Dye Removal Index (DRI)} = -100 [\Delta R^2 / R_1^2]$$

DRI = Percent Color Removal by Bleaching Process