Color technology has opened the door to many new possibilities in the world of science and discovery. Just like Newton's laws of motion, there are certain laws that pertain to light absorption and color concentration of various compounds. This information can provide a wealth of data about specific chemical properties. Spectrophotometers are important tools used in color technology that can measure light wavelengths and calculate this data to pertain to a variety of science and industry applications.

Understanding Absorption and Transmittance Measurement

Every chemical compound absorbs, transmits, or reflects light over a certain wavelength. Spectrophotometers measures how a chemical substance absorbs or transmits light, and quantifies how much of that light is transmitted through a sample. This data can be broken down into various categories based on wavelength measurement, dictating the instrumentation needed for each specific application.

- *UV-VIS Spectrophotometers measure light wavelengths in the ultraviolet and visible range:*
    - ultraviolet range (185-400nm)
    - visible range (400-700nm)
- *IR Spectrophotometers measure light over the infrared range of the electromagnetic radiation spectrum*:
    - Infrared range (700-15000nm)

Many color technology applications can be performed in the UV/VIS spectral range and follow a basic formula for measuring the absorption and transmittance values of a sample solution. With spectrophotometric instrumentation, specific principles and formulas are applicable to numerous fields of science and industry, including chemistry, physics, biochemistry, material and chemical engineering, and clinical applications.[1]

The Beer-Lambert Law

Understanding the relation between absorption and transmittance data requires the use of the Beer-Lambert Law, which is a specific formula that provides a percentage value for light transmittance. As light passes through a sample, a certain level of absorption takes place and the radiation that passes through the sample can be measured as radiant power P_0 . The amount of radiation absorbed can be measured in several ways using spectrophotometric technology[2] as shown below:

Transmittance: $T = P / P_0$

% Transmittance: $\%T = 100\ T$

Absorbance:

$A = \log_{10} P_0 / P$

$A = \log_{10} 1 / T$

$A = \log_{10} 100 / \%T$

$A = 2 - \log_{10} \%T$

The last equation, $A = 2 - \log_{10} \%T$, is most commonly used because it allows for easy calculation of absorbance from percentage transmittance data. This data can then be used to differentiate the properties of a specific compound. Applications in food science, clinical medicine, pharmaceuticals, and chemical industries all utilize this color technology formula to classify specific compounds, quantify data for repeatability, identify changes, and measure compound purity for safety and consistency.

Advanced Spectrophotometric Technology

Color technology and spectrophotometry have seen many advancements since the early 1940s.[3] Today's spectrophotometers are available in a wide range of options that are specifically tailored to meet industry needs and regulations. These options include in-line production measurement tools, as well as portable or benchtop models. The ability to rapidly and repeatedly evaluate materials for quality, consistency, and safety makes spectrophotometers an ideal choice among color technology instrumentation. The durable and efficient design allow for numerous applications in production and laboratory settings, as well as in the field.

Full article with photos available here:

https://www.hunterlab.com/blog/color-measurement-2/the-amazing-world-of-color-technology-absorption-transmittance-and-the-beer-lambert-law/