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Waltemode GmbH

Optical or Acoustic

Process measurement of liquids

- **APHA Color in Hazen Units**
- **ASTM / Saybolt Color**
- **EBC Color**
- **Application Specific Colors**
- **Quality Control**

Color Photometry

What does Color mean?

Color is defined as a light released sense impression mediated by eye.
The physical science considers light as electromagnetic waves. Color is not a clear defined magnitude like e.g. temperature or pressure, color is a subjective impression.

How arises a Color Impression?

A color impression will be caused, in case electromagnetic waves of the visible spectrum (wavelengths of about 380nm up to 750nm) will fall on the eye.

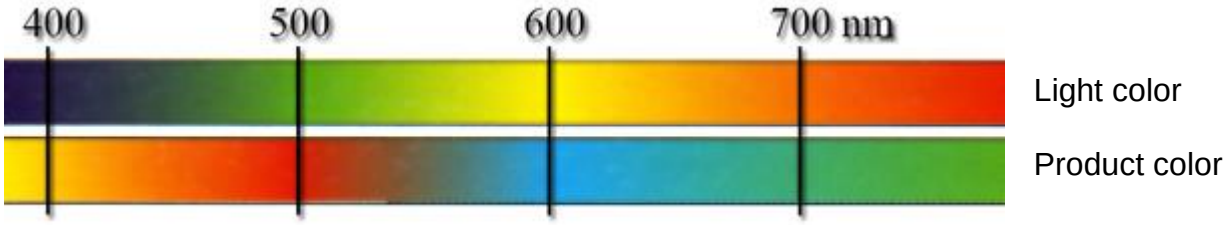
How accrues Color?

White light (colorless) consists from the summation of all colors of the visible spectrum. A color impression accrues for the eye, in case a specific range of wavelengths within the visible spectrum will be absorbed.

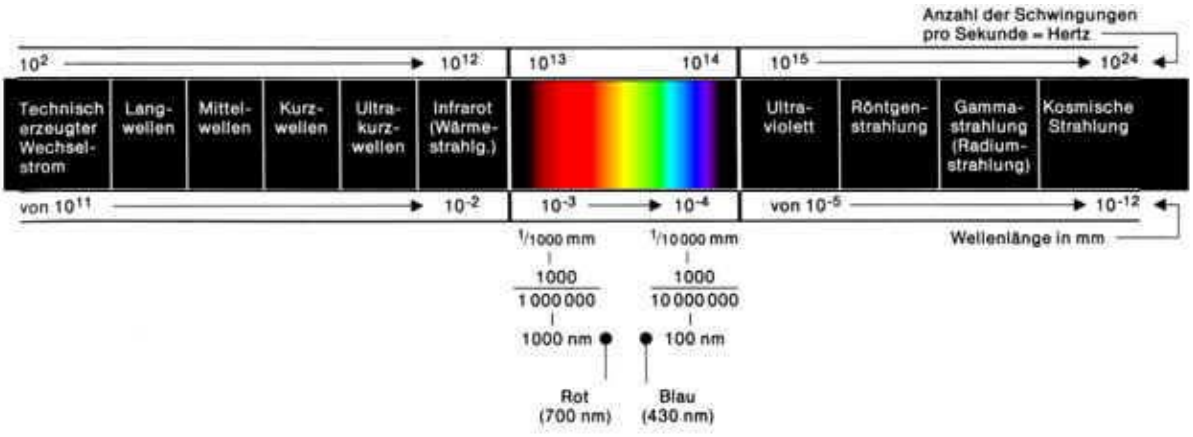
Context between Wavelength and Color

Absorbed Wavelength λ [nm]	Color of absorbed Light	Visual impression human eye
380 – 435	violet	yellow-green
435 – 480	blue	yellow
480 – 490	greenish-blue	orange
490 – 500	bluish-green	red
500 – 560	green	magenta
560 – 580	yellow-green	violet
580 – 595	yellow	blue
595 – 650	orange	greenish-blue
650 – 780	red	bluish-green

Comparison absorbed light color / product color



Total Spectrum



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Measurement of Color

The following methods are used for the measurement of a “color concentration” in a liquid; both methods are based on the principle of light absorption at specific wavelengths.

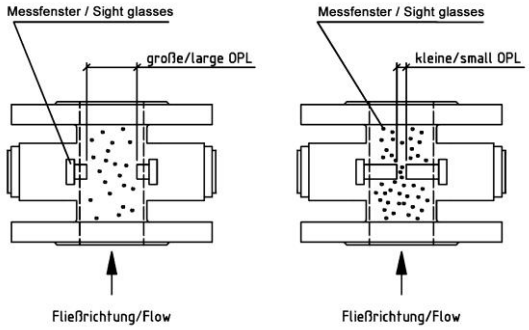
Example single wavelength absorption:

Measurement of blue color in a liquid.
The light absorption in a spectral range of approximately 600nm will be detected and evaluated; this is the range of wavelengths where the blue color generates light absorption.

Mainly two parameters will affect the sensitivity of the measurement.

1. The initial intensity of the white light source, which is a constant value of the respective sensor.
2. The optical path length (OPL) which is a variable magnitude of the sensor.

The sensor requires a large optical path length (OPL) to generate enough light attenuation at low color concentration.
The sensor requires a small optical path length (OPL), to ensure enough light intensity penetrates the product at high color concentration.



Large optical path length/OPL = measurement of low concentrations/high sensitivity
Small optical path length/OPL = measurement of high concentrations/low sensitivity

Single Beam dual Wavelength Measurement

The previously described method of single wavelength absorption operates with filtrated liquids with low particle content only, because the particles in the liquid absorb the light as well as color. Therefore, particles affect the measurement results. Particles absorb the light at the complete spectral range and not at specific wavelengths only. Color absorbs the light at specific wavelengths in the visible spectrum. Therefore, color is typically measured at two different wavelengths ranges. The measurement channel detects in a spectral range where color and particles absorb. The reference channel detects in a spectral range where only color absorbs. This method is called, single beam dual wavelength measurement.

The measurement channel detects the absorption caused by color and particles.
The reference channel detects the absorption caused by particles only.

The difference of both signals will result the absorption caused by color only.

The difference measurement compensates for cross interference’s caused by particles, window coatings and lamp ageing

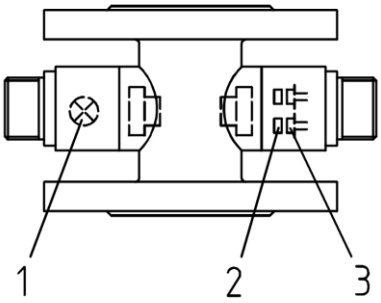
Example dual wavelength absorption:

Measurement of blue color in liquid.
The measurement channel detects the light absorption in a range of approx. 600nm (color and particles).
The reference channel detects the particle absorption at 850nm (invisible NIR light, unaffected by color).

Measurement Ch. (blue color + particles) – **Reference Ch.** (particles only) = **Color Concentration**

The difference of both signals will result the absorption caused by color only.

Basic Construction



1. Light source
2. Interference filter, transparent for defined ranges of wavelengths.
3. Light sensitive detector used for the detection of light intensity (Absorption).

Typical Applications and Measurement Units

Color- EBC:	Measurement of beer color or wort
Hazen color acc. APHA:	Measurement of yellow color in water / chemicals
Saybolt:	Measurement of refining products
ASTM D-1500:	Measurement of refining products
%:	Product specific color / quality control
OD (optical density):	Measurement of cell growth in bio reactors

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