chemtronic
Waltemode GmbH

Process measurement of liquids

- Turbidity
- Colour
- Oil in Water
- Water in Oil
- Oil on Water

Process UV- / VIS- / NIR- Photometry

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Measurement of Colour / Colour Photometry

What does Colour mean?

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

How a Colour Impression arise?

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

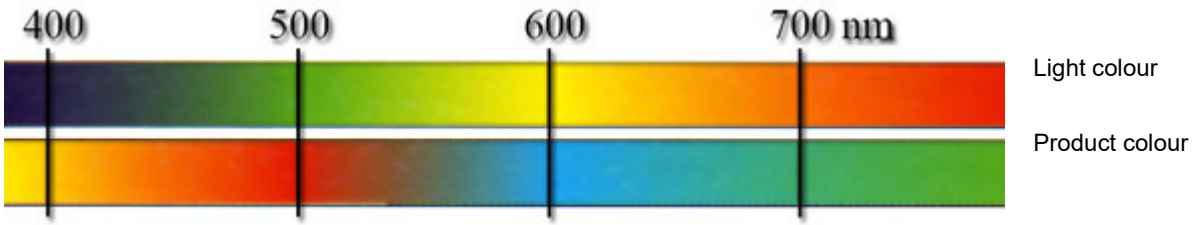
How accrues Colour?

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

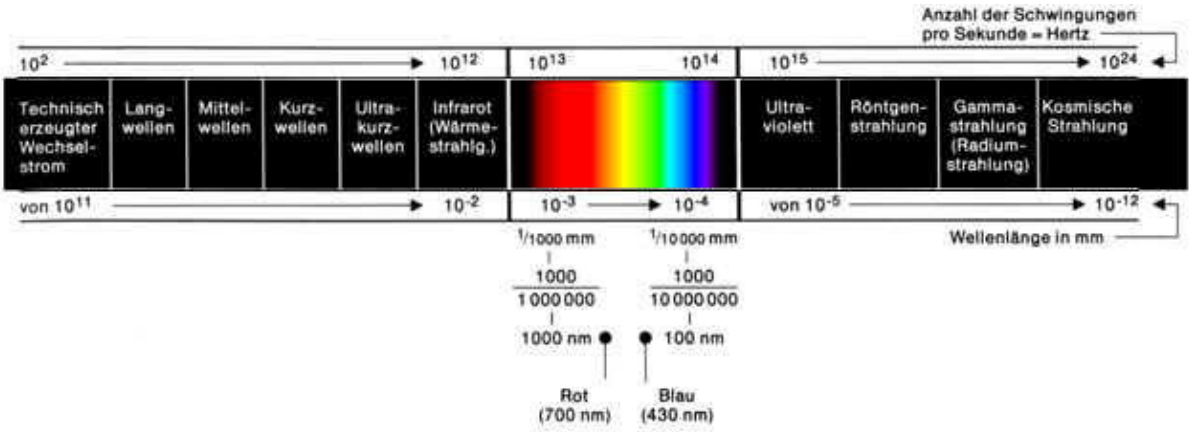
Context between Wavelength and Colour

Absorbed Wavelength λ [nm]	Colour 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 colour / product colour



Total Spectrum



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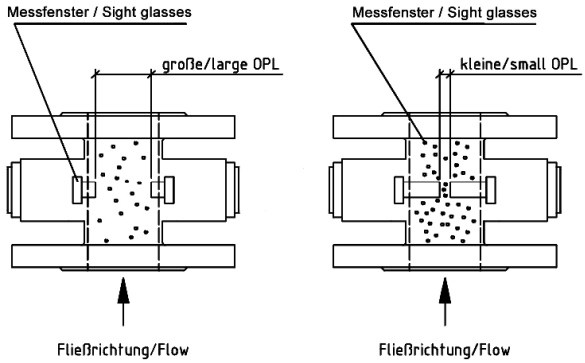
The Detection of Colour in liquid Products

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

Mainly two parameters will affect the sensitivity of the measurement.

1. The initial intensity of the 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 colour concentration.
The sensor requires a small optical path length (OPL), to ensure enough light intensity penetrates the product at high colour 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 single Wavelength Measurement

Is the easiest method to measure colour.
The measuring lamp shines through the optical path with the sample.
A detector in opposite of these lamp measures the absorption caused by the colour in these sample.
For this purpose, the detector should only detect the wavelength of the colour to be measured.

Example:
Measurement of blue colour in a liquid.
Blue colour absorbs light of 600nm.
So the absorption detector should detect 600nm light only, to see these blue colour.

This measuring principle can be used in liquids without or with low turbidity only (water, gasoline, etc.).
There is no compensation for turbidity absorption, window coatings or other disturbance parameter.

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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 colour. Therefore particles affect the measurement results. Particles absorb the light at the complete spectral range and not at specific wavelengths only. Colour absorbs the light at specific wavelengths in the visible spectrum. Therefore colour is typically measured at two different wavelengths ranges. The measurement channel detects in a spectral range where colour and particles absorb. The reference channel detects in a spectral range where only colour absorbs. This method is called, single beam dual wavelength measurement.

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

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

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

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

Measurement Ch. (blue colour + particles) – **Reference Ch.** (particles only) = **Colour Concentration**

Dual Beam dual Wavelength Measurement (UV- and colour photometry)

This measuring principle operates with two alternating light beams.
The emission of measuring light beam is typically within the UV- / Vis- spectrum (wavelength is application specific).
The reference light beam is typically in the NIR- spectrum at 850nm (wavelength is application specific).
Two measurements are performed in succession. The first measurement at measurement wavelength, the second measurement at reference wavelength.
The absorption at measuring wavelength detects the UV- / Vis- absorption caused by UV- / Vis- absorbing compounds or colours as well as the absorption of total solids.
The absorption at reference wavelength detects the absorption caused by total solids only.
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The difference of both signals will result the absorption caused by colour only.

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

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

Measurement Ch. (blue colour + particles) – **Reference Ch.** (particles only) = **Colour Concentration**

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Related Chemtronic Photometers

- Sensor model MoniSpec-C-A
  Single wavelength process colour photometer for pipe or bypass installation (Vis / Nir).

- Sensor model MoniSpec-C-AD
  Single beam, dual wavelength process colour photometer for pipe or bypass installation (Vis / Nir).

- Sensor model UVI-II
  Dual beam, dual wavelength process colour photometer for pipe or bypass installation (UV /Vis / Nir).

- Sensor model UVS-I
  Dual beam, dual wavelength process photometer, insertable probe for pipe, open channel, basin or tank installation (UV /Vis / Nir).

Applications UV- / Vis- Photometry:

- Product colour
- Hazen colour according APHA
- ASTM 1500 colour & Saybolt Colour
- Lovibond colour & EBC colour
- UV254 (optional with reference wavelength 850nm)
- UV280 (optional with reference wavelength 850nm
- Spectral Absorption Coefficient (SAC)
- TOC / COD / PAC
- Toluene, Benzene, Gasoline, Diesel oil, Naphta, …..

Operational areas :

- Chemical industry
- Petrochemical industry
- Vegetable oil
- Brew & Beverage
- Potable water / Waste water treatment
- Food and drinking industry
- Bio technology
- Pharmaceutical
- Etc.

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