

The Difference Between UV Transmission and UV Absorbance

By Melody White, Application Development Manager, Hach

Carlos Williams, Application Development Manager, Hach

Introduction

Many UV instruments, like the DR 6000 Spectrophotometer and online UVAS plus sc probe from Hach, offer two methods using the UV/254 nm wavelength for measuring organic constituents in a water sample: UV transmission (UVT) and UV absorbance (A₂₅₄). At first glance, the methods appear to be complementary to each other.

This is true as the UV/254 Transmission Method measures the light transmitted or passed through a sample while the UV/254 Absorbance Method (A₂₅₄) measures the amount of UV light that is absorbed by the sample.

However, while both methods are often referenced as measuring organic constituents, the models for each method have different applications and it is important to understand the meaning and use of the value obtained.

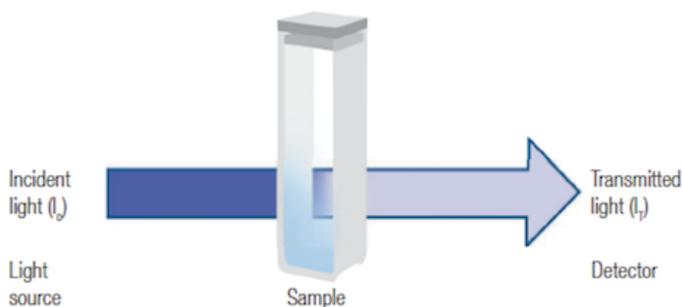


Figure 1: Incident Light vs Transmitted Light

Background:

When light is passed through a sample, a portion of the light is absorbed or scattered by substances present in the sample. The amount of light energy exiting the sample is less than the initial incident light applied.

The light reaching the detector is the transmitted light (I_t) or transmittance. The ratio of the transmitted light (I_t) to the incident light (I₀) is the transmittance (T) expressed as %T.

UVT is assumed to mean the %T at 254 nm unless noted otherwise.

The incident light that is absorbed or scattered by the sample is called the absorbance (A). The absorbance and transmittance values are related by the logarithmic equation of $A = \log(1/T)$.

To determine which method to use, one needs to ask if you need to measure the amount of light reaching the detector (typical in a UV disinfection application) or if you are interested in measuring the properties of the sample that are absorbing the 254 nm light (typical in controlling disinfection byproducts).

UV Transmission Method: UV Disinfection Applications

The UV transmission method is used where there is a need to measure the amount of light reaching a detector or sensor.

For example, this method would be used to determine the UV lamp output settings on continuous flow UV reactors. The UVT value is also used for the compliance monitoring of UVT analyzer calibrations and in the determination of UVT water quality characteristics for designing UV treatment facilities. These applications require UVT values of the water to insure the UV light dose delivery is sufficient to inactivate pathogenic microorganisms and to verify that UVT analyzers are properly calibrated so the analyzers accurately measure and control the intensity of the UV/254 light being delivered.

It is important to note that in these types of unfiltered samples, the UVT value is determined by the sample color, turbidity, particles and the soluble organic or inorganic compounds present in the water. A full list of interferences and additional precautions is given in the "Organic Constituents UV Absorbing (UV-254), Method 10054" DR 6000 procedure manual (more information at www.hach.com).



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Application: UVT and UVA In Disinfection

UV Absorbance Method: Disinfection Bypass Control

The UV Absorbance Method (A254) is commonly used to characterize the organic constituents in a water sample.

Research has shown that the organic compounds absorbing at 254 nm have a greater tendency to form chlorinated disinfection byproducts when contacted with chlorine in the disinfection of drinking water.

Source waters can be monitored for major changes in quality, or for DBP formation potential. With the lab A254 method, turbidity and particles in the water that absorb or scatter the 254 nm light are first removed by filtering through a 0.45 micron filter prior to making the absorbance measurement. Using the continuous-monitoring UVAS, the turbidity and particles in the water are compensated by a reference wavelength, so filtration is not necessary.

It is important to note that some methods call for adjusting the sample pH before measuring the A254 absorbance. However, when the A254 value is used for other UV disinfection applications, the water sample should be analyzed without filtering or adjusting the pH.

The UV/254 absorbance value is also used in the calculation of Specific Ultraviolet Absorbance (SUVA). SUVA is defined as the ratio of the A254/cm to the total DOC concentration in the filtered sample. The DOC is determined by running a TOC test on a sample that has been filtered through a 0.45 micron filter.

$$\text{SUVA (L/mg-M)} = \text{A254/cm} / \text{DOC (mg/L)} \times 100 \text{ cm/M}$$

The SUVA value is a measure of the dissolved organic carbon concentration available to likely form disinfection byproducts when chlorinated. The value can also be used in the process of removing natural organic matter to reduce the DBP formation potential.



Figure 2: The Hach UVAS Sensor

Normalization Calculation

A254 and UVT measurements are normalized to one centimeter and expressed as Abs(254)/cm or % UVT/cm respectively. The cm designation refers to the length of the quartz sample cell pathlength used to make the measurement.

Measurements made on higher quality waters often have a low absorbance or high transmittance levels. Longer pathlength 5 cm or 10 cm cells are often used to obtain better measurement sensitivity and accuracy.

The UV Transmittance and UV Absorbance methods both offer the ability to help understand your water and effectively manage your treatment processes. However, it is important to understand the meaning and use of the value obtained.

If you have any further questions about these measurements, please contact your local sales representative or visit www.hach.com.

HACH World Headquarters: Loveland, Colorado USA

United States: 800-227-4224 tel 970-669-2932 fax orders@hach.com

Outside United States: 970-669-3050 tel 970-461-3939 fax int@hach.com

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