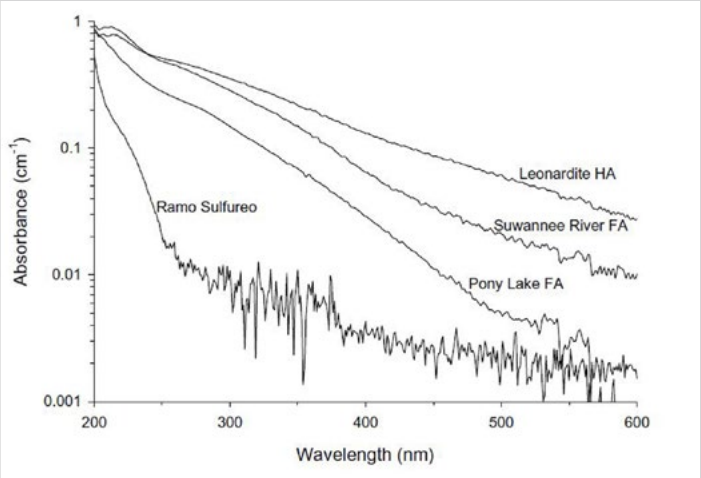
Application tips for UV254, SAC254, UVA, and SUVA

What are UV254, SAC254, and UVA? Why measure these?

Some organic compounds commonly found in water and wastewater (e.g., lignin, tannin, humic substances, and various aromatic compounds) strongly absorb ultraviolet (UV) radiation. Strong correlations may exist between UV absorption and organic carbon content, color, and precursors of disinfection byproducts (DBPs) such as trihalomethanes (THMs) and haloacetic acids (HAAs).[1] UV absorption is a useful surrogate measure of such constituents in fresh waters, salt waters, and wastewaters, because it is a simpler test than the total organic carbon (TOC), chemical oxygen demand (COD), and biological oxygen demand (BOD)[2] tests generally used to measure organic compounds. UV absorption has been used to monitor industrial wastewater effluents and to evaluate the effectiveness of coagulation, carbon absorption, and other water treatment processes that remove organics[1].

UV254 and SAC254 (spectral attenuation coefficient at 254 nm) are the amount of UV light absorption at the wavelength 254 nm, which is the historical choice for this measurement of organic compounds. Some methods allow for a scan between 200 and 400 nm to determine the presence of interfering substances and to choose a preferable wavelength, if indicated. For example, the wavelength 280 nm may correlate more closely to BOD in some waters.

The figure to the right[2] shows four spectral scans. The top three scans correspond to three waters with high levels of natural organic matter (NOM), which is present as humic acid and fulvic acid. A subsurface water (Ramo Sulfureo) has very little of this organic material and lacks the smooth, featureless curve of the other scans.



What is SUVA and why measure it?

Specific UV absorbance (SUVA) is the ratio of UV absorption at 254 nm to dissolved organic carbon (DOC) concentration.

$$SUVA = UVA/DOC$$

SUVA is used to characterize the type of organic matter in the water. The lower the calculated SUVA, the lower the potential to form DBPs, which are known to cause long-term health risks.

In the United States, the Stage 1 Disinfectants and Disinfection Byproducts Rule (DBPR) requires specified water treatment facilities to remove a certain percentage of TOC between the source water influent and the combined

filter effluent. The Stage 2 DBPR requires that enhanced water treatment be used to remove TOC before the application of disinfectant, if the source water is high in organic matter. However, if the source or treated water has a SUVA value <2 L/mg-m, then the TOC removal requirement may be waived and the facility is not required to perform enhanced coagulation or enhanced softening. Low SUVA values indicate organic matter that is not likely to form DBPs.

UV254 testing

For UV254 testing, a spectrophotometer for use between 200 and 400 nm is specified, along with matched quartz cells providing a light path of 1 cm. For low-absorbance samples, a longer path length may be chosen, such as 5 or 10 cm. An instrument that can scan the UV range is useful for evaluating and correcting for UV absorption caused by some interfering compounds.

- Before sample testing, the pH of the sample is adjusted to pH 4 to 10, if necessary, and then the sample is filtered.
- Using quartz cells, the filtered sample is measured against an organic-free water filter blank.
- The results are reported in units of cm^{-1}. See Standard Methods 5910 UV-Absorbing Organic Constituents for details (www.standardmethods.org).
- Quality control includes: replicate measurements, field duplicates, baseline absorbance checks, filter blanks, a spectrophotometer check sample, and a filtrate turbidity check (optional).

SAC254 testing

For SAC254 testing, a spectrophotometer for use between 200 and 750 nm is specified, along with fused quartz cells providing a light path of 1 cm or 5 cm, for example. A spectral bandwidth of 10 nm or less is specified.

- Membrane filtration of the sample will not be necessary if turbidity is compensated for at 550 nm.
- Zero the instrument with optically pure water before every sample measurement.
- Measure the absorption at 254 nm and at 550 nm. Calculate the corrected spectral attenuation coefficient.
- The results are reported in units of m^{-1}. See DIN 38404-3 Determination of Spectral Absorption in the UV Range, Spectral Absorption Coefficient (C 3) for details (http://www.beuth.de/de/)
- Quality control includes: zero checks and in-house measurement of uncertainty.

SUVA testing

For SUVA testing, the spectrophotometer must be able to measure the absorbance at 254 nm in the range of 0.0045 to >1.0 cm^{-1} UVA and accommodate a quartz sample cell with a path length of 1, 5, or 10 cm.

- Before testing, pass the sample through a 0.45 µm filter to remove particulate organic carbon. Do not adjust the pH of the sample.
- Zero the instrument with laboratory reagent water (LRW) and measure the filtered samples.
- Report results in cm^{-1}. See EPA Method 415.3 for details. (https://cfpub.epa.gov/si/index.cfm).
- Quality control includes: an initial demonstration of capability (repeated annually by instrument manufacturer, scientific service company, or by the analyst with a certified spectrophotometer filter set), laboratory reagent water readings, zero checks, filter blanks, field duplicates, and a spectrophotometer check sample.

Interferences

Source waters containing colloidal particles and UV-absorbing inorganics such as ionic iron, nitrates, nitrites, and bromine have been reported to interfere with measurements of UVA at 254 nm. Certain oxidants and reducing agents also absorb UVA. A UV absorption scan from 200 to 400 nm can be used to determine presence of interferences. For UVA testing, an alternate wavelength may be selected, if the interference is more than 10% of total absorption. For SUVA testing, flag the result as “suspected UVA interferences”.

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Equipment for testing UVA, UV254, SAC254, and SUVA

The Thermo Scientific™ Orion™ AquaMate™ UV-Vis Spectrophotometer covers the required wavelengths, allows for spectral scanning, has a spectral bandwidth (Δλ) of 2 nm, and offers the accuracy, dependability, and ease of use your lab requires. The Orion AquaMate UV-Vis Spectrophotometer offers the additional ability to perform wavelength accuracy verifications based on the Xenon lamp emissions spectra, without the need for a standards kit. The meter accommodates 1, 5, and 10 cm cells, and it meets the requirements for UVA, UV254, SAC254, and SUVA testing per accepted methods. For details and accessories, please go to: thermofisher.com/aquamate.

Other accessories, parts, and consumables can be found at https://www.scientificinstrumentparts.com

To purchase Orion AquaMate meter, electrodes, and solutions, please contact your local equipment distributor and reference the Cat. Nos. listed below:

Product	Cat. No.
Instruments	
Orion AquaMate UV-Vis Spectrophotometer	AQ8000 / AQ8100
Orion AquaMate Visible Only Spectrophotometer	AQ7000 / AQ7100
Accessories	
1 cm (10 mm) Quartz Cells	331742-000
5 cm (50 mm) Quartz Cells	331734-000
NIST-traceable wavelength accuracy and photometric accuracy verifications and services	
Wavelength Verification Filter Set (per Sect. 6.13 of EPA Method 415.3)	333150
AquaMate Performance Verification Kit	840-326100
Annual spectrophotometer performance calibration services-please contact: wlp.techsupport@thermofisher.com	
Thermo Scientific Barnstead Smart2Pure 12 UV Water Purification System	50129890*

*Please contact your local Thermo Scientific representative for support to order the best water purification system for your application, and visit our website at thermofisher.com/labwater.

References

1. Method 5910, UV-Absorbing Organic Constituents (2011), Standard Methods for the Examination of Water and Wastewater, www.standardmethods.org
2. Birdwell JE, Engel AS (2010) Characterization of dissolved organic matter in cave and spring waters using UV–Vis absorbance and fluorescence spectroscopy. *Organic Geochemistry* 41:270–280.

Find out more at **thermofisher.com/aquamate**

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