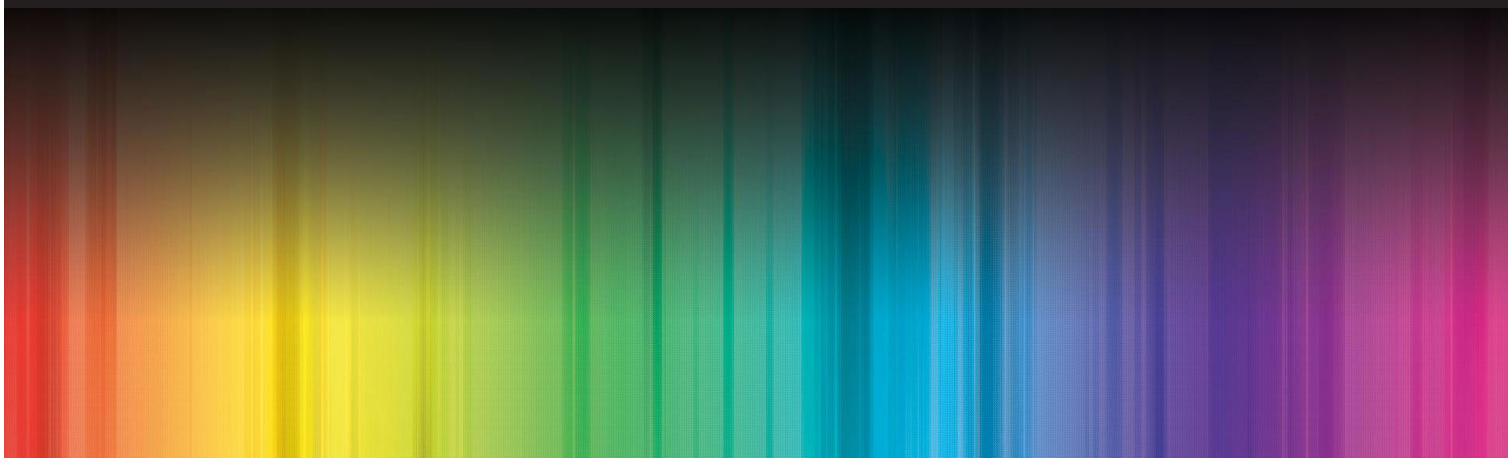
Color Analysis [OMA-300-CLR]

Applied Analytics Application Note No. DS-001E — Revised 21 April 2017



Application Summary

Analyte: Sample color

Detector: OMA-300 Process Analyzer (using UV-Vis dispersive absorbance spectrophotometer)

Available Scales: ASTM Method D1500, APHA (ASTM D1209), Saybolt (ASTM D156), Rosin, nonstandard scales

Introduction

The color of liquid in a process streams is often observed as an indicator of potential problems with product quality or equipment. Subtle changes in process coloring can signify a variety of issues, including dips in process efficiency, overheating, floating dilution ratios, distillation column malfunction, and equipment failure (e.g. leaky heat exchangers or filter breakdown).

Human judgment on color is subjective and variable. The common photometric detectors is dependent on a single, isolated measurement wavelength — a method susceptible to distortion from bubbling, contamination, or wavering light levels, as all of these conditions are misrepresented in readings as color changes.

The OMA system continuous measures sample color using full-spectrum visible absorbance spectrophotometry. The photodiode array measures absorbance at every single integer wavelength in the visible range from 340 to 720 nm; the ECLIPSE software uses this rich collateral data to secure the measurement against the typical distorting phenomena.

OMA Benefits

» Continuously measures sample color using dispersive UV-Vis absorbance spectroscopy

» Totally solid state build with no moving parts — modern design for low maintenance

» Ideal instrument for color analysis of: hydrocarbon liquid streams (diesel, gasoline, LNG, kerosene, natural gas liquids, naphtha, heavy distillate), wastewater, and food & beverage product streams

» Easily configurable software can use any standard color scale or a custom (nonstandard) correlation

» Ultra-safe fiber optic design with dedicated sample flow cell — no toxic/corrosive sample fluid in analyzer enclosure

» No re-calibration required after initial system setup — Auto Zero normalizes spectrophotometer reading

» Stable xenon light source with average 5 year lifetime

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Human Color Judgment vs. Online Spectroscopic Analysis by OMA

In various industrial processes, the color of a liquid stream can be an indicator of product quality or the health and efficiency of the process. The trouble with human analysts is that their judgment is subjective; while they can perceive change well, two analysts might grade the same process stream as different colors.

When the color variation in the stream is well-encapsulated by a standard one-dimensional scale (e.g. APHA), absorbance spectroscopy is an extremely effective method for measuring stream color optically and continuously. Using a UV-Vis spectrophotometer such as the OMA, the absorbance within the measured wavelength range is correlated directly to the grades of the linear color scale required by the end user.

The Multi-Faceted OMA advantage

» **Objective color analysis.** The color grading is not variable with the subjective view of the human observer; instead, the color grading is extremely consistent as the direct correlated output from the stream absorbance, which is not a subjective parameter. Additionally, the OMA auto-zeroes itself periodically to prevent any measurement drift.

» **Continous analysis.** While human judgment is less frequent, the OMA monitors stream color in real time with extremely fast response (the optical measurement uses a virtually instantaneous pulsed light signal). Not only can this system provide instant notifications/alarms when certain changes or color thresholds are reached, but it also provides rich, automated trend data for the process.

» **Analyze mutliple streams and/or sample points with one unit.** With its multiplexing capability, the OMA can synchronously monitor the color inside several sample pull off points located at different points in the facility. This dramatically increases the value of the system.

» **Does not use optical filters.** The full-spectrum nova II uses a ‘digital filter’ by totaling the absorbance under the spectral curve for the wavelength range defined by the scale standard. This no-filter method allows the system to be easily re-configured for a different color scale correlation in the Eclipse software., without purchasing new filters or modifying the detector assembly.

» **Excellent dynamic range.** The high-resolution detector reads the absorbance structure within the defined measurement range, and is programmed to recognize when certain wavelengths may be irrelevant to the reading due to either light saturation or over-absorbance at that wavelength. The software logic automatically redefines the analysis wavelengths in step with real-time stream absorbance to provide a system that is seamlessly accurate, even when the stream ranges dramatically from transparent to opaque.

» **Never requires re-calibration.** Auto-zero is the only necessary drift mediation.

Robust Collateral Data for Internal Referencing

While optical filters used in other photometers operate by physically totaling the absorbance within the filter range, the “digital filter” in the OMA ECLIPSE software sums the individual absorbance values from the data points within the measurement range. This is a non-destructive method that still allows the analyzer to read the absorbance curve structure — a critical capabililty for verifying that a change in the total measured absorbance is truly caused by a change in process color. Since the system knows what shape the spectrum should take, the measurement is impervious to fluctuations from over-absorbance, turbidity, or bubbling in the liquid.

Collateral data is what powers the OMA’s seamless accuracy through a wide range of conditions in the sample.

Example Application: APHA Color Measurement

APHA (the American Public Health Association) provides a common color standard defined by ASTM method D1209 which was first used for wastewater color assessment and has been employed in a variety of industrial processes. This scale is used to quantify the yellowness of the process stream. Each grade in the scale is defined by the color of a specific concentration of standard platinum-cobalt (Pt-Co) solution. The APHA value corresponds to the concentration (ppm) of PtCo in the equivalent standard - see Table 1:

Table 1 — PtCo Stock Solutions and Corresponding APHA Values

PtCo Dilution	Distilled water	500 ppm PtCo
Corresponding APHA Value	APHA 0	APHA 500

Each APHA value has a corresponding absorbance spectral pattern in the visible light wavelength range. This allows the OMA to recognize each shade of yellow by its distinct spectral pattern, as calibrated by the PtCo standards.

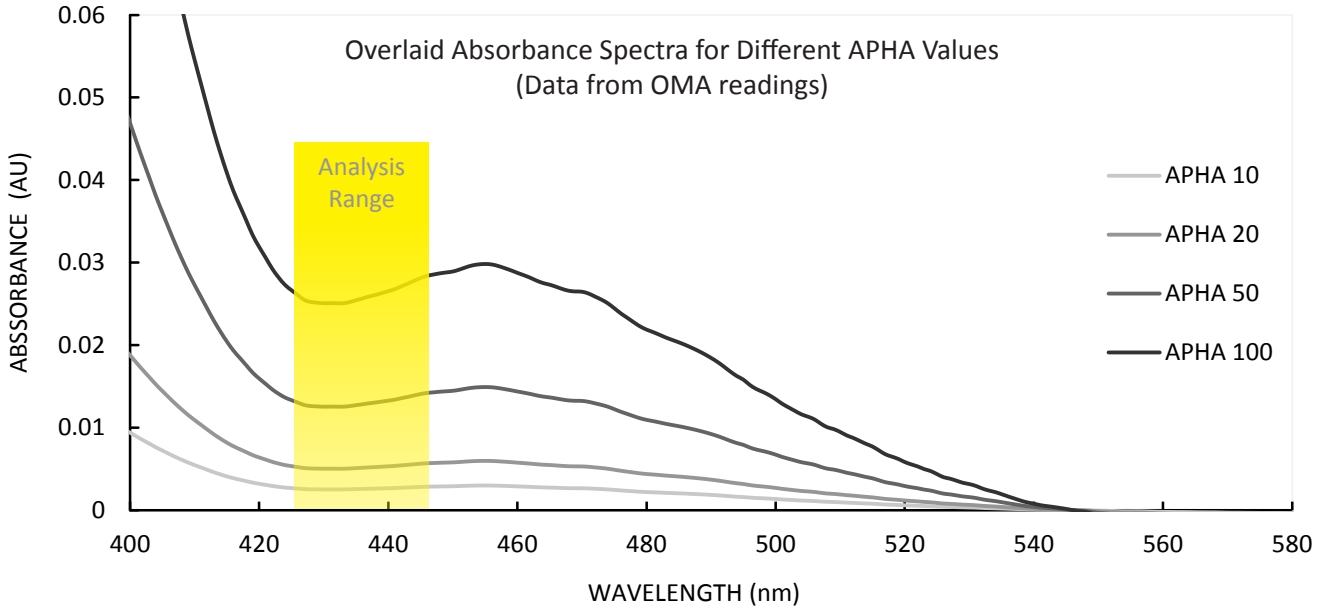

Figure 01

In “Figure 01” the analysis range for APHA color is indicated as 425-445 nm. This is the spectral range that determines the yellowness of the sample.

For this application, the OMA applies a “digital filter” to only consider these measurement wavelngths in the correlation. The filter totals the area under the curve within the range by summing the absorbance from each measurement wavelength.

The major advantage of the digital filter is that the OMA can be repurposed at any time — for a different color scale, a different measurement range, or a different measurement application entirely — all by simple software recalibration.

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The specifications below represent performance of the OMA-300 Process Analyzer in a generic color application.

For technical details about the OMA-300 Process Analyzer, see the data sheet:
http://aai.solutions/documents/AA_DS001A_OMA300.pdf

All performance specifications are subject to the assumption that the sample conditioning system and unit installation are approved by Applied Analytics. For any other arrangement, please inquire directly with Sales.

Application Data	
Performance Specifcations	
Repeatability	±0.5% of scale

Further Reading

Subject	Location
OMA-300 Process Analyzer Data sheet	http://aai.solutions/documents/AA_DS001A_OMA300.pdf
Advantage of Collateral Data Technical Note	http://aai.solutions/documents/AA_TN-202_CollateralData.pdf
Multi-Component Analysis Technical Note	http://aai.solutions/documents/AA_TN-203_MultiComponentAnalysis.pdf

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