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UV-Vis Spectrophotometer UV-1900i Plus

Application News

Using UV-1900i Plus to Evaluate Raw Materials for Chemical Products Based on the Hazen Color Scale

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User Benefits

- The color of liquid raw materials can be quantified in Hazen units.
- The spectral assessment feature in LabSolutions™ UV-Vis Color enables simple evaluation of samples based on the Hazen color scale.

■ Introduction

The ISO 6271:2015[1] and the Japanese Industrial Standard (JIS) K0071-1:2017[2] describe how to measure colors in Hazen units (also called the platinum-cobalt scale or APHA color scale) to evaluate the color of chemical products. The Hazen color scale is used in quality controls and to evaluate the color of samples ranging from colorless or transparent to yellowish. These regulations stipulate preparing platinum-cobalt color standard solutions with 24 different fixed concentrations of potassium hexachloroplatinate (IV) and cobalt (II) chloride hexahydrate that range in color from 0 to 500 Hazen units and then using these standard solutions as reference criteria (Fig. 1). The Hazen unit value of a sample is determined either by visual comparisons against these standard solutions or by performing measurements with a colorimeter.

The prescribed method for measuring Hazen unit values with a colorimeter involves measuring the transmittance of the 24 platinum-cobalt color standard solutions, using these measurements to calculate XYZ tristimulus values, and preparing a calibration curve based on these values. Samples are then measured to calculate their tristimulus values, and the calibration curve is used to find the corresponding standard solution color and Hazen unit value.

LabSolutions UV-Vis Color is an optional software product for LabSolutions UV-Vis that includes a calibration curve created from platinum-cobalt color standard solutions that conform with ISO 6271:2015 and JIS K0071-1:2017. To evaluate a sample based on the Hazen scale, a user just has to analyze the sample, and LabSolutions UV-Vis Color will then calculate the corresponding Hazen unit value.

Fig. 1 Platinum-Cobalt Color Standard Solutions

■ Measuring the Transmission Spectra of Raw Materials for Chemical Products

In this analysis, glycerin and acetylacetone, liquids that are almost colorless and transparent and very difficult to distinguish by visual inspection, were measured (Fig. 2).

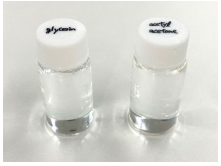

Fig. 2 Glycerin Sample (Left) and Acetylacetone Sample (Right)

Glycerin is used in many applications, including as a polymer and solvent, and its color is used as a parameter in quality controls. JIS K3351:2009 (Glycerines for industrial use)[3] stipulate the Hazen unit value of 20 or below as an appearance criterion for glycerin.

The molecular structure of acetylacetone includes double bonds, and it is known to polymerize when exposed to light. Because it turns increasingly yellow during polymerization, the degree of acetylacetone polymerization can be determined by its color. JIS K8027:2020 (Acetylacetone (Reagent))[4] stipulates the Hazen unit value of 100 or below for the appearance criterion for acetylacetone.

Based on the stipulations of ISO 6271:2015 and JIS K0071-1:2017, the transmittance of glycerin and acetylacetone was measured using pure water as a control and a cell with an optical path length of 50 mm. To perform measurements with a 50-mm optical path length cell, a long optical path cell holder was attached to the UV-1900i Plus UV-Vis spectrophotometer. The UV-1900i Plus system used to perform these measurements is shown in Fig. 3.

Fig. 3 UV-1900i Plus

Glycerin and acetylacetone were analyzed using the conditions shown in Table 1 and the resulting transmittance spectra are shown superimposed in Fig. 4. Since ISO 6271:2015 and JIS K0071-1:2017 stipulate using pure water as a control, a cell with pure water was used for baseline correction before the transmittance of the sample liquids was measured.

Table 1 Conditions for Transmission Spectra Measurement

Equipment:	UV-1900i Plus Long-path rectangular cell holder
Measured Wavelength Range:	380 to 780 nm
Sampling Interval:	1.0 nm
Scanning Speed:	Fast
Slit Width:	1 nm

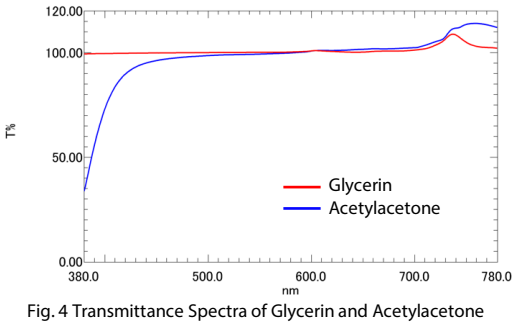

Fig. 4 Transmittance Spectra of Glycerin and Acetylacetone

Glycerin exhibited strong transmittance at wavelengths between 380 and 780 nm and acetylacetone weak transmittance at wavelengths below 500 nm (Fig. 4). Transmittance was over 100 % for both samples between 700 and 780 nm. This was because pure water was used as the control. (Sample transmittance can exceed 100 % at wavelengths where it is higher than the transmittance of pure water and at wavelengths that are absorbed by pure water.)

■ Evaluating Raw Materials for Chemical Products Based on the Hazen Scale

A Hazen scale-based evaluation (Hazen color test) was performed using LabSolutions UV-Vis Color, an optional software product for LabSolutions UV-Vis. LabSolutions UV-Vis Color includes a built-in calibration curve created by measuring 24 standard solutions with Hazen unit values between 0 and 500 in a 50-mm cell as described in ISO 6271:2015 and JIS K0071-1:2017 (Fig. 5).

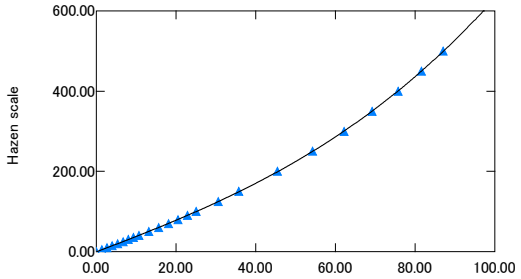

Fig. 5 Calibration Curve for Calculating Hazen Unit Values

A Hazen scale-based evaluation is performed by loading the Hazen Unit template file in the configuration window of the spectral assessment feature. Fig. 6 shows the window where advanced settings are configured for a Hazen scale-based evaluation. This window is used to configure the number of decimal places that are displayed and the pass/fail conditions. The red box in Fig. 6 shows the conditions for pass/fail (pass if ≤ 20 on the Hazen scale) that are configured according to the JIS K3351:2009 standard for industrial use glycerin.

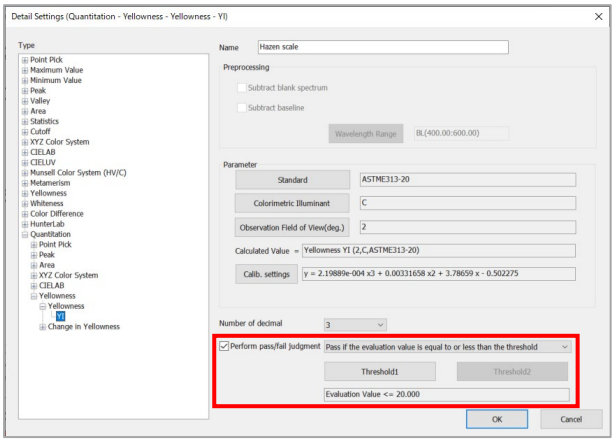

Fig. 6 Advanced Settings Window for Hazen Scale-Based Evaluation

Once the pass/fail conditions for the Hazen scale-based evaluation are entered, clicking the OK button displays the evaluation table. After the transmission spectrum of a liquid sample has been loaded into the evaluation table, the software calculates the Hazen unit value and displays a pass or fail judgment based on the configured pass/fail criteria (Fig. 7).

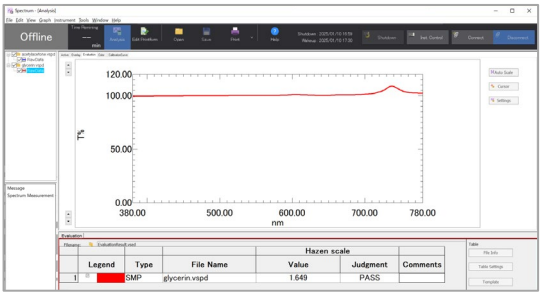

Fig. 7 Hazen Scale-Based Evaluation Table

The Hazen scale-based evaluation of the glycerin and acetylacetone samples, based on their respective transmittance spectra and according to JIS K3351:2009 and JIS K8027:2020, found that both met their respective criterion for appearance (Figs. 8 and 9).

	Hazen scale		
File Name	Value	Judgment	Comments
glycerin.vspd	1.649	PASS	

Fig. 8 Hazen Scale-Based Evaluation of Glycerin Sample
(pass if ≤ 20 on the Hazen scale)

	Hazen scale		
File Name	Value	Judgment	Comments
acetylacetone.vspd	16.980	PASS	

Fig. 9 Hazen Scale-Based Evaluation of Acetylacetone Sample
(pass if ≤ 100 on the Hazen scale)

Comparing the lower Hazen unit value for the glycerin sample (1.649) to the acetylacetone sample (16.980) showed that the glycerin sample was closer to a colorless, transparent solution. As described above, Hazen units can be used to quantitatively evaluate chromatic differences between liquid samples that cannot otherwise be determined by visual inspections.

■ Conclusion

The transmittance spectra of glycerin and acetylacetone, two materials used in chemical production, were measured and used to calculate the Hazen unit values and evaluate the materials. It was found that both samples met the criteria for external appearance stipulated by ISO and JIS. The Hazen units calculated by this analysis also identified a very slight difference in color between the samples.

LabSolutions UV-Vis Color includes a calibration curve for calculating Hazen unit values, allowing the user to calculate Hazen unit values just by measuring sample transmittance without measuring the transmittance of numerous standard samples.

Although this case study used ISO's and JIS's Hazen scale criteria, many other standards, such as ASTM D1209-05(2019)[5], also use the Hazen scale as evaluation criteria. When performing an evaluation based on any of these standards, verifying that these standards are the latest versions of those standards is recommended.

<References>

1. ISO 6271:2015 Clear liquids — Estimation of colour by the platinum-cobalt colour scale
2. JIS K0071-1:2017 Test methods for colour of chemical products—Part 1: Estimation of colour in Hazen units (platinum-cobalt colour scale)
3. JIS K3351:2009 Glycerines for industrial use
4. JIS K8027:2020 Acetylacetone (Reagent)
5. ASTM D1209-05(2019) Standard Test Method for Color of Clear Liquids (Platinum-Cobalt Scale)

<Related Application News Articles>

1. Using UV-2600i Plus to Evaluate Ultraviolet-Degraded Plastics Based on the Hazen Color Scale
   Application News No. 01-00835-EN

01-00834-EN First Edition: Feb. 2025

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