COLOR (Spectrophotometric)

PRINCIPLE

When the light passes through a solution, certain bands of the spectrum may be absorbed while others are transmitted. The relative amounts of the various transmitted bands provide the visual sensation of color. By using a spectrophotometer as a source of monochromatic light, color and brightness can be specified by measuring the light transmitted by the sample at selected wavelengths (Note 1).

SCOPE

The method applies to crude, semi-refined and refined oils derived from corn or grain sorghum, which are substantially optically clear. It does not apply to liquids having dominant wavelengths which vary significantly from 575 nm (Note 2).

SAFETY

Follow good laboratory practices throughout.

SPECIAL APPARATUS

1. Spectrophotometer: An instrument capable of continuously variable wavelengths in the visible spectrum and designed to permit cell depths of at least 4 cm. A special absorption cell carrier is needed to use 2 × 4 cm absorption cells.

2. Sample Cells: 2 × 4 cm rectangular absorption cells of optically clear glass, with open tops for easy filling and cleaning, are recommended. Cells should have matching transmittance values (± 0.5% T) under the test conditions recommended by the manufacturer.

PROCEDURE

Filter samples of crude oil, measure 10.0 mL in a graduated cylinder, dilute to 100 mL with hexane, and mix thoroughly (dilution factor = 10) (Note 3). For
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semirefined and refined oils, determine color of original sample (dilution factor = 1).

Fill a clean absorption cell (Note 4) with purified water, and fill another with the sample to be tested (Note 5). Place both absorption cells in the special carrier so that the light beam passes through the 4-cm cell path (Note 6).

Set the wavelength scale at 450 nm, and calibrate according to the manufacturer's instruction. Obtain the transmittance (% T) of the sample at 450, 550 and 600 nm.

CALCULATION

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\text{Color} = \frac{(\log \% T \text{ at } 600 \text{ nm} - \log \% T \text{ at } 450 \text{ nm} \times DF^*)}{\text{Cell Length (cm)}}
\]

\[
\text{Brightness (Note 7)} = \text{Antilog}[2 = \frac{(2 - \log \% T \text{ at } 550 \text{ nm} \times DF^*)}{\text{Cell Length (cm)}}]
\]

*DF = Dilution Factor

NOTES AND PRECAUTIONS

1. This method was adopted after examination of the C.I.E. (Commission Internationale de l'Eclairage) color specification procedure which describes the primary visual stimuli-dominant wavelength, purity and luminance (luminous transmittance or reflectance). "Dominant wavelength" is that property by which the eye differentiates hue or color type. "Purity" is a measure of color concentration or saturation with respect to a pure spectral standard. "Luminance" expresses the percentage of total incident energy which is perceived by the eye as transmitted or reflected. "Luminance," sometimes referred to as brightness or brilliance, is indicated on a scale between 0 and 100 representing absolute black and perfect white, respectively.

Those interested in more comprehensive examination of the C.I.E. color specification method are referred to: "Handbook of Colorimetry" (Arthur C. Hardy, The Technology Press, Massachusetts Institute of Technology,
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Cambridge, Mass. 1936), and "The Science of Color" (Optical Society of America, Committee on Colorimetry, Thomas Y. Crowell Company, New York, 1953).

Although C.I.E. values are objective, accurate and internationally reproducible, the method is laborious or requires costly equipment. Therefore, the simplified method described herein was developed.

2. Dominant wavelengths or hues of corn oils are relatively constant, varying from about 570 nm to 580 nm at concentrations suitable for spectrophotometric analysis. This factor is responsible for the precise correlations existing between C.I.E. color specifications (purity and luminous transmittance) and values obtained by this method (color and brightness).

3. Solution concentrations are selected at convenient values to obtain transmittances in the most accurate range of the instrument. Application of the dilution factor provides solution color values corresponding to those of the original samples.

4. Clean absorption cells with detergent and warm water. Remove iron stains with dilute hydrochloric acid and grease films with cleaning solution. Absorption cells should be dry and free of fingerprints on outside surface through which the light beam passes.

5. Avoid introduction of air bubbles when filling absorption cells because they reduce light transmission.

6. The proposed sample concentrations may occasionally yield a 4-cm transmittance below 20% at 450 nm. In such cases the transmittance may be determined with a 2-cm cell path.

7. Brightness is the calculated transmittancy (% T) at 550 nm of a 1-cm column of sample at original concentration.